

Politecnico di Torino

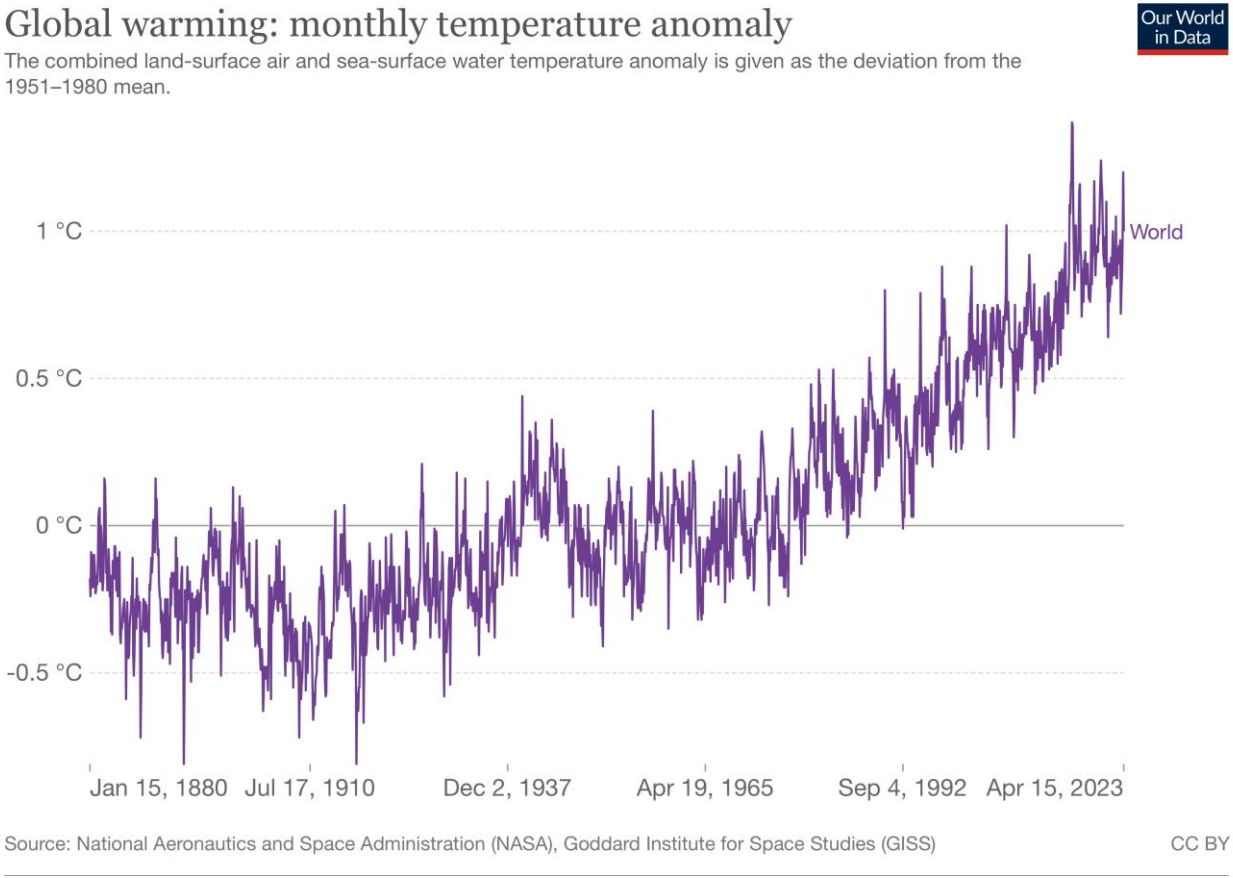
PoliTO Sostenibile

Le città di fronte alla sfida climatica: strumenti di lavoro ed esperienze in corso

Patrizia Lombardi

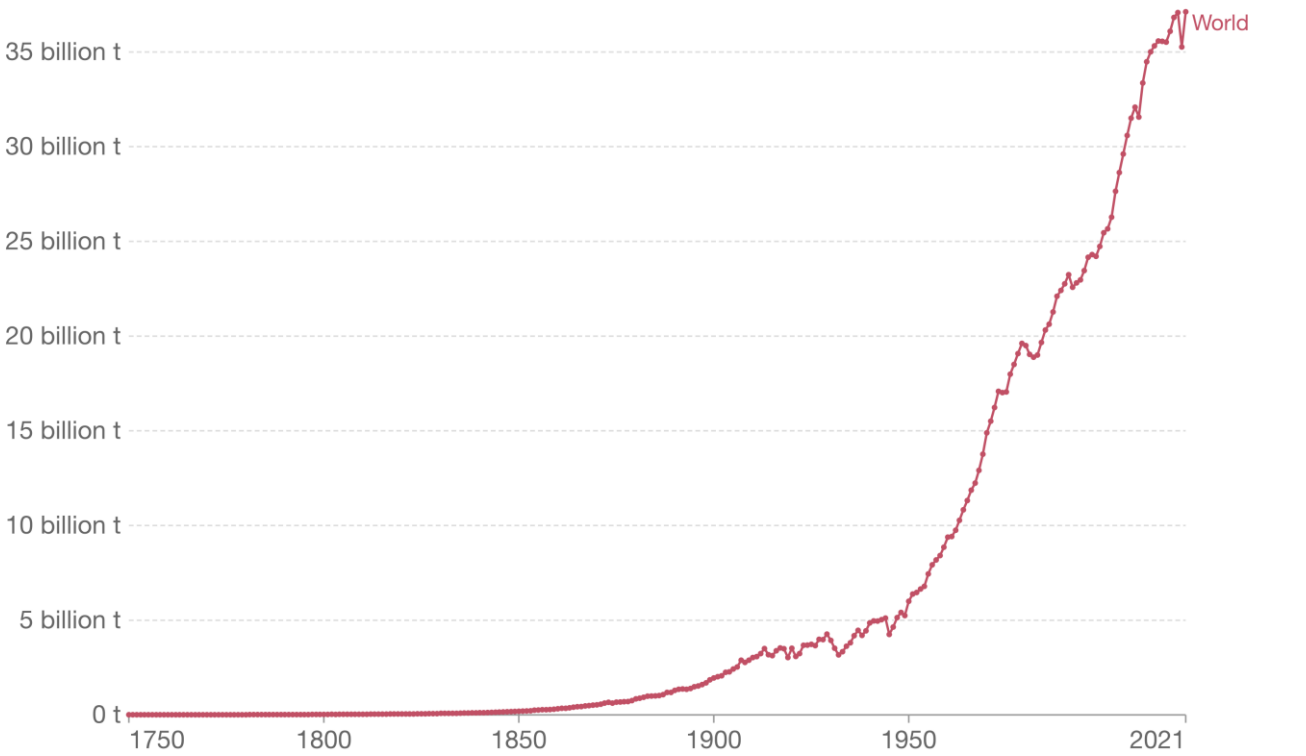
Vice-rettrice per campus sostenibile e living lab

Più di un secolo di uso di combustibili fossili, energia e risorse ha portato a un riscaldamento globale di **oltre 1,1°C rispetto ai livelli preindustriali.**



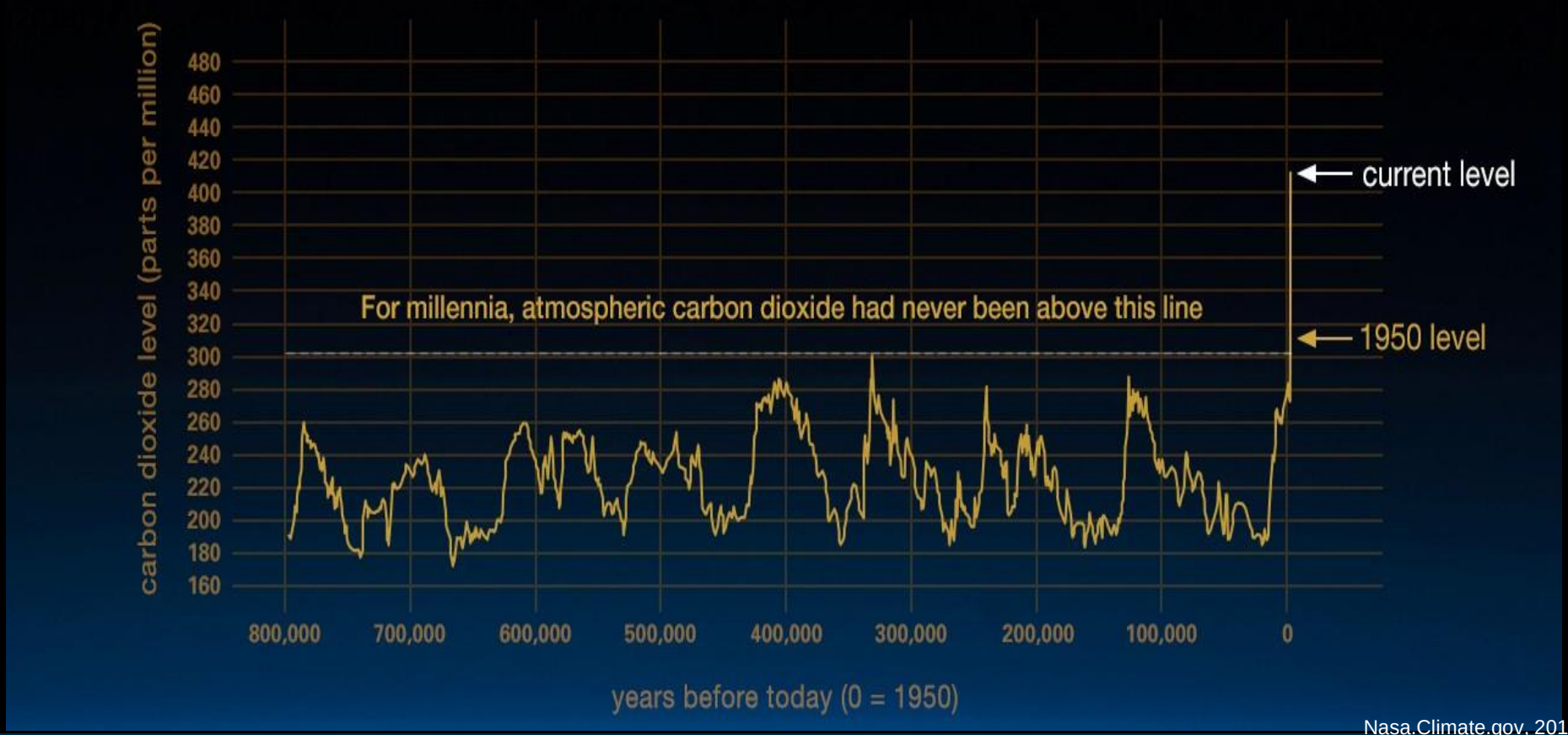
Annual CO_2 emissions

Carbon dioxide (CO_2) emissions from fossil fuels and industry[1] . Land use change is not included.



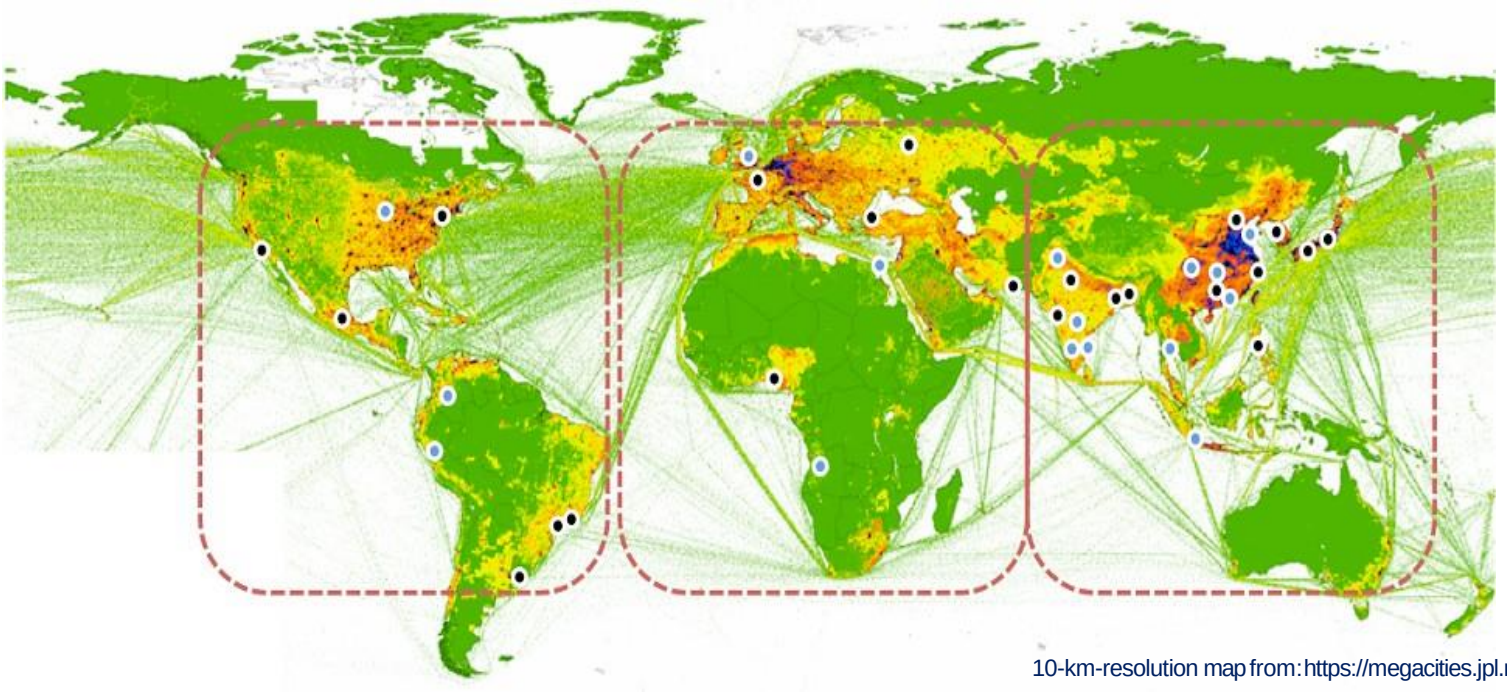
Source: Our World in Data based on the Global Carbon Project (2023)

OurWorldInData.org/co2-and-greenhouse-gas-emissions • CC BY



Nasa.Climate.gov, 2019

Fonti di emissioni di CO_2 da fonti fossili : distribuzione e intensità



10-km-resolution map from: https://megacities.jpl.nasa.gov/

Le città occupano solo il 3% della superficie terrestre, ma ospitano più del 50% dei cittadini e sono le maggiori responsabili delle emissioni globali di gas serra.

Consumo:

75% of natural resources

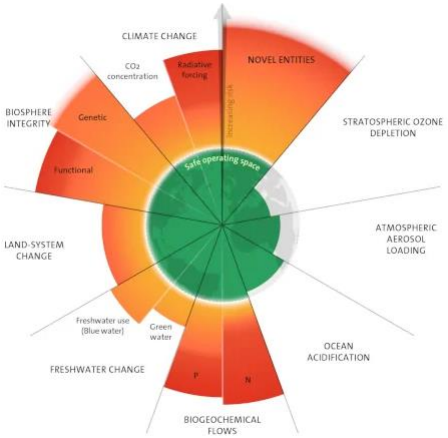
67-76% of energy

Produzione :

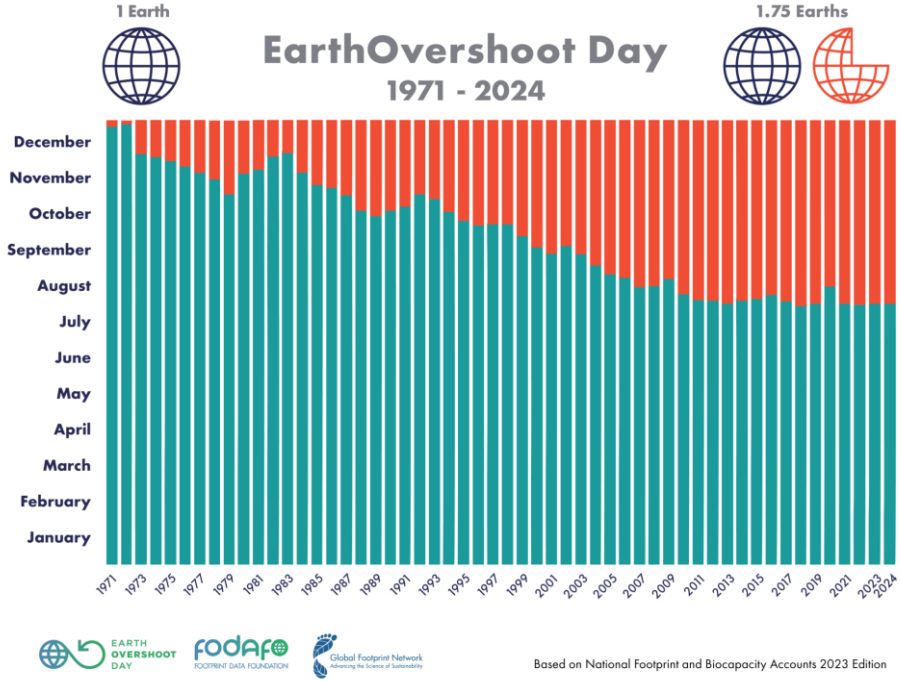
50% of waste

71-76% of energy-related GHG emissions.

6 dei 9 limiti planetari sono già compromessi. Stiamo esaurendo le risorse del pianeta

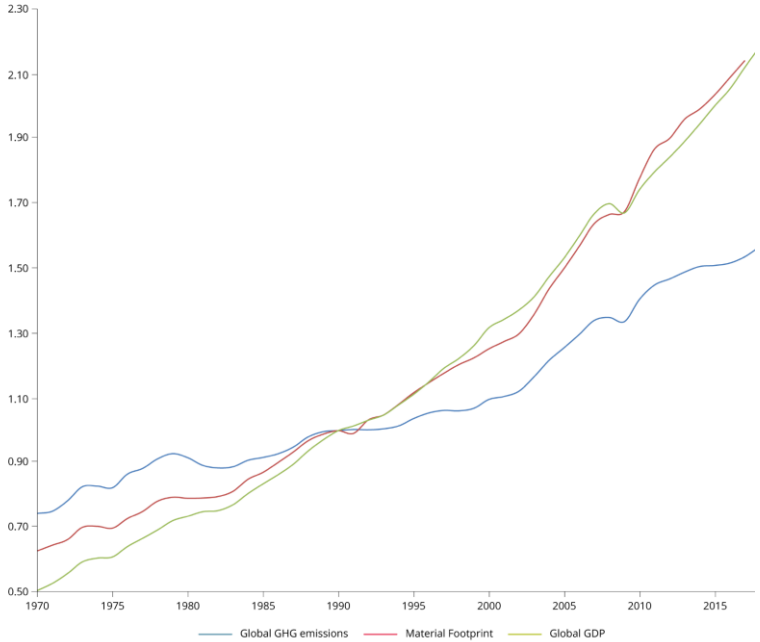


- Cambiamento climatico
- Perdita di Biodiversità
- Ciclo dell'azoto e del fosforo
- Inquinamento da sostanze chimiche
- Modifica del sistema agrario
- Utilizzo delle acque dolci
- Acidificazione degli oceani
- Riduzione dello strato di ozono
- Aerosol

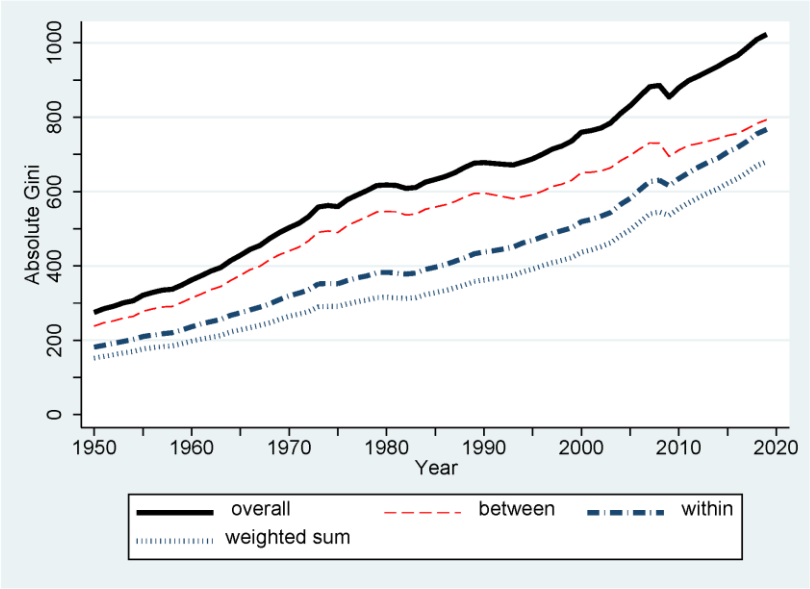


Fonte: Johan Rockström dello Stockholm Resilience Centre e Will Steffen dell'Australian National University

Non si tratta di frenare la crescita economica ma di disaccoppiare questa pericolosa correlazione…

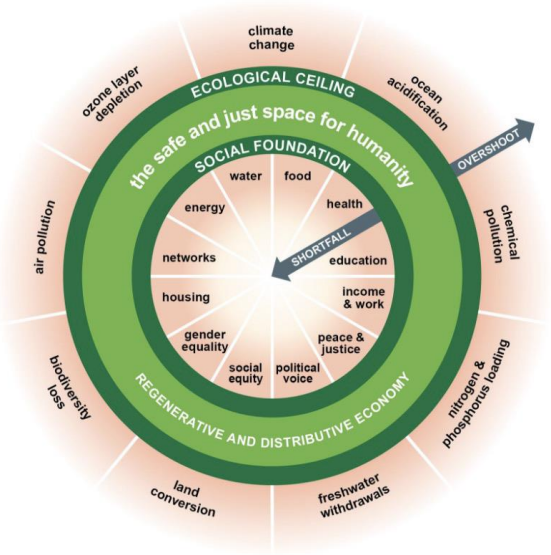


Sources: Modified from Wiedmann et al. (2020).



Note: Absolute Gini/1000. Weighted sum is average index across countries weighted by population.
Source: Gradin (2021),

Puntando a un’economia rigenerativa e circolare, che riconosce le interconnessioni e le dipendenze



Kate Raworth

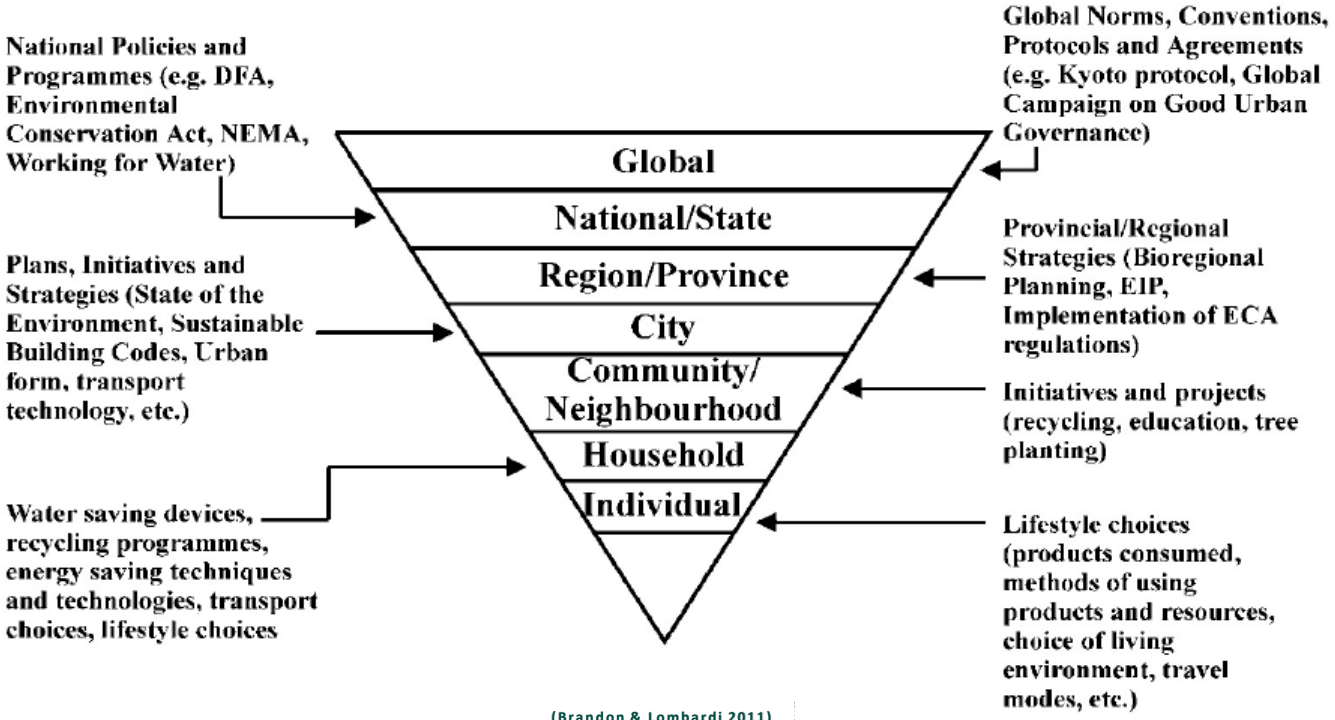


Ellen MacArthur Foundation



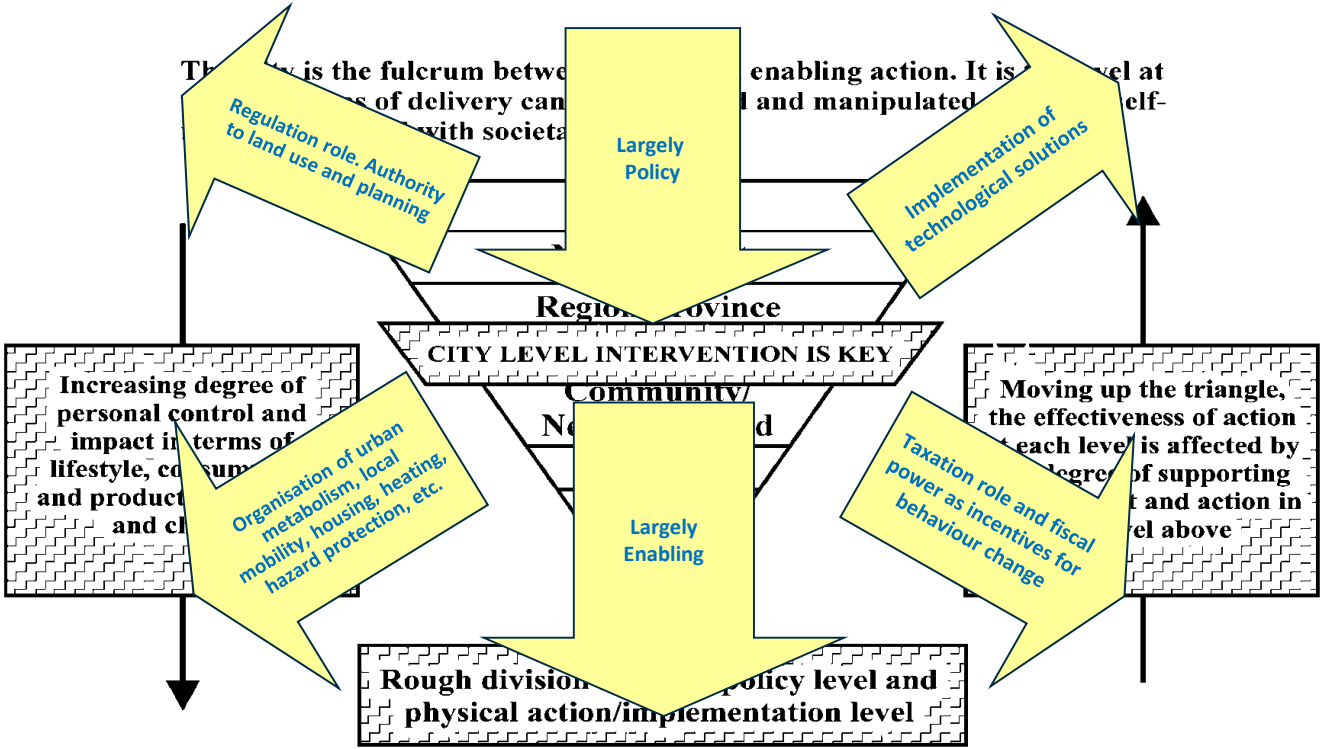
Stockholm Resilience centre

Livelli decisionali



(Brandon & Lombardi 2011)

Il ruolo cruciale delle città



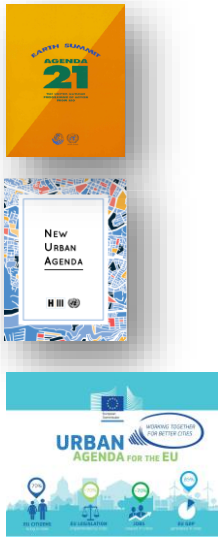
(Brandon & Lombardi 2011)

Impatto sull'Agenda 2030

«It is in cities that the battle for sustainability will ultimately be won or lost», U.N Deputy Secretary-General Jan Eliasson

TAPPE SUSTAINABLE CITIES

- **1987**: Our common future (Brundtland)
- **1992**: Agenda 21
- **1996**: Habitat Agenda Instanbul declaration
- **2015**: Agenda 2030
- **2016**: New Urban agenda – Quito declaration
- **2019** – The European Green Deal
- **2022** – The European Green Deal goes local



Circa **il 65% dell'agenda globale** non può essere pienamente senza il coinvolgimento delle città.

Circa **un terzo degli indicatori** può essere misurato a livello locale.

Anche se gli SDGs sono OBIETTIVI GLOBALI, richiedono il **coinvolgimento di tutti gli stakeholder**. Le azioni locali possono avere un elevato impatto su scala globale.

SDG indicators
United Nations Global SDG Database

IAEG-SDGs —SDG Indicators (un.org)

Impatto sul clima

L'Unione Europea (UE) si è impegnata a ridurre le emissioni nette del **57% entro il 2030** (rispetto ai livelli del 1990), con l'inclusione di obiettivi di uso del suolo e di sequestro del carbonio.

Questa azione per il clima sarà guidata da **100 città degli Stati membri dell'UE** che si sono impegnati a raggiungere la neutralità climatica entro il 2030.





EU MISSIONS



100 Climate-neutral and smart cities by 2030

Garantire che queste città agiscano come hub di sperimentazione e innovazione per mettere tutte le città europee in grado di diventare neutrali dal punto di vista climatico entro il 2050.

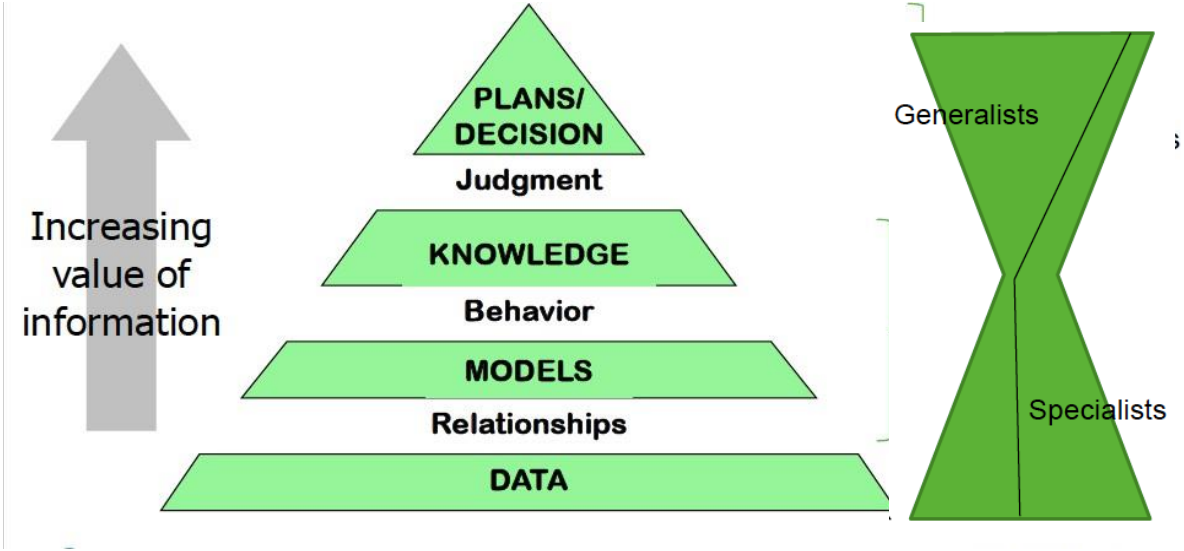






COME ?

Aumentando il valore delle informazioni



Adapted from Ullman 2010

Alcuni strumenti utili

1. **GIS (*Geographic Information Systems*)**
   - Utilizzare GIS per analizzare e **visualizzare dati spaziali e supportare la pianificazione e la gestione urbana**.
   - GIS può essere utilizzato per la mappatura del suolo, l'analisi delle infrastrutture e la gestione delle risorse.
2. **Modelli di Simulazione Urbana e di supporto alla decisione**
   - Strumenti di ***decision support systems***, cruscotti per prevedere gli impatti delle decisioni di pianificazione e valutare **scenari di sviluppo urbano.**
   - **Digital twin urbani**
3. **Certificazioni di Sostenibilità**
   - Applicare standard e certificazioni come LEED for Neighborhood Development, BREEAM Communities, il **framework SNTool** per la valutazione della sostenibilità urbana
4. **Partecipazione della Comunità**
   - Strumenti per il coinvolgimento della comunità come **workshop, consultazioni pubbliche e piattaforme digitali** per raccogliere input dai cittadini.
   - Utilizzare processi partecipativi per assicurare che la pianificazione risponda alle esigenze della comunità.

Schema di processo decisionale (DM)

PCM
Project cycle management

Identification of the DMs and definition of the objectives

Construction of the problem space

Problem Framing

Discussion between DMs and stakeholders for constructing a vision



Generation of the scenarios

Evaluation of the scenarios

Scenario Building





Risk and uncertainty management and final decision
Preparation of the operational strategies

Problem Solving

DALLA DIAGNOSI ALLA COSTRUZIONE DEGLI SCENARI

Analisi critica del contesto territoriale per l'impostazione del Progetto

1

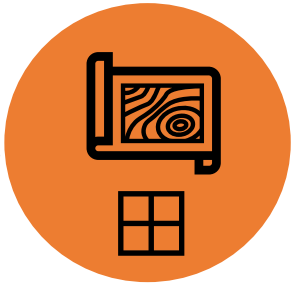
PCM

Stakeholder Analysis

Problem Analysis

Objective analysis

2



DIAGNOSI del territorio

Mapping
Database
GIS maps

3



Selezione KPIs

Delphi method

Playing cards method

Scenario futuro

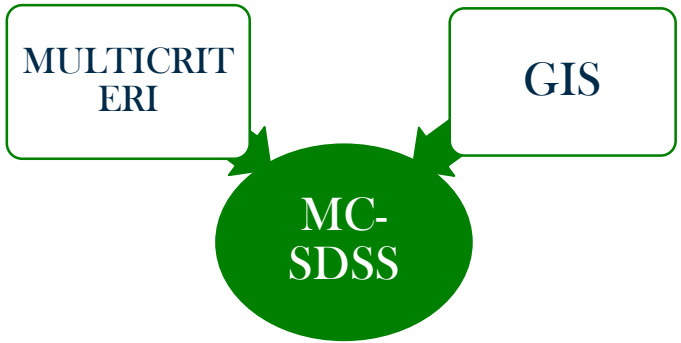
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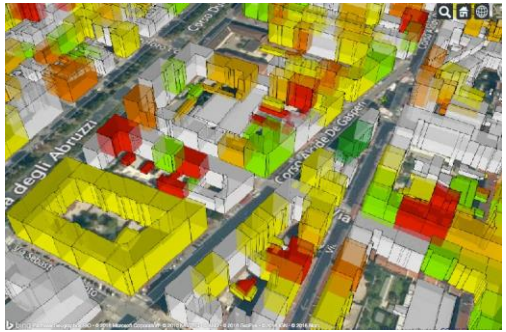


Costruire lo scenario migliore per indirizzare le strategie di sviluppo sostenibile

Spatial Decision Support Systems

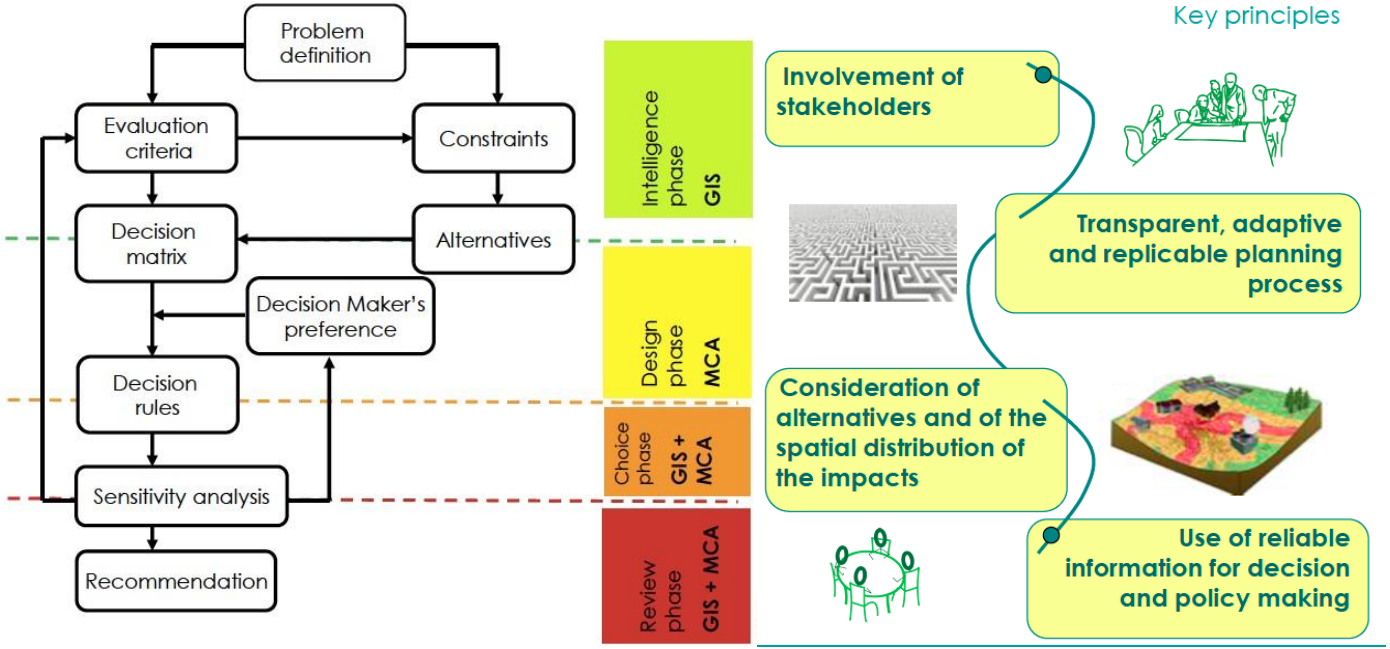
Due to the complexity of decision-making problems, appropriate **spatial visualisation approaches** based on new information and **artificial intelligence technologies** are needed to support decision-making and **empower stakeholders**.





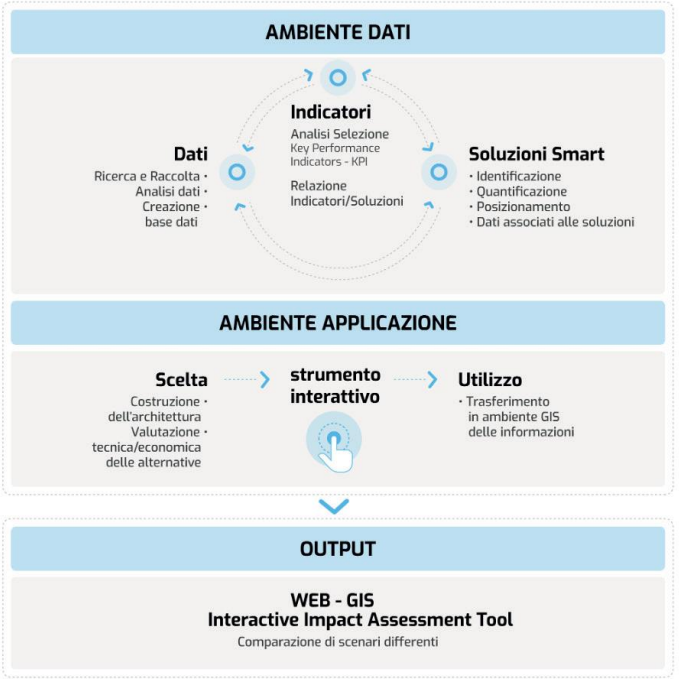


Fasi di sviluppo di uno SDSS



SDSS per progetti di smart city real estate

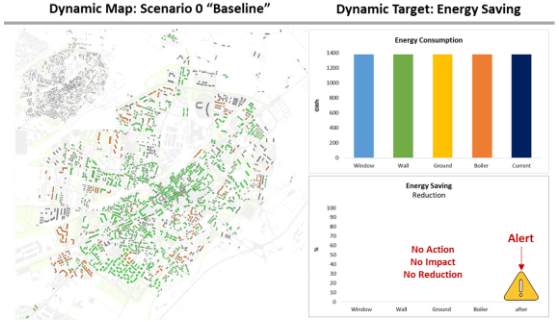


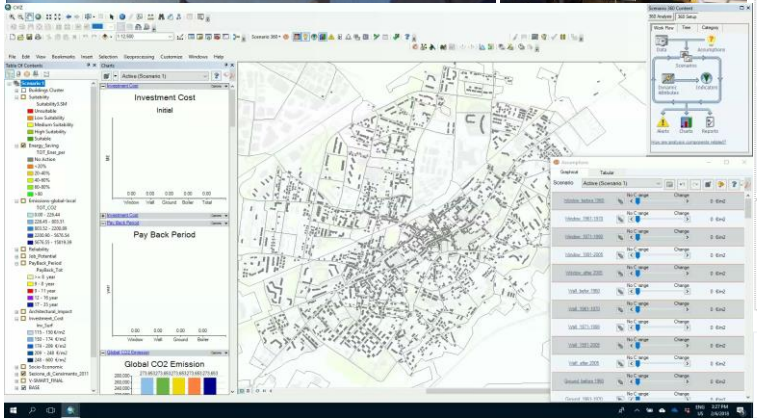


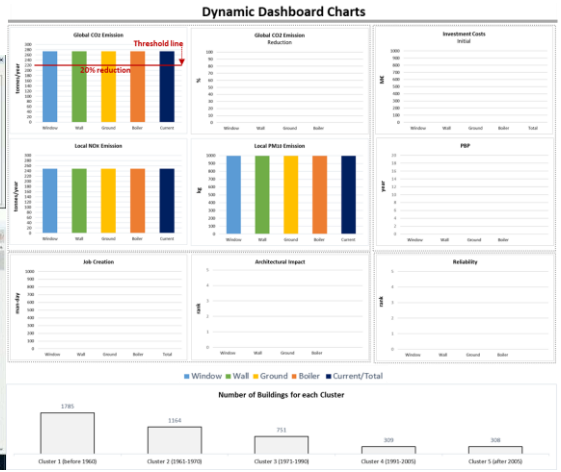


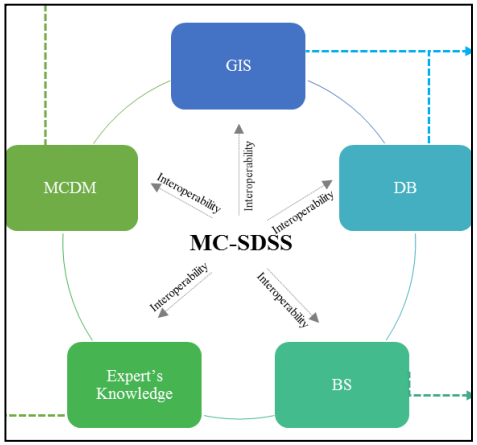


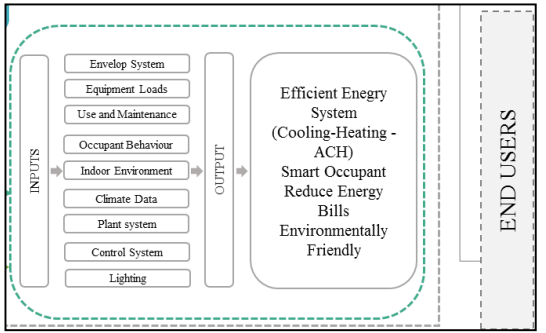










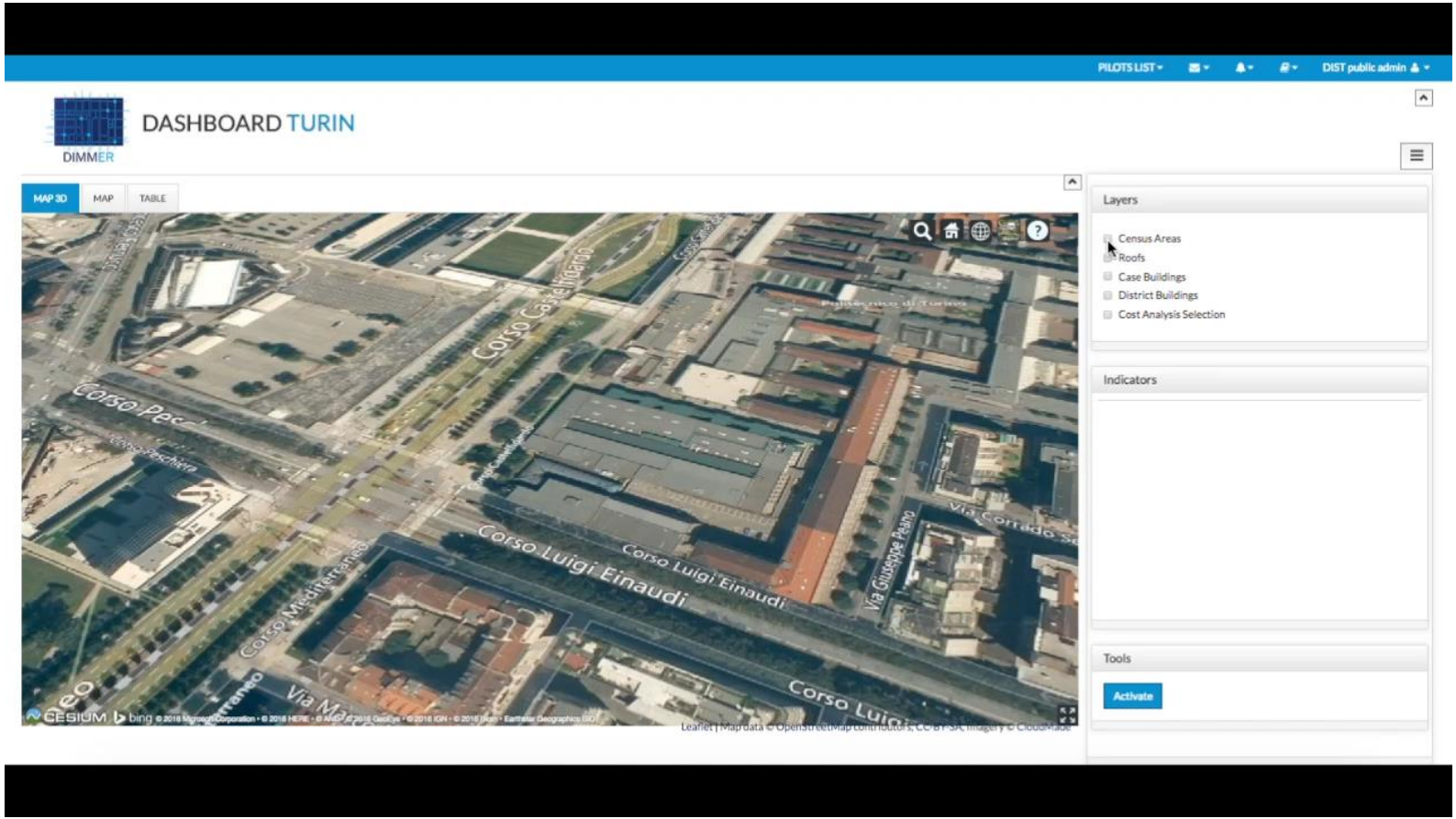


EEB Cluster - Zero Energy Buildings in Smart Urban Districts

Torabi Moghadam, S. e Lombardi, P. (2019). An interactive multi-criteria spatial decision support system for energy retrofitting of building stocks using CommuntiyVIZ to support urban energy planning, in «Building and Environment», 163, p. 106-233.

Politecnico di Torino

Esempio di cruscotto





ESPERIENZE

Progetti ed esperienze



MOLOC

Low Carbon Urban Morphologies (MOLOC) Interreg Europe
Duration: 2017-2021



GREEN-INN

CIRCGREEN-INN– **Growing Effective & Equitable Nature-based Solutions through Inclusive Climate Actions**
DUT - project
2024-26



POLITO SOSTENIBILE

Sustainable campus office
Green team, Politecnico di Torino
2019- on-going

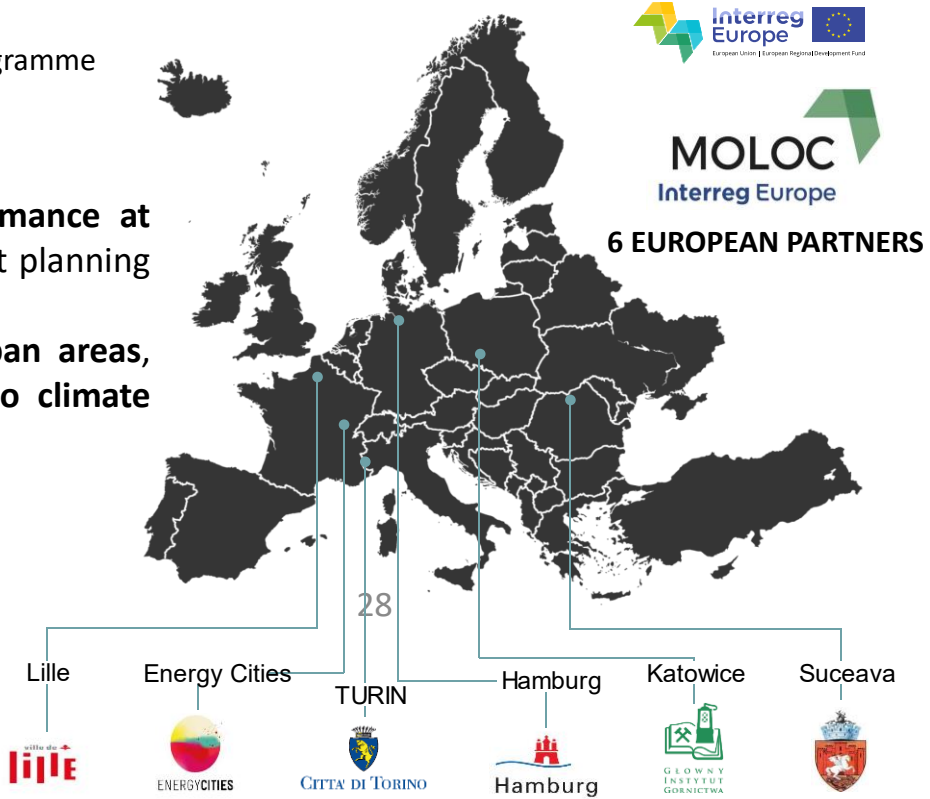
MOLOC PROJECT (MOrphologies LOw Carbon)

This project has received funding from Interreg Europe 2014-2020 Programme

GENERAL AIM

- To develop an assessment of the **sustainability performance at urban level** and propose a **future scenario** to support planning processes
- Identify good practices for the development **of urban areas**, with the widest purpose of achieving **adaptation to climate change and promoting energy transition processes.**

The City of Turin with the support of DIST-PoliTO took the opportunity of **MOLOC Project** to create a decision support tool and share its experience with others urban contexts to generate good practices.



METHODOLOGY

1 **Selection and validation of KPI indicators**

Progressive selection from **178** CEBSA MED Generic Framework **INDICATORS** of sustainability performance

1. Preliminary selection
2. Hierarchy
3. Final selection
4. Validation

2 **Impact assessment of indicators and evaluation of the sustainability performance level for the baseline scenario**

Measuring indicators with **GIS software**

ArcGIS Pro

ArcGIS

Cataloguing and identify unique synthesis values for each indicators

Implementation of decision making model **SNTool** (CESBA MED)

3 **Definition of a potential urban transformation scenario and evaluation of its sustainability performance level**

Analysis and synthetic interpretation of the territory

- Improvement Targets
- Strategic Framework and actions

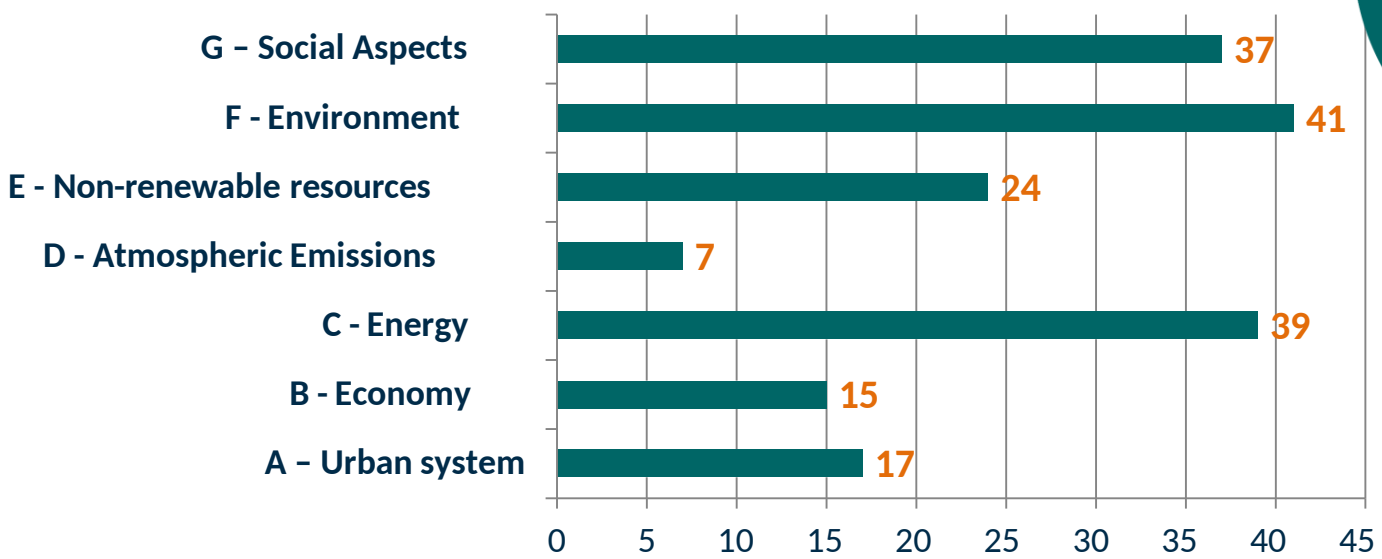
Implementation of decision making model **SNTool** (CESBA MED)

4 **Creation of an interactive storytelling dashboard**

Define the storytelling of the project using ArcGIS storymap

Define a dashboard for each indicator to facilitate the reading and interpretation of the data

Framework per la selezione degli indicatori





CESBA - Common European Sustainable Built Environment Assessment

Pignatelli, Maurizia; Torabi Moghadam, Sara; Genta, Chiara; Lombardi, Patrizia (2023)
Spatial decision support system for low-carbon sustainable cities development: An interactive storytelling dashboard for the city of Turin. In: SUSTAINABLE CITIES AND SOCIETY, vol. 89,

RESULTS

1 Selection and validation of KPI indicators

Pignatelli et al., 2023

178 **INDICATORS**

24

Participative decision process

12

Final selection



Workshop



June 11, 2019

The participants were divided into 2 GROUPS. Everyone has applied the **multi-criteria analysis methodology SRF** - "PLAYING CARDS" to identify and sort INDICATORS by priority

RESULTS

2 Impact assessment of indicators

Pignatelli et al., 2023

COMMON MEASUREMENT METHODOLOGY FOR THE 8 INDICATORS:

I. Data collection

II. Data spatialization on GIS software ArcGIS ArcGIS Pro

III. Data analysis, thematic MAPS and export results

IV. Processing the results and synthesizing the value of the indicator

The processes and the results have been collected in **8 cards**

CARDS

Quality of land	Intermodality urban facilities	Total final thermal energy consumption for residential building operations	Total final electric energy consumption for residential building operations	GHG emissions from energy used for all purposes in residential building operations	Air quality respect to particulates <10 mu	Albedo	Availability and proximity of key public human services to residential building
0,59 nr	2,46 nr	89 kWh/m2/year	31 kWh/m2/year	21,7 kgCO_2eq/m2/year	30 µg/m3/medio year	45 %	63 %

RESULTS

Pignatelli et al., 2023

2 Evaluation of the sustainability performance level for the baseline scenario

DECISION - MAKING MODEL IMPLEMENTATION

Outcomes:

- ENERGY
- SOCIAL ASPECT
- ATMOSPHERIC EMISSION
- BUILT URBAN SYSTEM
- ENVIRONMENT

Main critical issues that afflict the sustainability performance

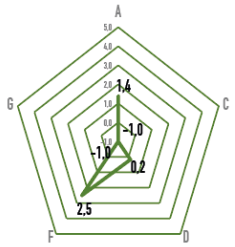
Higher scores

CESBA MED Passport

CESBA
Common European Sustainable Building Assessment

ISSUE	SCORE	WEIGHT
BUILT URBAN SYSTEM	1,4	15%
ENERGY	-1	35%
ATMOSPHERIC EMISSION	0,2	21%
ENVIRONMENT	2,5	22%
SOCIAL ASPECT	-1	7%
TOTAL SCORE	0,4 LOW - MINIMUM	

5	ECCELLENTE
4	OTTIMO
3	BUONO
2	DISCRETO
1	SCARSO
0	MINIMO
-1	NEGATIVO

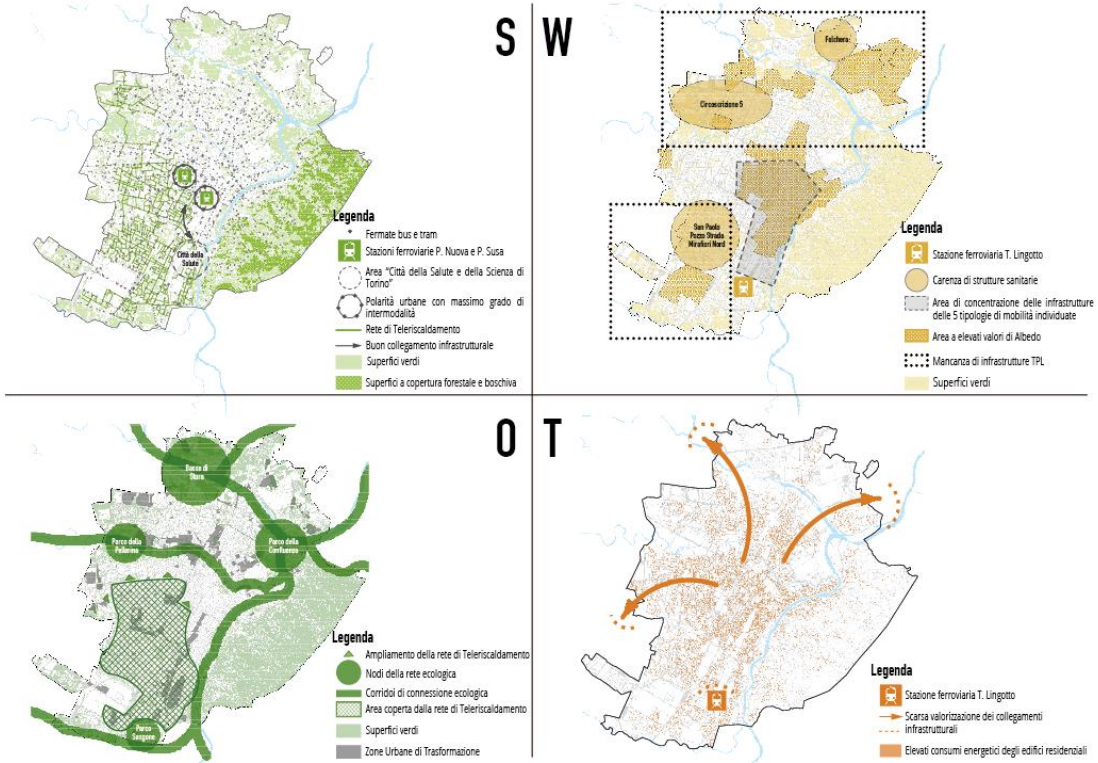


RESULTS

Pignatelli et al., 2023

3 Analysis and synthetic interpretation of the territory

- **URBAN SYSTEM** issue (land quality and urban transport system) shows significant potentiality, but also appreciable shortcomings.
- High **ENERGY CONSUMPTION** and mainly old building stock:
  - -Expensive and lengthy efficiency interventions
  - + Development of Energy Communities
  - + European Funds for energy requalification
  - + The district heating network is expanding
- Trends show a progressive decrease of **EMISSIONS** from residential buildings, especially emissions from electricity consumption thanks to the **diffusion of technologies that exploit renewable sources.**
- **PM10:** Turin counts the highest number of days exceeding the permitted concentration thresholds. However, the data show an annual average concentration lower than the benchmark threshold.
- The shortcomings related to the availability of **BASIC SERVICES** for some areas are also caused by a low accessibility.
- Regeneration and temporary uses can make up for the lack of services.



RESULTS

Pignatelli et al., 2023

3 Built the future scenario

1. SW / OT — Analysis, assessment and interpretation of baseline scenario
2. Interviews with expert stakeholders
3. Regulatory framework analysis
4. Research group meetings

FORWARD LOOKING SCENARIO
SHORT-MEDIUM TERM

IMPROVEMENT TARGETS

	1	2	3	4	5	6	7	8
	Quality of land	Intermodality urban facilities	**Total final thermal** energy consumption for residential building operations	**Total final electric energy** consumption for residential building operations	GHG emissions from energy used for all purposes in residential building operations	Air quality respect to particulates <10 mu	**Albedo**	Availability and proximity of key public human services to residential building
	0,59 nr	2,46 nr	89 kWh/m²/anno	31 kWh/m²/anno	21,7 $kgCO_2eq/m^2$/anno	30 µg/m³/medio anno	45 %	63 %
	0,65 nr	**3,8 nr**	**53,4 kWh/m²/anno**	**20 kWh/m²/anno**	**17,3 $kgCO_2eq/m^2$/anno**	**20 µg/m³/medio anno**	**53 %**	**70 %**

RESULTS

Pignatelli et al., 2023

3 Built the future scenario

Strategic Framework

BUILT URBAN SYSTEM

- Soil consumption “0”
- Declination of resilience and climate adaptation concepts in planning tools
- Instrument flexibility and introduction of SEA processes in urban and territorial plans

ENERGY

- Energy efficiency
- Use of renewable sources
- “Energy Communities”
- Management, knowledge and monitoring of consumption
- Energy certification of residential buildings

ATMOSPHERIC EMISSION

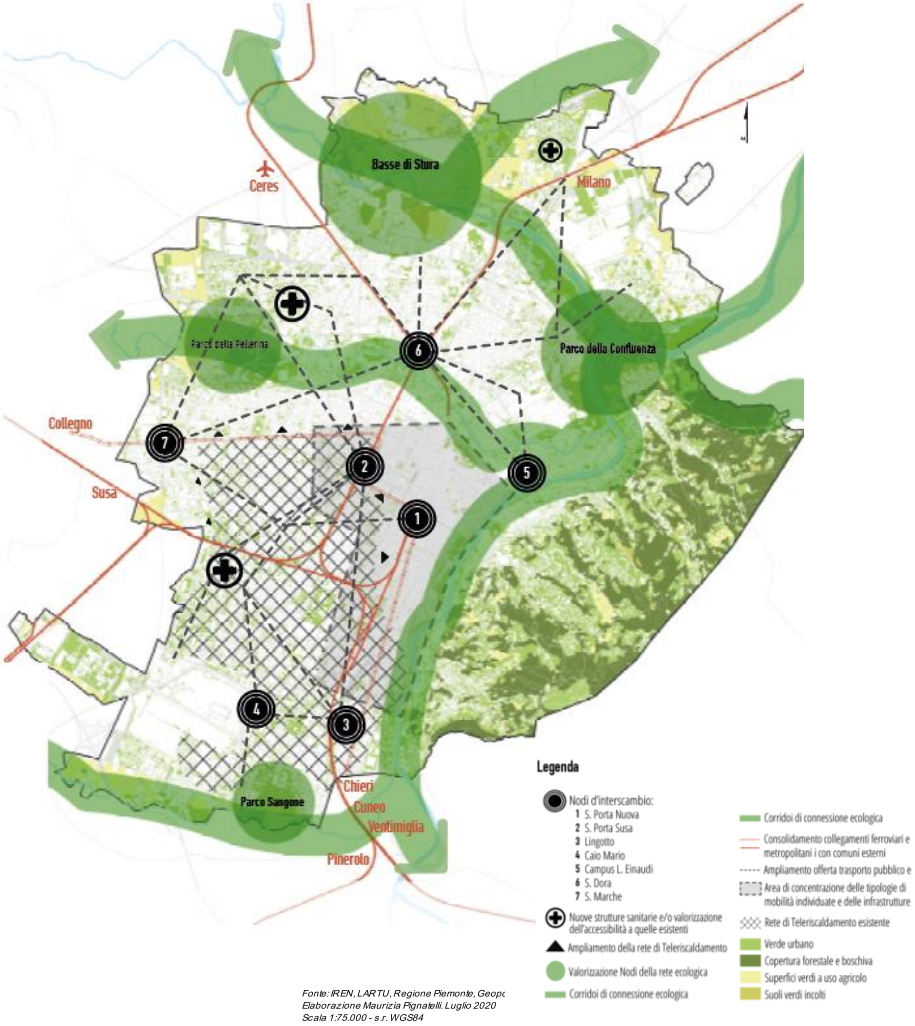
- Reduction CO2 total emission from residential buildings by 40% (between 1991 and 2030) (TAPE)

ENVIRONMENT

- Reduction of PM10 concentrations in atmosphere
- Replacement or use materials suitable for the reduction of the Albedo index (therefore the heat island effect)

SOCIAL ASPECT

- Improvement the quality of existing human services
- Promotion of access conditions by expanding the catchment area of services
- New ways of providing and fruition of services
- Equal distribution for a balanced territory
- Promotion of urban regeneration and expansion of temporary uses



Fonte: IREN, LARTU ,Regione Piemonte, Geopc
Elaborazione Maurizia Pignatelli: Luglio 2020
Scala 1:75.000 - s.r. WGS84

RESULTS

Pignatelli et al., 2023

3 Evaluation and comparison of the sustainability performance level of the baseline and future scenario

Direct comparison

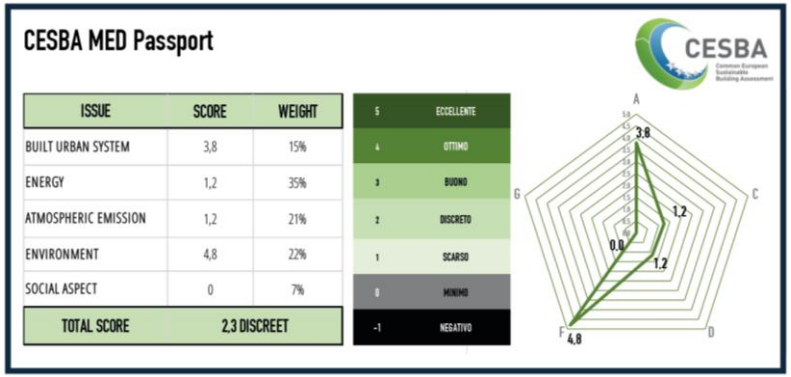
Baseline scenario



Outcomes:

- ENERGY
- SOCIAL ASPECT
- ATMOSPHERIC EMISSION
- BUILT URBAN SYSTEM
- ENVIRONMENT

Future scenario



Outcomes:

- ENERGY
- SOCIAL ASPECT
- ATMOSPHERIC EMISSION
- BUILT URBAN SYSTEM
- ENVIRONMENT

RESULTS

4 An interactive dashboard

[MOLOC project (arcgis.com)]

Assessment of urban sustainability through Key Performance Indicators. The spatial impact assessment of KPI is developed using ESRI GIS tools: ArcGIS Pro, ArcGIS dashboard, ArcMap.

SCALE OF ASSESSMENT: CITY LEVEL

KEY PERFORMANCE INDICATORS

SPATIAL ANALYSIS AND GIS SOFTWARE SUPPORT

SWOT ANALYSIS INTERPRETATION OF THE TERRITORY

Pignatelli et al., 2023



ESEMPIO DI APPLICAZIONE: CASO STUDIO



Progetto MOLOC (MOrphologies LOw Carbon)

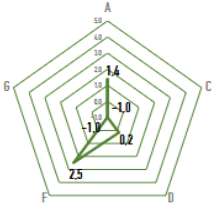
Confronto tra le valutazioni dello scenario del 'non fare' con la valutazione dello scenario di progetto

STATO DI FATTO

CESBA MED Passport

AMBITO	PUNTEGGIO	PESO AREA
SISTEMA URBANO	1,4	15%
ENERGIA	-1	35%
EMISSIONI ATMOSFERICHE	0,2	21%
AMBIENTE	2,5	22%
ASPETTI SOCIALI	-1	7%
PUNTEGGIO FINALE	0,4 MINIMO – SCARSO	

5	ECCELLENTE
4	OTTIMO
3	BUONO
2	DISCRETO
1	SCARSO
0	MINIMO
-1	NEGATIVO



Esiti:

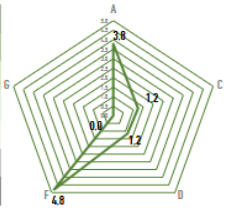
- ENERGIA
- ASPETTI SOCIALI
- EMISSIONI
- SISTEMA URBANO
- AMBIENTE

SCENARIO FUTURO

CESBA MED Passport

AMBITO	PUNTEGGIO	PESO AREA
SISTEMA URBANO	3,8	15%
ENERGIA	1,2	35%
EMISSIONI ATMOSFERICHE	1,2	21%
AMBIENTE	4,8	22%
ASPETTI SOCIALI	0	7%
PUNTEGGIO FINALE	2,3 DISCRETO	

5	ECCELLENTE
4	OTTIMO
3	BUONO
2	DISCRETO
1	SCARSO
0	MINIMO
-1	NEGATIVO



Esiti:

- ENERGIA
- ASPETTI SOCIALI
- EMISSIONI
- SISTEMA URBANO
- AMBIENTE

EVIDENTE MIGLIORAMENTO RISPETTO ALLO SCENARIO BASELINE

Anche se il punteggio finale non è ottimale fa riferimento a casi territoriali che si possono già ritenere good practies (www.cesba-med.interreg-med.eu).

CASO STUDIO

Progetto GREEN-INC (European DUT project)



GREEN-INC aims to evaluate the effectiveness of **"Inclusive Climate Actions (ICAs)" in 5 European cities** facing various climate change challenges. The project aims to identify institutional conditions and design principles that foster the adoption of **nature-based solutions (NbS) in different urban contexts.** The project will be supported by a practical validation phase in **5 living labs** using "**Digital Twin**" technology. The ultimate goal is to contribute to the implementation of **NbS** by integrating principles of **social equity** into decision-making processes.

January 2024, 36 months



DUT Driving Urban Transitions

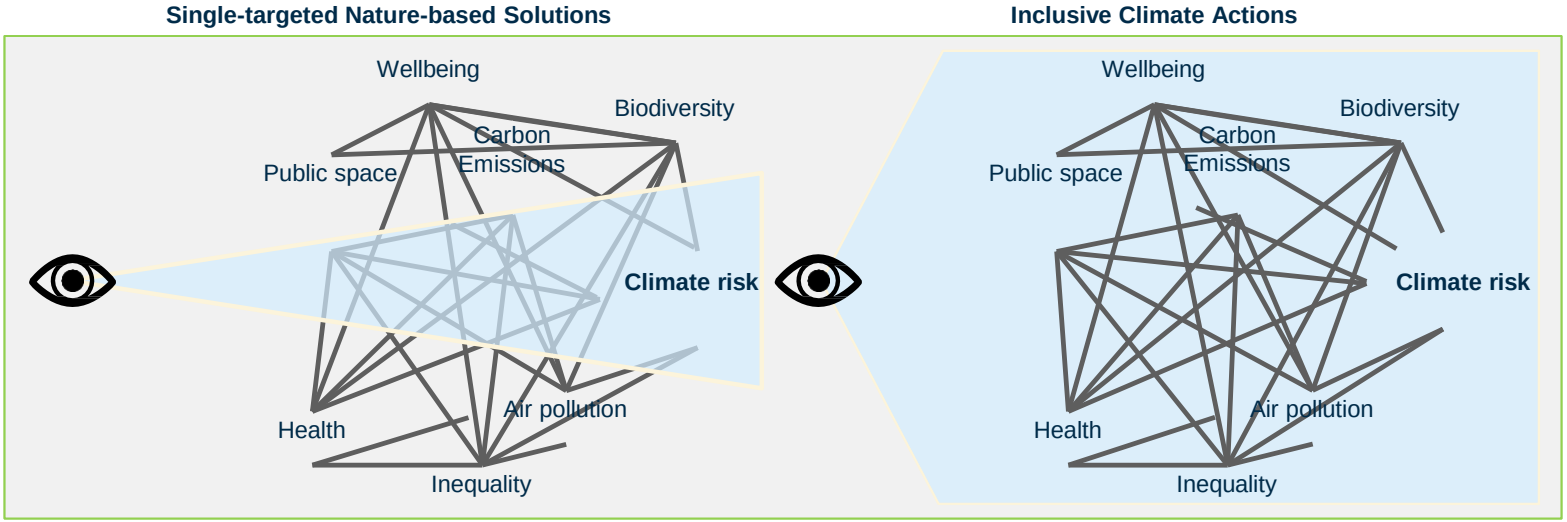
6 SCIENTIFIC PARTNERS

Universiteit van Amsterdam
Luleå Tekniska Universitet
VUB Vrije Universiteit Brussel
ULB Université Libre de Bruxelles
Politecnico di Torino
University of Bucharest

5 LOCAL PARTNERS

Citta' di Torino
egeb
Inform ART
waternet waterschap amstel gooi en vecht gemeente amsterdam
Skellefteå kommun

GREEN-INC Project: Inclusive Climate Actions (ICAs)



NbS projects in Torino





CONEXUS: Valdocco Vivibile
Microscale green solutions neighborhood interventions aimed at place regeneration and citizens' participation



CWC: Rainwater recovery rooftop garden and aeroponic greenhouse
Building-scale recovery of an existing building with rooftop garden and greenhouses

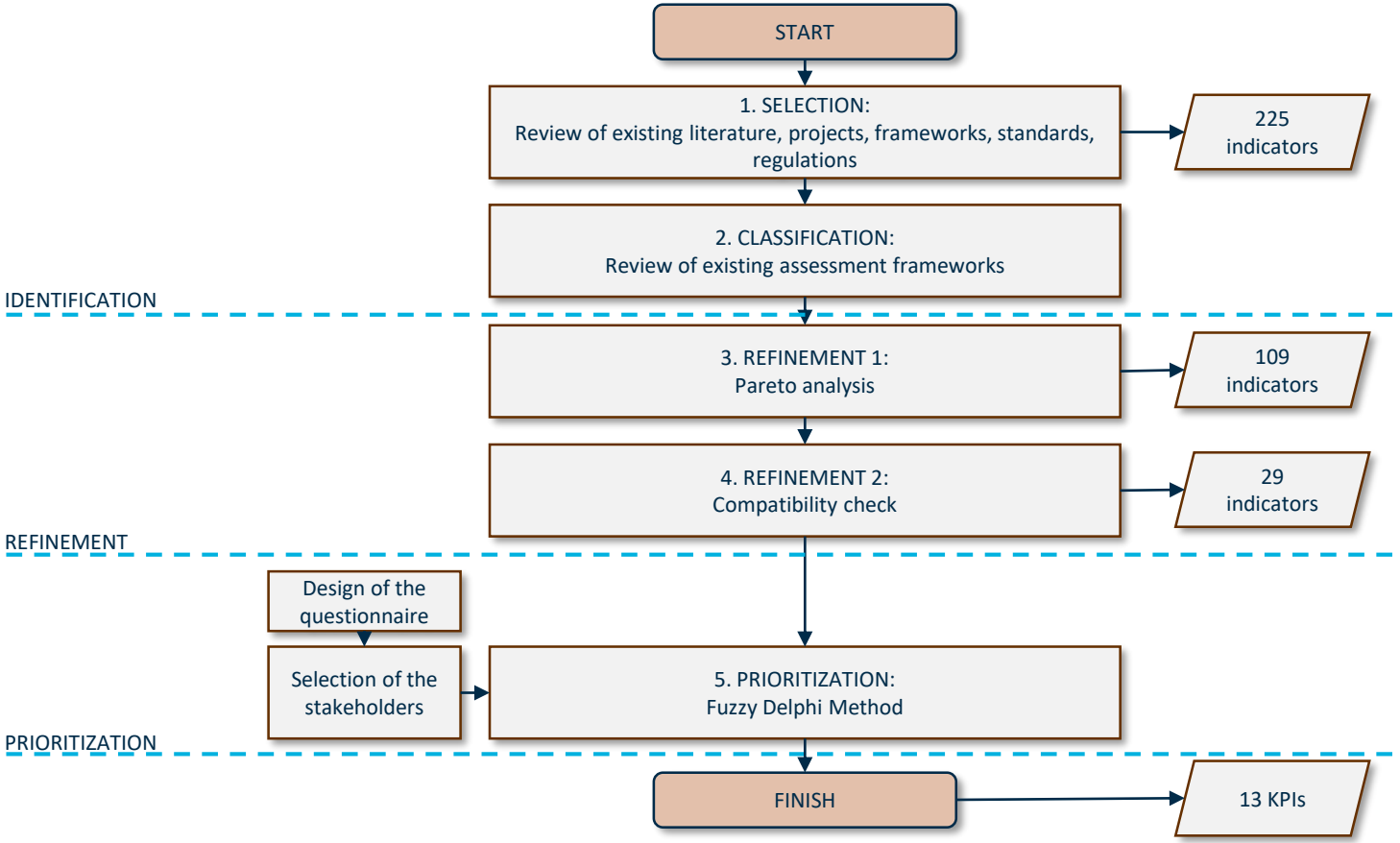


proGIreg: Urban living lab with green walls in a school and in a homeless shelter
Experimental outdoor and indoor green walls in two building intended as replicable examples



proGIreg - Orti Generali:
Urban community garden transforming post-industrial and metropolitan areas based on ecological sustainability and social equity

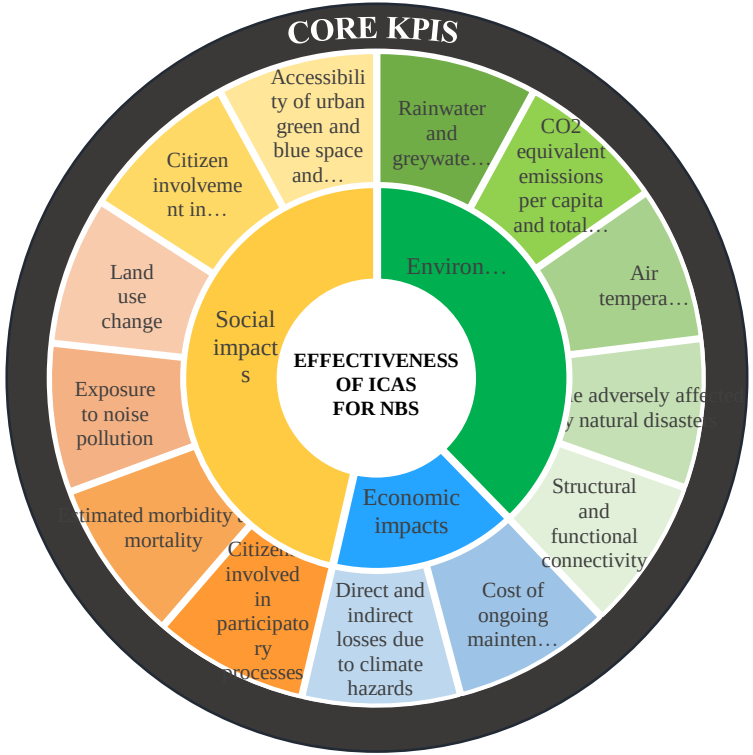
Generic framework: Selection of KPIs



Generic framework

The monitoring and evaluation framework is being implemented to assess the effectiveness of ICAs for NbS in demonstration projects in the cities of Turin, Brussels and Skellefteå.

The framework consists of 13 Key Performance Indicators (KPIs) that will be evaluated for each project.



Core KPIs

RAINWATER AND GREYWATER CAPTURE AND REUSE	AIR TEMPERATURE (Reduction of heath island)	ANNUAL CO2 EQUIVALENT EMISSIONS PER CAPITA AND TOTAL CO2 EMISSIONS	STRUCTURAL AND FUNCTIONAL CONNECTIVITY OF URBAN GREEN AND BLUE SPACES
Focus challenge: Water management	Focus challenge: Climate resilience	Focus challenge: Climate resilience	Focus challenge: Biodiversity enhancement
Volume of rainwater or greywater captured and re-used for irrigation or other purposes.	Measurement of mean and peak daytime temperature, includes the effect of albedo and tree shades as factors affecting air temperature.	Total amount of CO2 emitted, subdivided by sector (mobility, buildings, etc.) and per capita.	Structural connectivity is the proximity of blue-green spaces and the infrastructure matrix across a city. Functional connectivity the ability of the landscape to support the movement of organisms through it.
Typology: Outcome	Typology: Outcome	Typology: Outcome	Typology: Outcome
Level: District/Building	Level: District	Level: District/City	Level: District/City
Unità di misura: m3/year 	Unità di misura: °C	Unità di misura: tonnes/year	Unità di misura: 0-1 index

Core KPIs

COST OF ONGOING GREEN AND BLUE INFRASTRUCTURE MAINTENANCE PLANS	MEAN ANNUAL DIRECT AND INDIRECT LOSSES DUE TO NATURAL AND CLIMATE HAZARDS	LAND USE CHANGE	CITIZEN INVOLVEMENT IN ENVIRONMENTAL EDUCATION ACTIVITIES
Focus challenge: New economic opportunities and green jobs	Focus challenge: New economic opportunities and green jobs	Focus challenge: Place regeneration	Focus challenge: Knowledge and social capacity building
Costs incurred to keep the project in good condition or good working order (must include total annual labour costs, land leasing costs, machinery, energy costs, licensing, etc.).	Expected annual damage (monetary) from hydrometeorological risks.	Reclamation of land for NbS, expressed as total area (ha), area per capita or % of area reclaimed.	Number of participants to educational programs sponsored by schools, universities, municipal recreation departments, local or international not-for-profit organizations, and private entrepreneurs.
Typology: Outcome	Typology: Outcome	Typology: Outcome	Typology: Outcome/Process
Level: Building	Level: District/City	Level: District	Level: District/City
Unità di misura: €	Unità di misura: €	Unità di misura: %	Unità di misura: n° of people

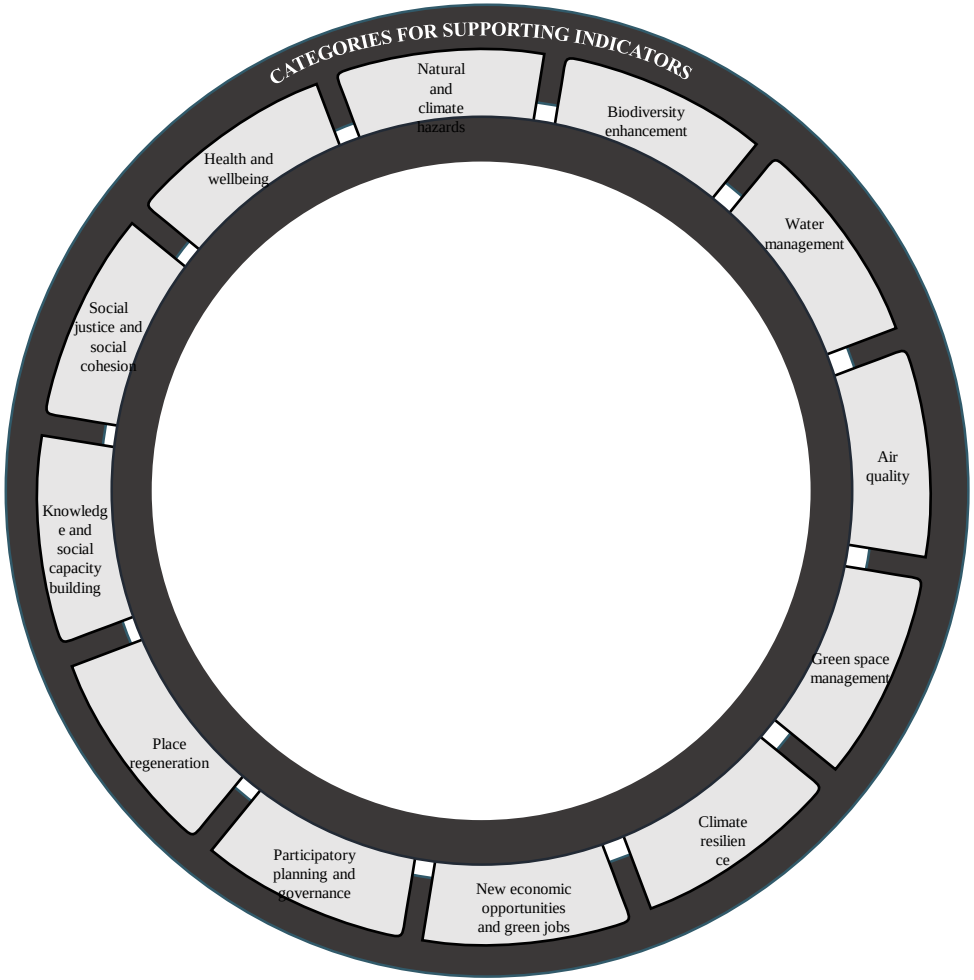
Core KPIs

PROPORTION OF CITIZENS INVOLVED IN PARTICIPATORY PROCESSES	ACCESSIBILITY OF URBAN GREEN AND BLUE SPACE AND RECREATIONAL SPACE	ESTIMATED MORBIDITY AND MORTALITY ASSOCIATED WITH CLIMATE CHANGE	EXPOSURE TO NOISE POLLUTION
Focus challenge: Participatory planning and governance	Focus challenge: Social justice and social cohesion	Focus challenge: Health and wellbeing	Focus challenge: Health and wellbeing
The proportion of citizens involved in participatory governance and design/planning phases.	The availability and distribution of green and blue space and recreational space with respect to specific individual or household socioeconomic profiles and landscape design.	Long-term (annual) incidence of morbidity and mortality due to air pollution, high temperatures, or other climatic conditions.	The per cent reduction of noise level measured at the receiver, or the number of inhabitants exposed to noise >55 dB(A).
Typology: Outcome/Process	Typology: Outcome	Typology: Outcome	Typology: Outcome
Level: District/City	Level: District	Level: District/City	Level: District/City
Unità di misura: %	Unità di misura: n° of residents	Unità di misura: n° of cases/year	Unità di misura: %

Place-based framework

Supporting indicators are specific to each case study, and they are selected according to the focus challenges of each project





The framework

CORE KPIs
Rainwater and greywater capture and reuse
CO2 equivalent emissions per capita and total emissions
Air temperature
People adversely affected by natural disasters
Structural and functional connectivity
Cost of ongoing maintenance plans
Direct and indirect losses due to climate hazards
Citizens involved in participatory processes
Estimated morbidity and mortality
Exposure to noise pollution
Land use change
Citizen involvement in environmental education activities
Accessibility to urban green and blue spaces and recreational spaces

SUPPORTING INDICATORS

BRUSSELS
Surface runoff
Soil quality
Number of species
Air quality
Mean land and property value in proximity to NbS
Perceived quality of urban spaces

TORINO
Energy consumption
Surface runoff
Soil quality
Food production in urban allotments and NbS
Mean land and property value in proximity to NbS
Perceived quality of urban spaces
Proportion of community who volunteer
Bridging and bonding

SKELLEFTEA
Number of species
Energy consumption
Secondary raw materials
Recreational value
Perceived quality of urban spaces

Environmental
Economic
Social

Focus su Torino

Area: città di Torino

Indicatori scelti e misurati:

SUPPORTING INDICATORS	TORINO
	Total final energy consumption
	Surface runoff
	Soil quality
	Local food production
	Mean property value in proximity to NbS
	Perceived quality of urban spaces
	Volunteering community engagement
	Bridging and bonding



KPIs assessment

Accessibility of urban green and recreational space

Percentage of residents living within acceptable access from the available effective public green and recreational areas.

Identification of public green areas larger than 2 ha

↓

Creation of the pedestrian network

↓

Definition of the service area around green and recreational spaces

↓

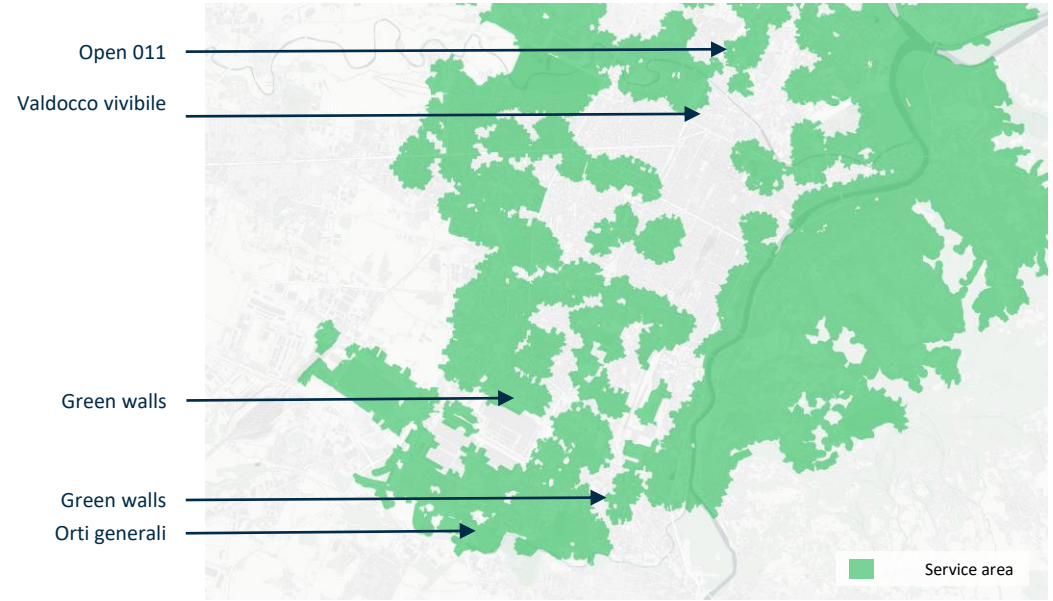
Definition of the share of population living within acceptable access level from green spaces

↓

Repetition of steps 1-2-3-4 for the years following the implementation of NbS project(s)

↓

Comparison of population living within acceptable access of the available green spaces pre and post implementation of NbS project(s).



	% of residents		
	Before implementation	After implementation	
Orti Generali	79%	80%	↗
Green walls	75%	75%	→
Open 011	40%	36%	↘
Valdocco Vivibile	7%	8%	↗

KPIs assessment

Accessibility of urban green and recreational space



1.



2.



3.

KPIs assessment

Estimated morbidity, mortality, and wellbeing

Prediction and perceptions of illness, death rates and wellbeing caused by environmental or social factors.

Data collection for illness and death rates

↓

Calculation of relative difference with city average

↓

Comparison of illness and death rates before and after NbS implementation or comparison between local/district scale and city scale values

↓

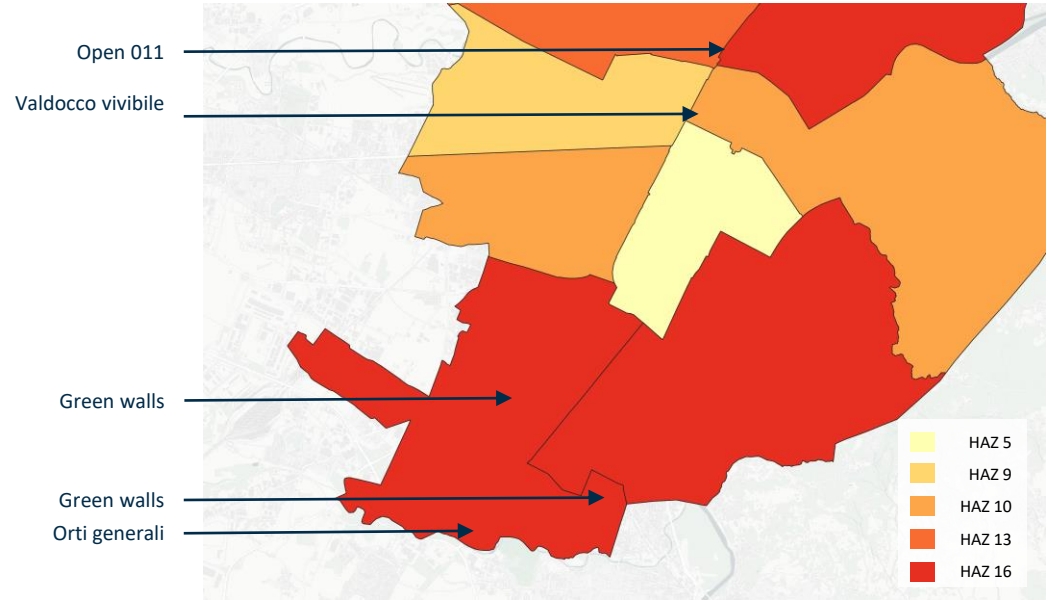
Definition of the questionnaire

↓

Distribution of the questionnaire

↓

Descriptive statistics for analysis of survey responses



	HAZ relative difference	Perceived improvement in physical wellbeing (%)	Perceived improvement in mental wellbeing (%)	Perceived improvement in physical and mental wellbeing (%)	
Orti Generali	0%	4.35	31.9	68.15	→
Green walls	0%				→
Open 011	-21%				↗
Valdocco Vivibile	-46%				↗

KPIs assessment

Citizen involvement in environmental education activities

Number of events organized within the context of educational programs.

Definition of survey questions

↓

Survey distribution

↓

Descriptive statistics for analysis of survey responses

↓

Integration of survey responses with inventory of activities

	Number of activities	
Orti Generali	133	↗
Green walls	36	↗
Open 011	17	↗
Valdocco Vivibile	15	↗

KPIs assessment

Citizens involved in participatory processes

The number of citizens involved in participatory governance and design/planning phases.

Definition of survey questions

↓

Survey distribution

↓

Descriptive statistics for analysis of survey responses

↓

Integration of survey responses with inventory of activities (interviews)

	Number of participants	
Orti Generali	116	↗
Green walls	170	↗
Open 011	0	↗
Valdocco Vivibile	230	↗



SUSTAINABLE CAMPUS

Politecnico di Torino

SOME FIGURES

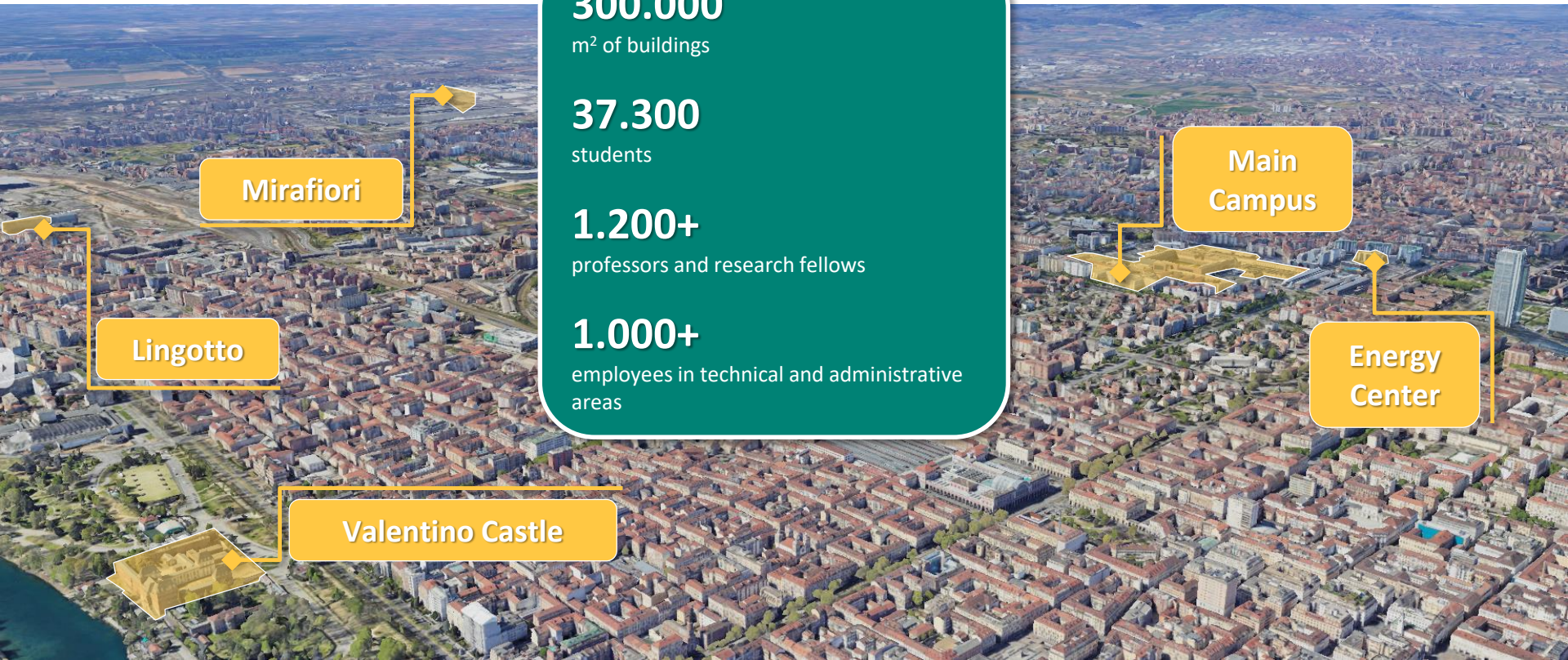
Politecnico di Torino in a nutshell

300.000
m^2 of buildings

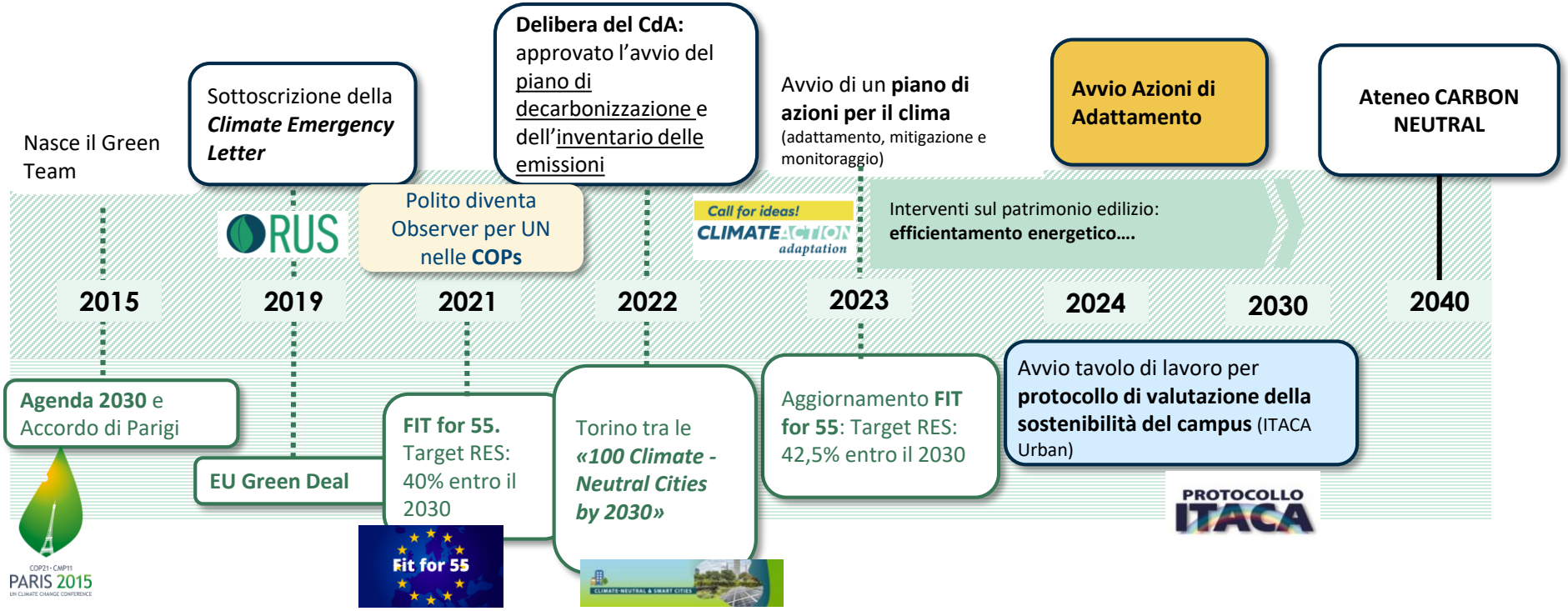
37.300
students

1.200+
professors and research fellows

1.000+
employees in technical and administrative areas

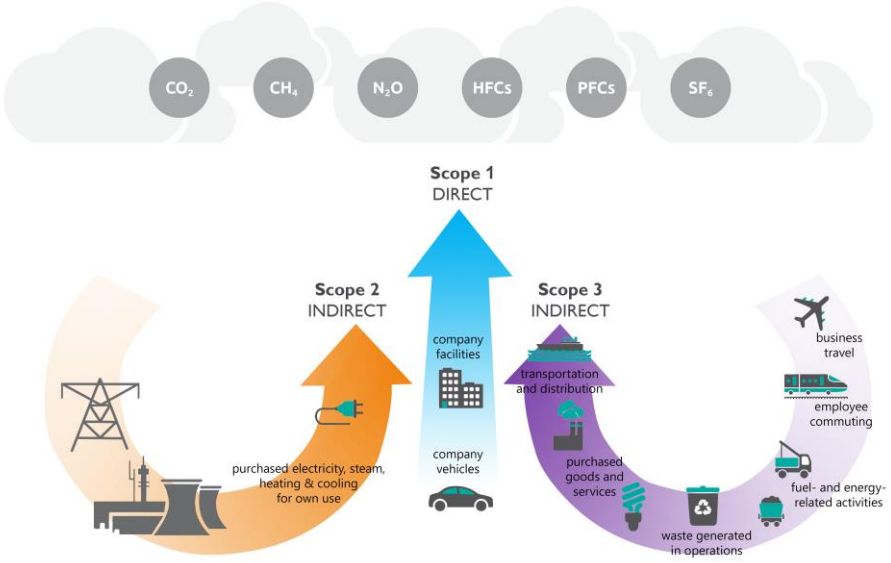


Il percorso verso la decarbonizzazione



L’inventario delle emissioni

Il protocollo GHG e gli ambiti di azione



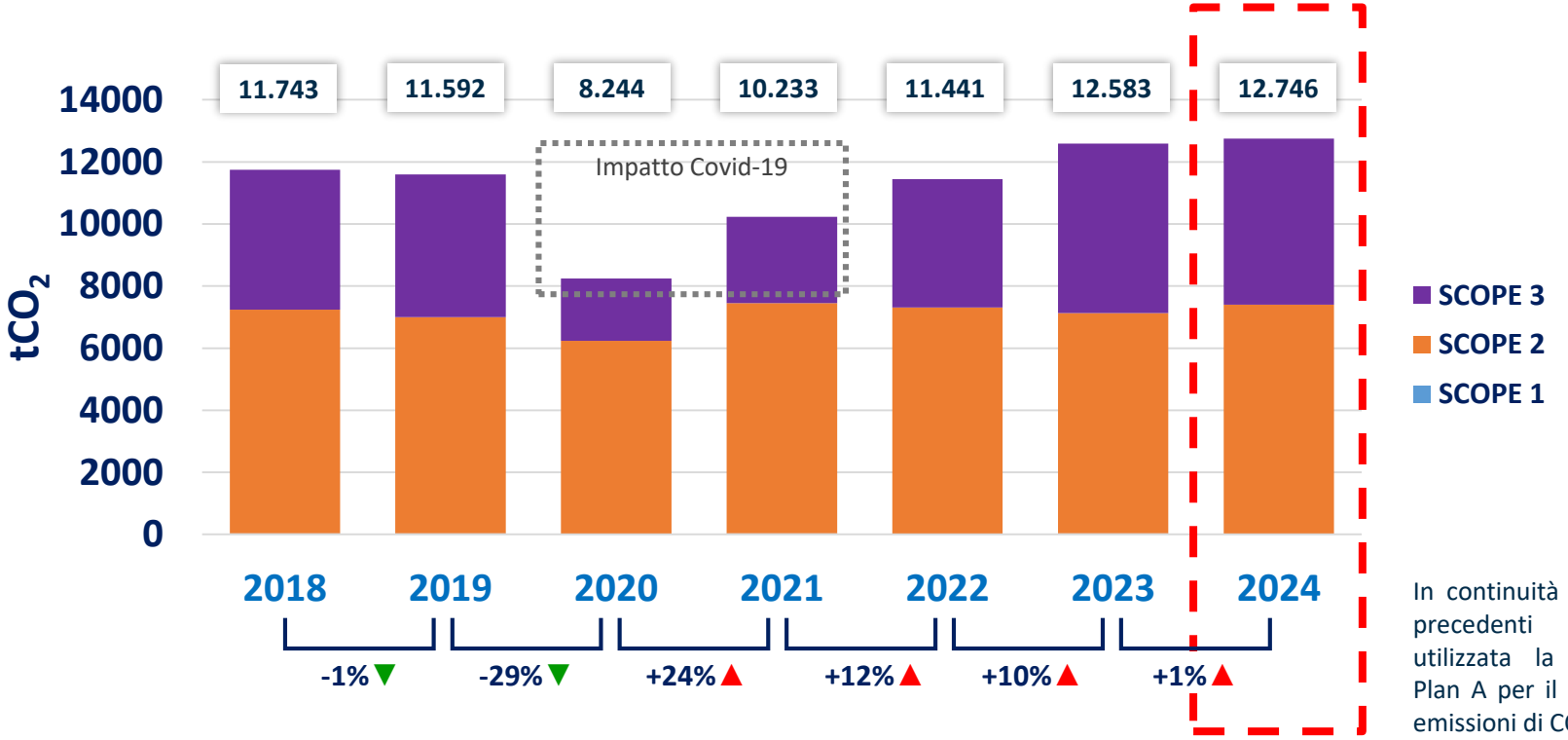
* *Elaborazione da https://www.epa.gov/climateleadership/scope-1-and-scope-2-inventory-guidance*

Il protocollo “**GHG Protocol Corporate Accounting and Reporting Standard**” (2004) fornisce una metodologia standardizzata per quantificare le emissioni di gas serra.
Il protocollo classifica le emissioni dirette ed indirette dell’azienda in tre “scope” (ambiti):

- **Scope 1**, emissioni dirette generate, la cui fonte è di proprietà o controllata dall’azienda/ente;
- **Scope 2**, emissioni indirette generate dall’energia acquistata e consumata dall’azienda/ ente;
- **Scope 3**, comprende tutte le altre emissioni indirette che vengono generate dalla catena del valore dall’azienda/ente

L’inventario delle emissioni

Le emissioni di Ateneo dal 2018 al 2024

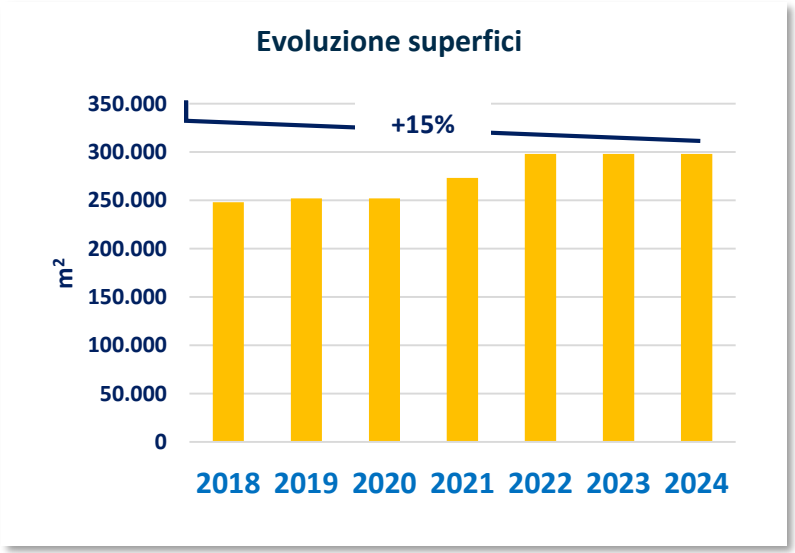


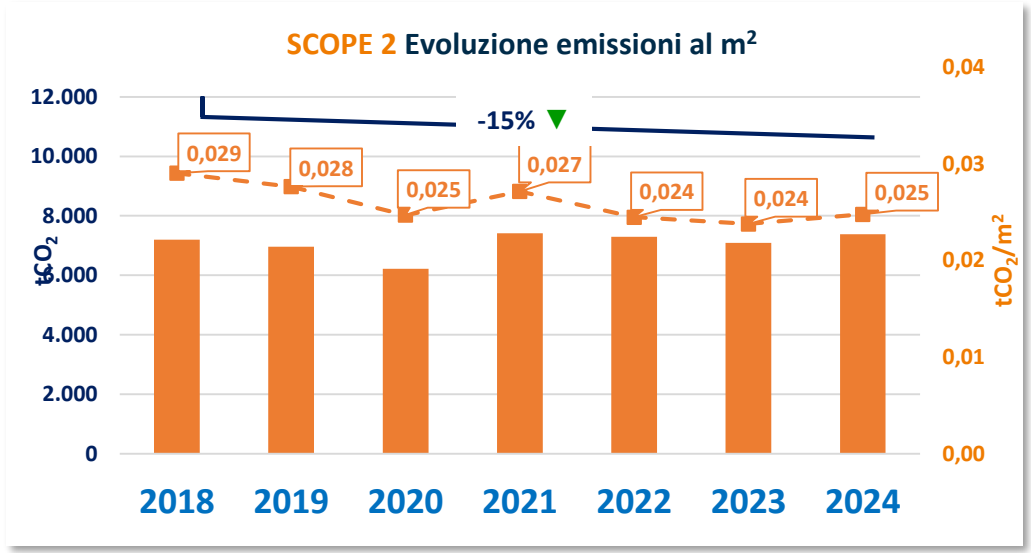
In continuità con gli anni precedenti è stata utilizzata la piattaforma Plan A per il calcolo delle emissioni di CO_2 del 2024.

Scope 2: emissioni *normalizzate* per m²

Il Campus Politecnico ha subito variazioni negli anni in termini di **estensione sul territorio** (nuove aule, spazi in ristrutturazione, nuovi spazi per laboratori…)

- 2018-2021 → **~260.000 m²**
- 2022-2024 → **~298.000 m²** (~+15%)



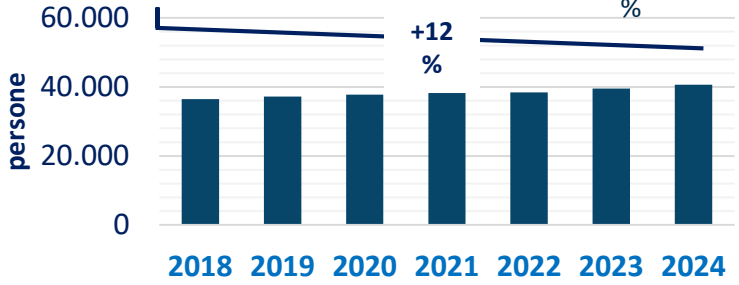


Emissioni *normalizzate* sulla popolazione complessiva

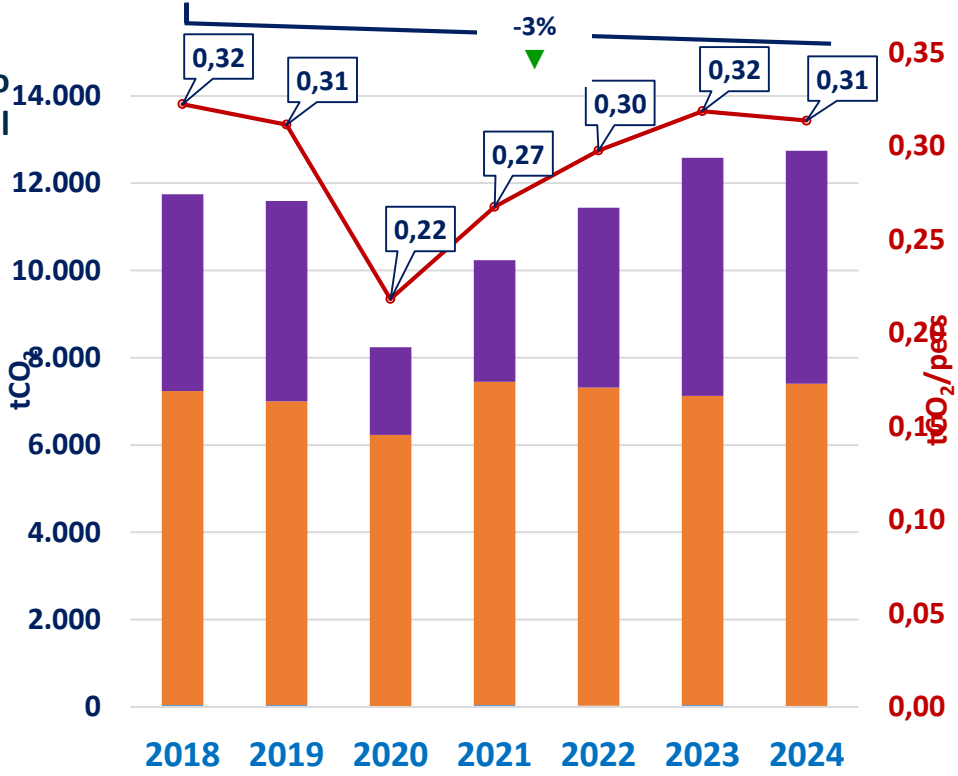
La **popolazione complessiva del Politecnico di Torino** (studenti + dipendenti) subisce **un incremento costante dal 2018 ad oggi**:

- 2018 → **36.434 unità**
- 2019 → **37.236 unità** +2,2%
- 2020 → **37.801 unità** +3,8%
- 2021 → **38.271 unità** +5,0%
- 2022 → **39.504 unità** +5,6%
- 2023 → **39.414 unità** +8,4%
- 2024 → **40.654 unità** +11,6 %

VS 2018



Evoluzione popolazione complessiva



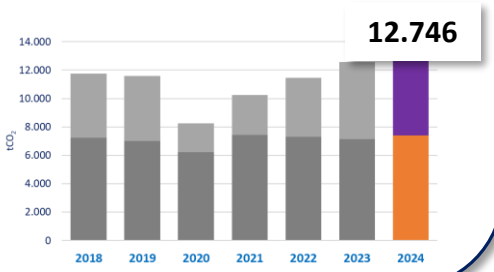
Le leve dirette per ridurre le nostre emissioni

Emissioni 2024 [tCO_2]

SCOPE 2
7.382

SCOPE 3
5.542

SCOPE 1
22



Ambiti di intervento su cui l'Ateneo ha «leve dirette»

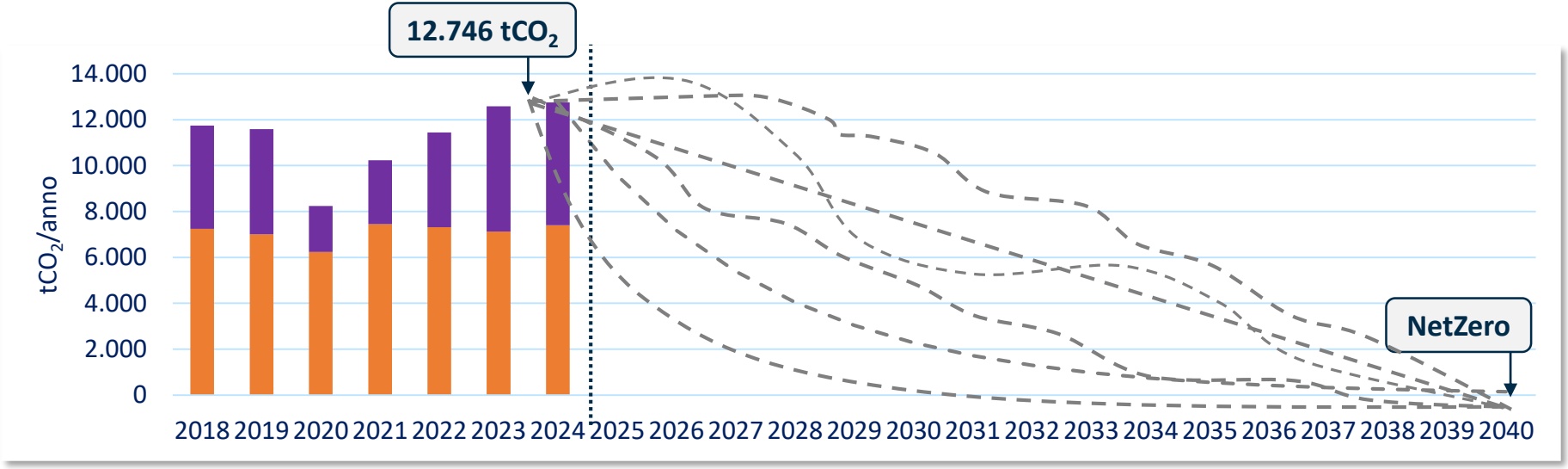
- Energia ed efficientamento
- Mobilità sostenibile
- Risorse ed economia circolare
- Coinvolgimento ed educazione della comunità

Piano di decarbonizzazione

- Energia ed efficientamento
  - Consumi (EE e ET)
  - Autoproduzione (PV)
  - Azioni tuning e alerting
- Mobilità sostenibile
  - Flotte di Ateneo
  - Missioni del personale
  - Mobilità comunità politecnica
  - Servizi per la mobilità sostenibile
- Risorse ed economia circolare
  - Rifiuti
  - Acqua
  - Catena del cibo
  - Acquisti di materiali
- Coinvolgimento ed educazione della comunità
  - Sensibilizzazione
  - Consapevolezza *capacity building*
  - Formazione

AZIONI DI MITIGAZIONE + ADATTAMENTO

Net Zero 2040 – Scenario teorico

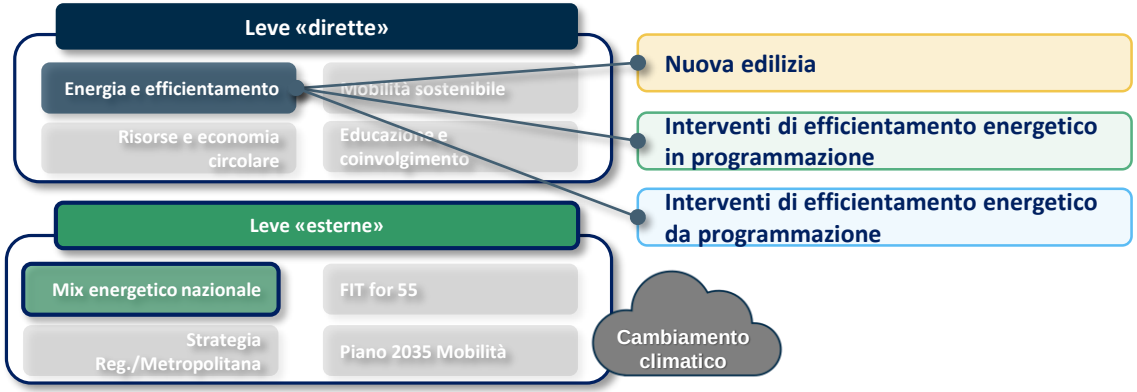


Per raggiungere l'obiettivo si possono seguire diverse strategie.

Esempio: percorso lineare = riduzione delle emissioni di ~800 tCO_2 ogni anno.

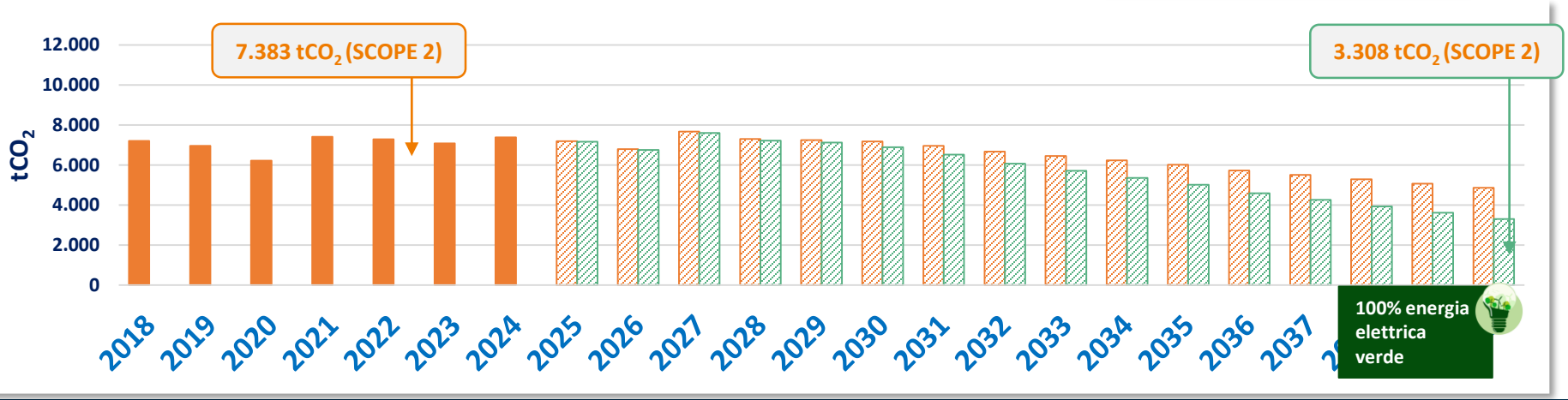
Tutte le ipotesi per raggiungere NetZero comportano importanti sforzi.

Net Zero 2040 – Scenario finale SCOPE 2



Emissioni TOTALI

2024	12.746 tCO_2
2040	- 4.075 tCO_2 (-55%)



Net Zero 2040 – Protocollo ITACA

SCOPE 2 → **Energia e efficientamento**

- Consumi (EE e ET)
- Autoproduzione (PV)
- Azioni tuning e alerting









Certificazione del Protocollo ITACA (edilizia universitaria) applicata alla nuova edilizia

Nuova edilizia: **~65.000 m²**

Esempio: punteggio certificazione: 2-2,5 (max 5 p.ti)
>> (circa) **-35-40% emissioni CO_2** rispetto alle emissioni di un edificio standard

Net Zero 2040 – Nature Based Solution

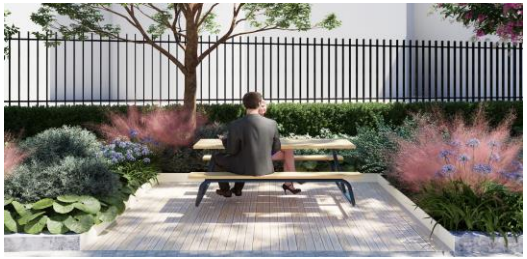
SCOPE 2 → **Energia e efficientamento** → • Consumi (EE e ET)

AZIONI DI MITIGAZIONE + ADATTAMENTO

Terrazza della Biblioteca di Ingegneria (A)



Aree verdi e spazi di aggregazione (A)



Green Walls (B)



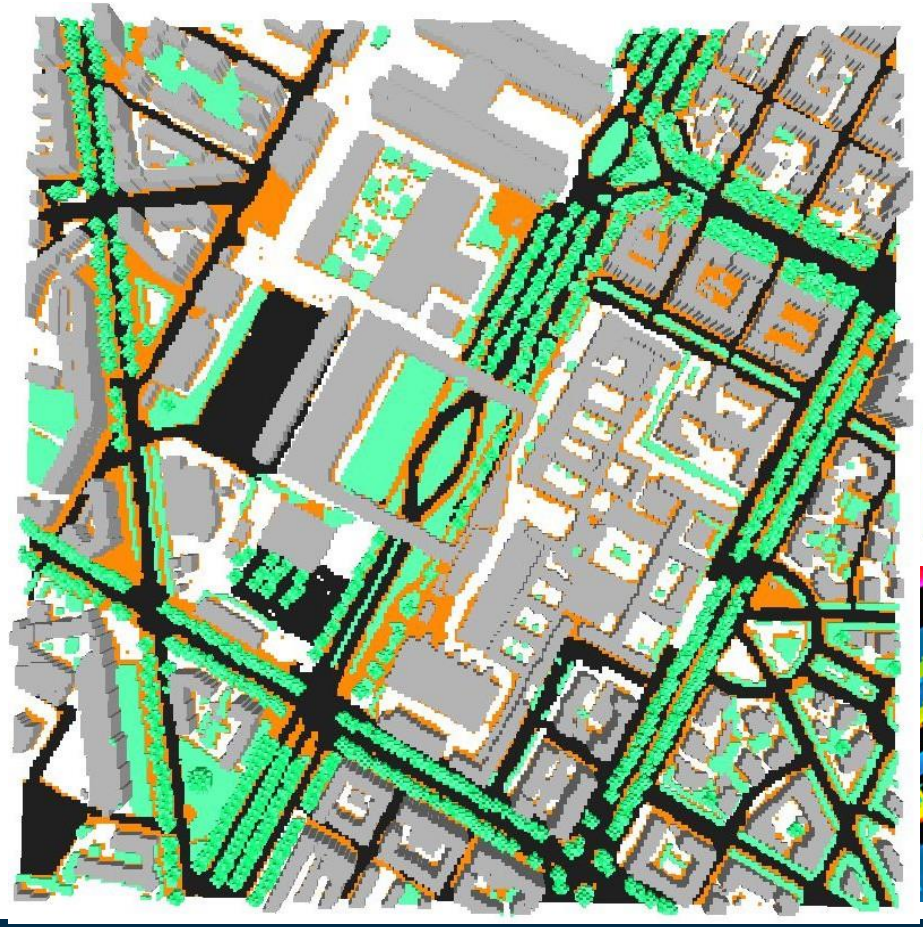
Pareti verdi, riprogettazione di aree verdi, viabilità e spazi di aggregazione



	kg of oxygen produced per year	kg of carbon sequestered per year	g of air pollution removed per year
green wall	433,9	162,7	947,8
average tree	100	25	800- 1400
	source: www.sciencefocus.com	source: https://ecotree.green/en/	source: Nowak, David J. 2020. Urban trees, air quality and human health.
green wall benefits equivalent	4,3 trees	6,5 trees	0,6 - 1,2 trees



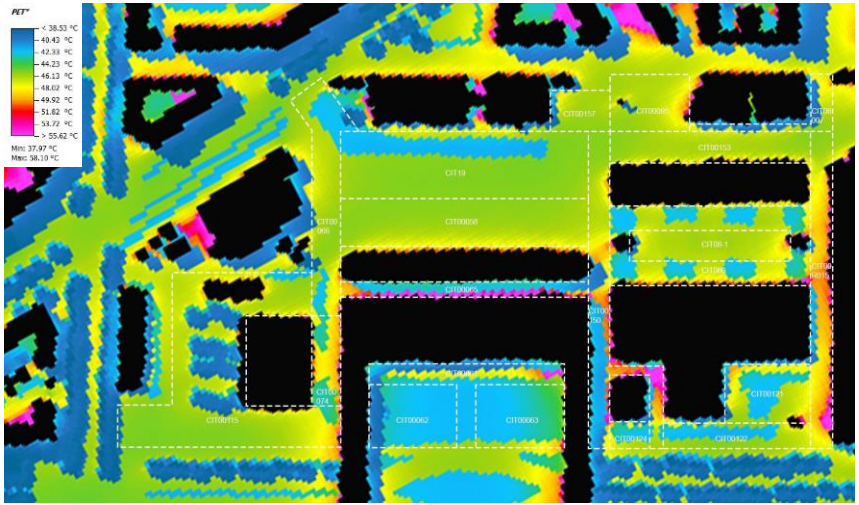
Proposte di intervento nella sede di Corso Duca degli Abruzzi



Applicazione del software

ENVI-met

Scala di dettaglio territoriale, celle 3 x 3 x 4 m.



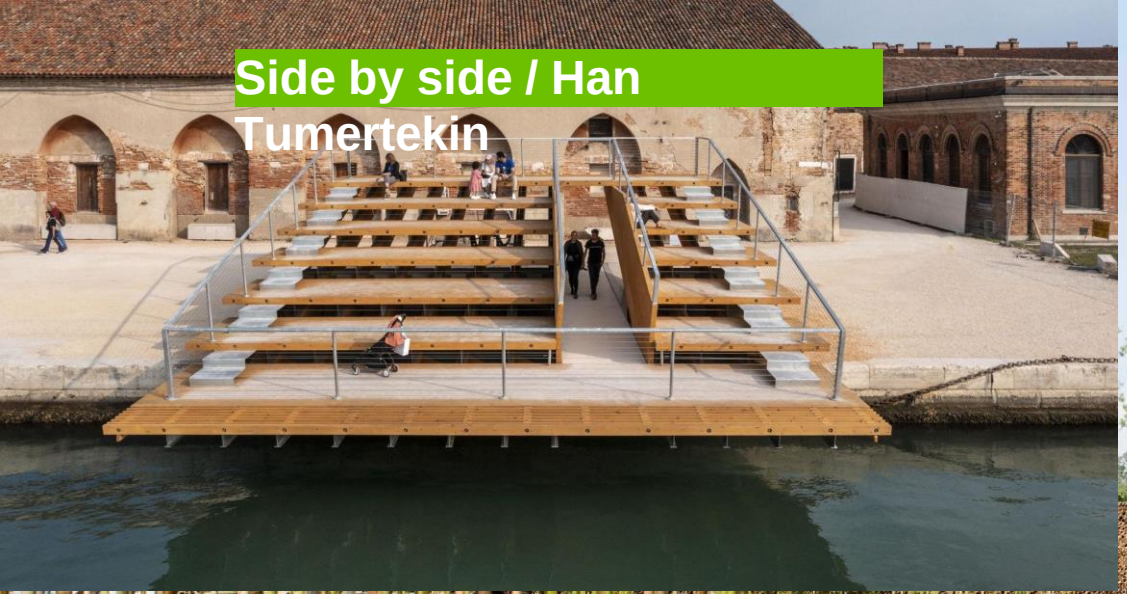

Insect hotel /
SLA


Fondamental / Son
Estudi


Perrache-Confluence
Sub
Rue Royale
Architectes


Casi studio - Prima corte
aulica


Pavillon de la France / Agence
ter



Side by side / Han Tumertekin

Wuhan jardin / Agence ter

Casi studio - Corte bar Denise









Casi studio - Secondo accesso corso Duca

Vigna urbana - *Campus Grapes*

Collaborazione con la start up ***Citiculture***



R1 - RENDER PIANO INTERRATO



R2 - RENDER PIANO INTERRATO



PLANIMETRIA

GRAZIE PER LA VOSTRA ATTENZIONE

Politecnico di Torino
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