GreenFORCE

Torino Summer School

Final report of team 3

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Horizon Europe Programme
HORIZON-WIDERA-2021-ACCESS-02-01
Twinning Western Balkans

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GREEN INFRASTRUCTURE AND CLIMATE CHANGE Subtitle Green

Infrastructure and Sustainable Mobility

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1 ABSTRACT *(max. 200 words)*

Turin's "city transition" represents a profound shift towards sustainability, climate resilience, and environmental stewardship, addressing climate change and environmental challenges. This transformation envisions urban areas as hubs of sustainability and social equity, committing to replace resource-intensive and environmentally harmful practices with sustainable, low-carbon, and socially inclusive alternatives.

Central to this change are green infrastructure and sustainable mobility, led by the pioneering "Multipurpose Transportation System project in microzones." This project not only enhances sustainable mobility but introduces a variety of vehicles, including electric buses, bicycles, electric scooters, and pedestrian-friendly pathways. These diverse vehicles within the project promote a multi-modal and eco-friendly approach to mobility in Turin's microzones.

The green infrastructure initiative goes beyond the ordinary, establishing a "green corridors network" connecting natural urban elements such as green spaces, vertical gardens, water retention systems, and urban wetlands. This network contributes significantly to carbon sequestration, improved air quality, temperature regulation, flood mitigation, and biodiversity support.

Turin's city transition identifies challenges and opportunities, charting a clear path towards sustainability and resilience. This comprehensive approach, now integrating a variety of vehicles, encapsulates Turin's vision for a greener, more sustainable, and environmentally responsible urban future.

2 THEORETICAL AND METHODOLOGICAL FRAMEWORK

Turin's "green transition" is built upon a robust theoretical and methodological framework grounded in sustainability, climate resilience, and social equity. It acknowledges urban areas as potential centers for sustainable development and environmental stewardship. To tackle climate change and environmental challenges, the framework focuses on replacing resource-intensive and environmentally harmful practices with sustainable, low-carbon, socially inclusive alternatives.

In the context of this transition, the "Multipurpose Transportation System project in microzones" assumes a central role. This innovative project introduces a variety of vehicles, including electric buses, bicycles, electric scooters, and pedestrian-friendly pathways within the microzones. This multi-modal approach to transportation is integral to Turin's sustainable mobility strategy.

2.1 Aim of the project *(max. 200 words)*

Turin's city transition signifies a profound shift toward sustainability, climate resilience, and social equality, aiming to replace harmful practices with eco-friendly alternatives. This commitment, aligned with Turin's designation as a "Climate-Neutral and Smart City by 2030," prioritizes overall welfare and well-being.

Environmental Actions focus on reducing the carbon footprint through initiatives such as creating urban green spaces, implementing sustainable drainage systems, and integrating green energy. Sustainable Mobility initiatives target reduced pollution and improved urban mobility, including promoting electric vehicles and implementing a Multipurpose Transportation System in Microzones.

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Social Actions address inequality by encouraging community participation, organizing events, and providing green job training. Urban Development Actions aim for sustainable urban spaces, including green building certification and integrated transportation planning.

This comprehensive approach aspires to create a sustainable, resilient, and socially equitable urban future, benefiting both the environment and the well-being of Turin's residents. The initiatives encompass environmental responsibility, social equity, and improved quality of life, aligning with Turin's role in leading Europe's transition to zero-carbon urban environments.

2.2 Literature review on Just Green Transitions *(max. 500 words)*

The concepts of a "just green transition" and the imperative for a low-carbon shift emerge as pivotal frameworks amidst urgent global challenges, addressing climate change, environmental sustainability, and social equity. This exploration delves into the origins, roles in climate policy, associated challenges, and the need for nuanced vulnerability understanding.

The just transition concept originated in late 20th-century US labor movements, advocating for state support in the face of disarmament and fossil fuel transitions. Evolving beyond labor-centric origins, it gained global recognition through milestones like the Rio+20 Earth Summit and the Paris Agreement, encompassing broader aspects related to climate and the environment. Scholars stress transcending historical meanings, integrating it with environmental, climate, and energy justice, making it a multifaceted term.

Thematic sections highlight its labor-oriented roots, integration with justice frameworks, consideration as a socio-technical transition, examination of governance strategies, and emphasis on public perception. Scholars argue that justice is integral to sustainability, emphasizing the interconnectedness of environmental and socio-economic aspects.

Building blocks of a just green transition involve critical climate mitigation policies, including laws, sectoral policies, and regulations across governance levels. Achieving balance amidst economic growth, environmental preservation, and social equity requires comprehensive planning.

The European Union's "Green Deal," adopted in 2019, positions it as a front-runner in becoming the first climate-neutral continent by 2050. With 2030 targets demanding substantial investments, this strategy integrates sustainability, environmental objectives, and social fairness, aligning with the broader concept of a just green transition.

Simultaneously, addressing anthropogenic climate change through a low-carbon transition unveils complex socio-technological shifts. Phasing out fossil fuels presents both benefits and risks, with potential benefits in resilient and democratic energy systems and challenges arising from job losses in carbon-intensive industries. The just green transition offers a comprehensive framework, emphasizing the importance of addressing not only environmental but also social and economic equity amidst global urgency to address climate change and preserve the environment.

2.3 Mapping Turin's Strategic Development Priorities *(max 500 words)*

Turin is committed to a comprehensive and sustainable mobility strategy, aligning with a just green transition and its strategic development priorities, particularly in collaboration with Stellantis. The city's focus on key

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initiatives is geared towards enhancing environmental sustainability, fostering economic growth, and promoting social equity.

Bike-Friendly Infrastructure and Pedestrian Zones: Turin is investing in a robust network of bike lanes and bike-sharing programs to encourage cycling as an eco-friendly transport mode. Simultaneously, creating pedestrian-friendly zones in the city center enhances the walking experience, reduces conventional vehicle demand, and contributes to a cleaner urban environment, aligning with the green transition goals.

Electric Vehicles (EVs) and Carpooling: Promoting clean transportation involves expanding the EV charging infrastructure and providing incentives for EV owners. Additionally, initiatives encouraging carpooling and ride-sharing significantly reduce traffic congestion and emissions, aligning with the city's overall sustainability objectives.

Smart Mobility Apps and Integration of Modes: Turin recognizes the role of technology in sustainable mobility, with mobile applications offering real-time information on public transportation, biking, traffic updates, and car-sharing. Integrating modes of transport ensures a seamless and flexible experience for residents in their daily commutes.

Promotion of Green Vehicles and Public Awareness: Incentives such as tax breaks and subsidies for low-emission vehicles contribute to reducing the environmental impact. Turin's comprehensive public awareness campaigns educate residents on the benefits of sustainable mobility, air quality, and the environmental impact of transportation choices, influencing behavior towards greener options.

Turin has already demonstrated progress with initiatives like the Bike Mobility Plan and successful bike-sharing services like "ToBike" and "Mobike." In collaboration with Stellantis, the city is making significant investments to become a sustainable mobility tech leader, targeting carbon neutrality by 2038. Projects like the Mirafiori Complex for electric transmission production and the Circular Economy Hub play pivotal roles in Turin's transition towards a more sustainable and environmentally responsible urban future.

Emphasizing eco-friendly transportation, circular economy initiatives, and strategic collaboration with Stellantis, Turin is on track to achieve its vision for a more livable and equitable urban environment through a just green transition.

2.4 Methods *(max. 500 words)*

The project will be organized in three parts, which are the pre- work, mid- work and post- work, with the following process:

1. Pre-work

1.1 Preparation work

1.1.1 Analysis of project research context

By reviewing literature, planning policies, and case studies to gain scientific knowledge.

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1.1.2 Field research and pre-interview with stakeholders

Providing in-depth data and connections, refining research objectives ethically.

1.1.3 Collection and analysis of current data

Gather project area data through field research and official sites, analyze using GIS and related software, laying groundwork for problem analysis.

1.2 Analysis of current challenges & issues

Based on the preparatory work, existing challenges and issues in the project's study area are analyzed around sustainable transportation and green infrastructure, and it is ensured that each issue is supported by corresponding data.

1.3 Identification of project research topic & goals

As a result of the above work, sustainable transportation and green infrastructure were identified as the project topic, and the project objectives were defined based on the three dimensions of environment, society and urban development.

2. Mid-work

2.1 Development of key actions

2.1.1 Sustainable transportation

Multipurpose transportation System in micro zones; Improve the cycling lanes network; Adjustment of public transportation frequencies to achieve justice.

2.1.2 Green infrastructure

Pave the green foundation combined with the cycling lanes network; Micro green zones

2.2 Technical approach & Interview with stakeholders

Visualize proposed actions through GIS and relevant software to show them more clearly and systematically. Cost-benefit analysis is used to analyze the economics of the proposed actions and help determine the feasibility of them. At the same time, proposed actions are adjusted in a timely manner by maintaining contact with stakeholders. The visualization steps need to be modified in real time in response to changes in the proposed actions.

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Surveys and Questionnaires: Engage residents and stakeholders to understand perceptions and preferences, gaining insights into public opinions on the green transition.

Interviews: Conduct in-depth discussions with officials, project leaders, and experts to gather comprehensive information on the "Multipurpose Transportation System project in microzones" and green infrastructure development.

Observations: Systematically monitor green infrastructure elements, emphasizing field observation to evaluate performance and impact.

Document Analysis: Review reports, policy documents, and research literature to understand Turin's green transition within theoretical and policy contexts.

Secondary Data: Utilize existing environmental and urban development data sources for broader sustainability and resilience perspectives.

Data analysis, using quantitative and qualitative methods, assesses the effectiveness of green infrastructure and its impact on sustainable mobility. Statistical, thematic, and geospatial analyses align with Turin's sustainability and resilience goals

3. Post-work

3.1 Interview with stakeholders & decision-makers

Stakeholders and decision makers can evaluate whether the project has met its objectives and can provide valuable feedback on their satisfaction with the project's results, which helps to determine what is going well and what can be improved and thus completes the integrity of the project.

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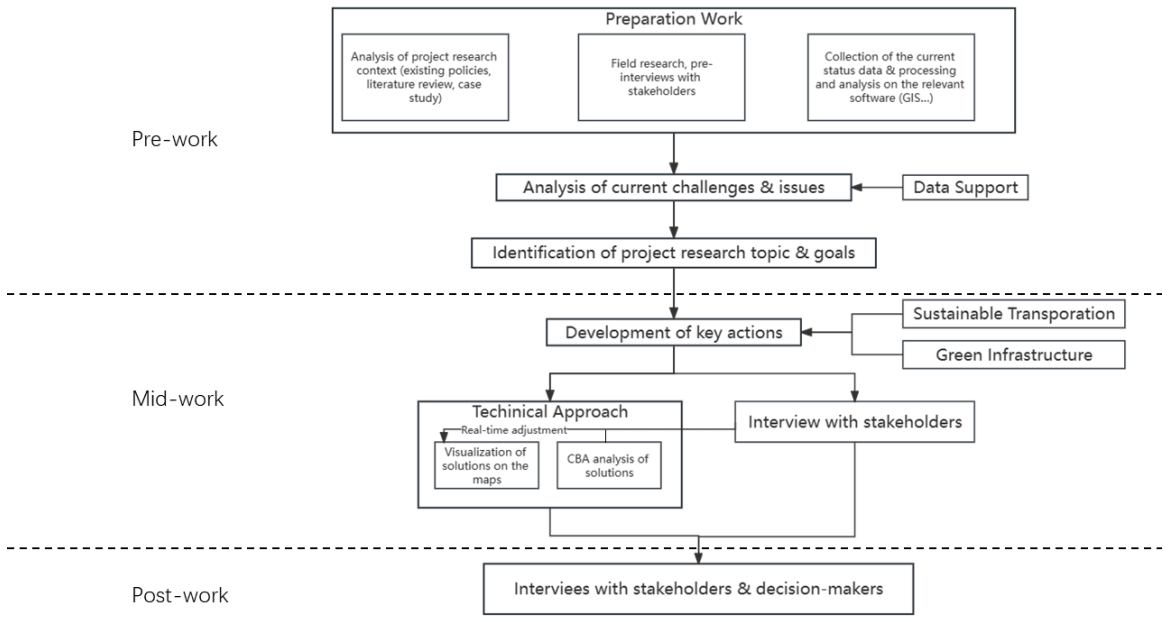

(Figure 2.4.1. Methodology Flowchart)

3 CASE STUDY ANALYSIS

3.1 **Thematic Study Selection** *(max 500 words)*

1. Maximizing Micro mobility- Unlocking Opportunities to Integrate Micro mobility and Public Transportation

Micro mobility is an affordable, efficient, low-carbon transportation option that has become an attractive alternative to private vehicles for short trips. Multimodal trips are based on the combination of micro mobility and public transportation (Figures.).

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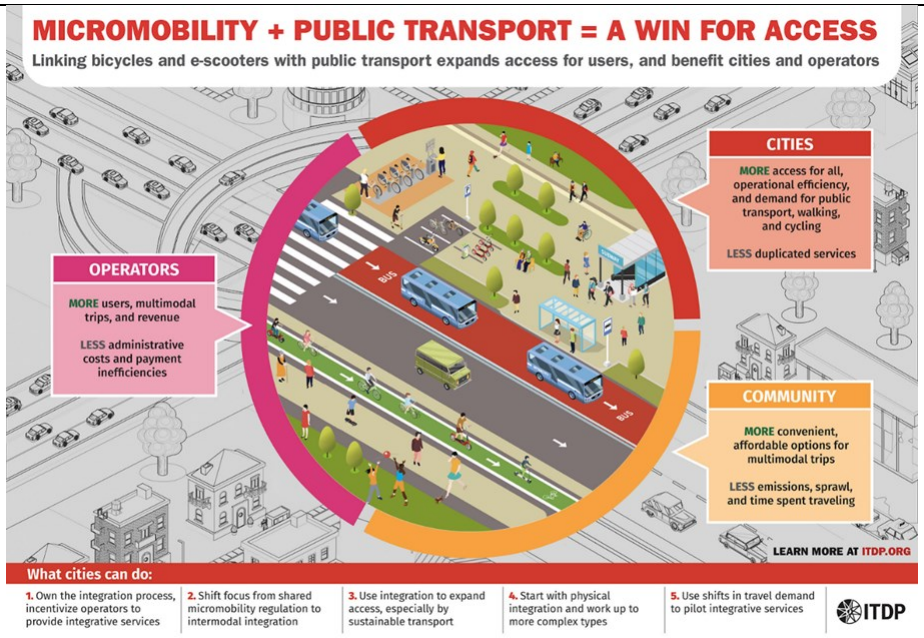

(Figure 3.1.1. Defining Micro-mobility Infographic)

Multimodal trips are characterized by the use of multiple modes of travel to reach a destination. Multimodal integration brings together physical infrastructure, payment, information, and/or institutional management across multiple transport modes to improve the multimodal trip experience for users.

The benefits of multimodal integration are multi-dimensional:

(1) Expand station service areas for people to be able access the network more easily or affordably.

(2) Increase use of public transport, walking and cycling which are the more reliable and flexible travel options.

(3) Improve experience for users by providing safe, convenient connection to fixed-route public transport services.

(4) Reduced congestion and air pollution due to the shift away from the traditional private vehicle model

(5) Improve equity and quality of life by shortening travel times and lowering the cost of longer-distance trips, especially for the low-income residents who live farther from the city center.

Micromobility integration should be supported by the public sector proactively and cooperate with the private sector. **To achieve this goal, approaches below can be done:**

(1) Physical integration:

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a. Micro mobility parking near public transport stations;

b. Protected micro mobility lanes (cycling lanes) that complement major public transit corridors and connect to transit stations.

(2) Payment and fare integration:

a. SMART CARDS for integrated payment between transport modes, such as city-managed bikeshare and public transit

b. MOBILE PAYMENT APPS for common digital payment across multiple modes.

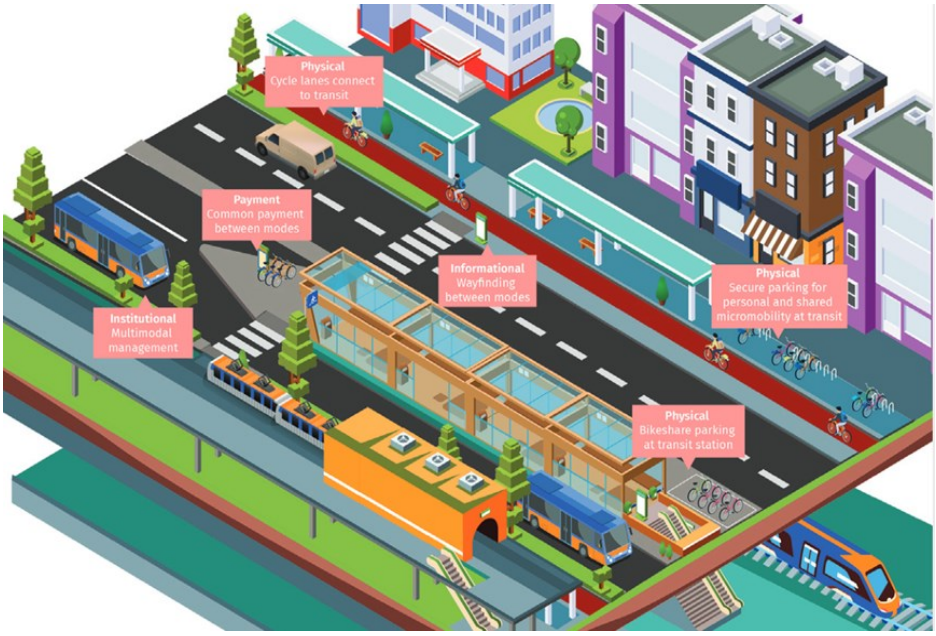
(3) Informational integration

Wayfinding Signage,Mobile Applications And Qr Codes.

(4) Institutional integration

Multimunicipal service areas, Multimodal management, Multi city micro mobility

pilot



(Figure 3.1.2. Schematic diagram of Multimodal integration)

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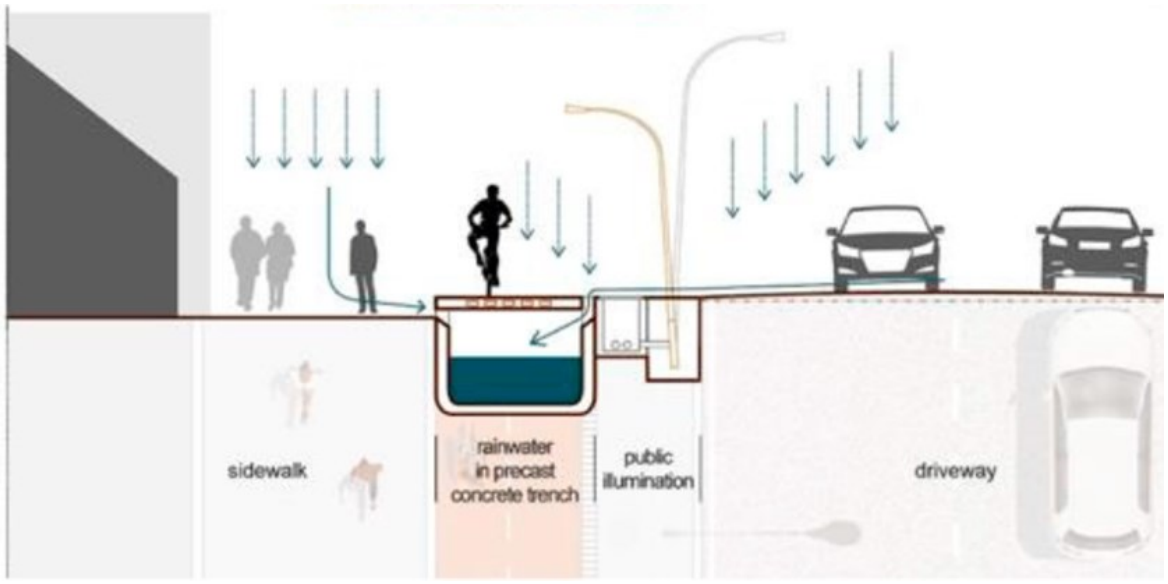
2. The Copenhagenize Current – Stormwater Management and Cycle Tracks (Clemente - 2022 - The cycle network as an environmental infrastructure)

To address the risk of urban flooding, Copenhagen has proposed transforming streets into infrastructure for storing and draining stormwater, and "The Copenhagenize Current - Stormwater Management and Cycle Tracks" goes one step further by proposing the use of narrowest streets to store stormwater.

As the section shown below, the project envisions combining bike lanes with a storm drain system, reserving space under the bike lanes to store stormwater and diverting stormwater from the sidewalks and sides of the road to stop stormwater retention. The bike lanes are constructed of sturdy earthen panels with LED lights to improve visibility and improve infrastructure for cyclists. Building on this, Prof. Jensen developed a project to create a wall of plants that, while serving as a noise barrier separating bicycle and automobile traffic, would act as a sponge to absorb the stormwater that accumulates in the channel below the road.



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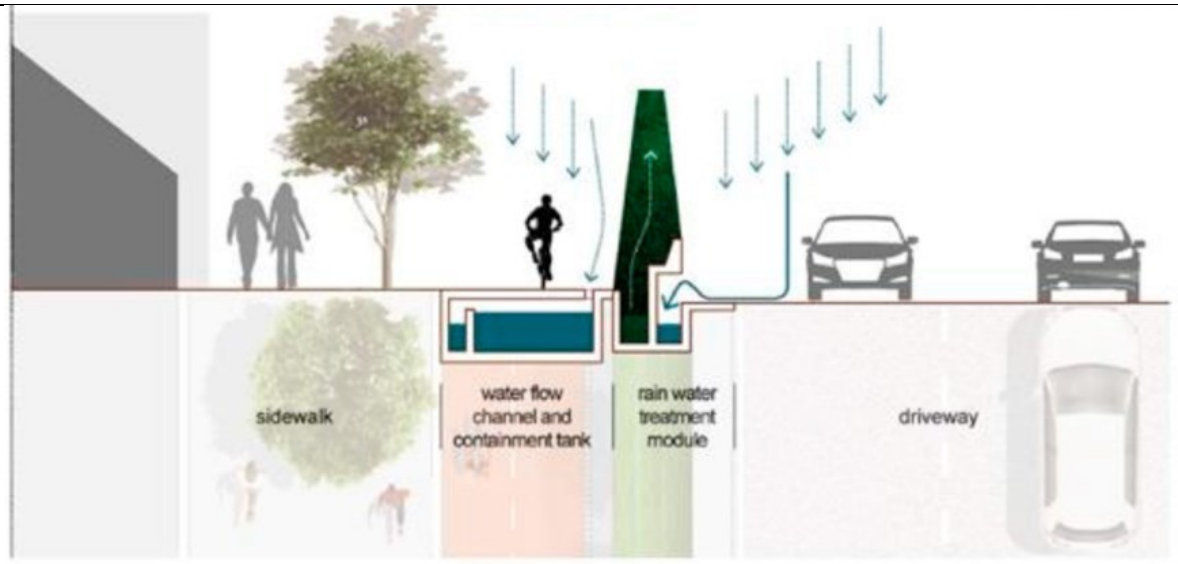

(Figure 3.1.3. Schematic diagram of "The Copenhagenize Current")

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3.2 **Spatialisation of Just Green Transition Impacts** *(max. 750 words)*

The "Spatialisation of Just Green Transition Impacts" represents a comprehensive and forward-thinking approach to addressing some of the most pressing challenges of our time. It centers on environmental responsibility, social equity, and geographic specificity. This concept offers a roadmap for fostering a more sustainable, inclusive, and environmentally conscious future while ensuring that the benefits of the transition are distributed fairly across diverse communities and regions.

The green transition, often referred to as the "green transformation," represents a fundamental shift toward a more environmentally sustainable and ecologically responsible economy and society. At its core, it involves a departure from practices that harm the environment, such as a heavy dependence on fossil fuels, and instead promotes the adoption of eco-friendly technologies and practices. The overarching goal is to reduce the environmental footprint and enhance overall sustainability.

A critical element within the green transition is ensuring that it unfolds in a just way. This means safeguarding communities, territories, and specific social groups from the potential negative consequences of these policies, or better yet, empowering them to actively participate in and benefit from these transformative processes. This notion is encapsulated in the term "Just Transition."

The "Spatialisation" component of this concept involves rendering the impacts of the green transition tangible by mapping, analyzing, and addressing them in specific geographic locations or regions. This spatial perspective is crucial for understanding where the effects are most pronounced and where targeted intervention may be necessary. By having a geographic dimension, this approach allows for a more precise allocation of resources and efforts.

The green transition has significant economic implications that ripple across various sectors. Investments in sustainable practices and technologies can lead to economic growth through a multiplier effect. As more resources are channeled into sustainable initiatives, the resulting increase in demand for sustainable products and services stimulates production, thereby boosting overall economic expansion. Forecasts from the International Energy Agency (IEA) suggest that global GDP could experience significant growth, with a projection of more than 4% higher by 2030.

This promising economic growth is further substantiated by the estimates of the International Monetary Fund (IMF), which suggests that the output multipliers for spending on renewable energy could range from 1.1 to 1.5. These figures compare favorably with the 0.5 to 0.6 multipliers associated with investments in fossil fuels. Consequently, the green transition presents not only the prospect of creating new job opportunities but also driving innovation within sustainable industries, thereby enhancing long-term economic stability.

Yet, amidst these optimistic economic forecasts, it's essential to consider the potential impact of inflation in the context of the green transition. This inflation, often termed 'climate flation,' may result from higher costs associated with the adoption of renewable energy and carbon taxes. However, in the long term, it is expected to have a disinflationary effect as energy costs decrease in a carbon-free economy.

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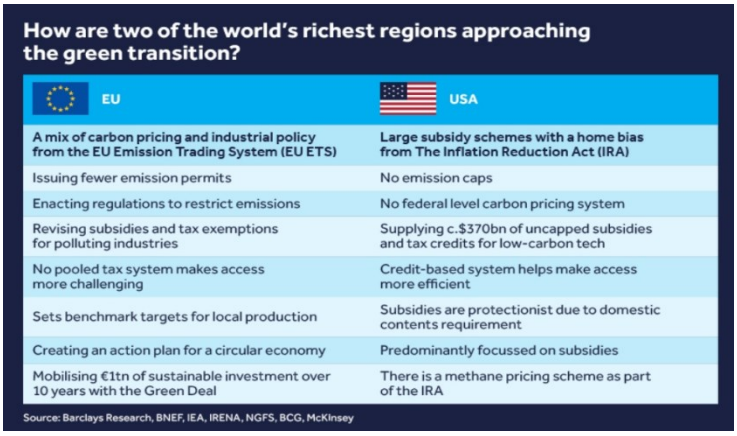
Furthermore, the revenue generated from carbon taxes can be strategically employed to lower other taxes or to increase public investment. This, in turn, contributes to economic sustainability by facilitating a transition toward greener and more sustainable economic practices.

In summary, the "Spatialisation of Just Green Transition Impacts" is a visionary concept that addresses the complex interplay of environmental responsibility, social equity, and economic resilience in the face of environmental challenges. This comprehensive approach offers a roadmap for ensuring that the benefits of sustainable policies and initiatives are distributed fairly across various regions and communities, fostering a more sustainable, inclusive, and environmentally responsible future. The green transition, an imperative in the global fight against climate change, offers the potential to significantly reduce greenhouse gas emissions and improve air quality. It also plays a crucial role in preserving natural resources and biodiversity. However, it's vital to ensure that vulnerable communities and specific social groups are protected from potential negative consequences, in line with the principles of a "Just Transition." Geographic specificity, as emphasized by "Spatialisation," allows for tailored strategies to address regional disparities and ensure equitable benefits.

On the economic front, the multiplier effect provides a positive outlook, suggesting that increased investments in sustainable practices and technologies can stimulate economic growth. This, in turn, creates new job opportunities, fosters innovation, and bolsters long-term economic stability. While inflationary concerns are valid, the green transition's potential to reduce energy costs and the strategic use of carbon tax revenue offers a promising path to economic sustainability in the long run.



(Figure 3.2.1. Comparison table of actions taken by the EU and the US to approach the green transition)

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3.3 Cost-Benefit Analyses to measure Just Green Transitions *(max. 750 words)*

Title: SE-CBA of Green infrastructure and sustainable mobility in Turin, Italy

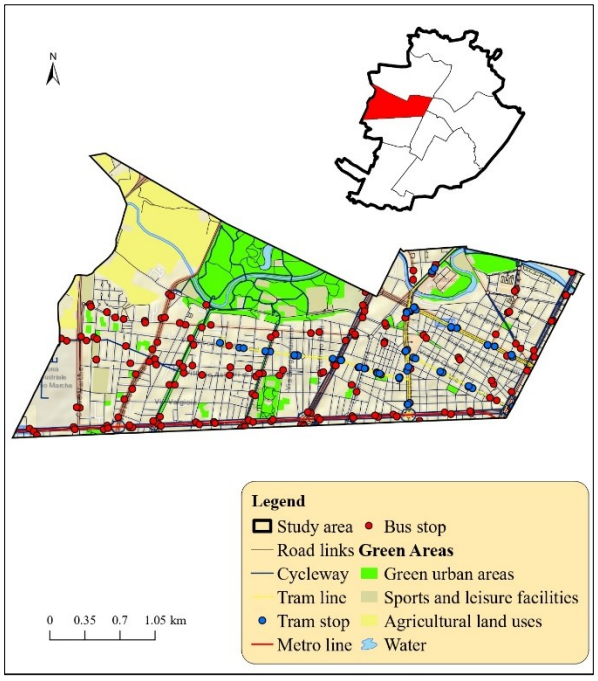
Subtitle: *A Vision for Multimodal Transport in Microzones*

Introduction:

Turin, with its rich cultural heritage and growing urban landscape, stands at a crucial juncture where the demand for efficient, sustainable, and inclusive transportation is more pressing than ever. As the city navigates the challenges of urbanization and seeks to enhance the quality of life for its residents, the integration of a multimodal transport system in microzones emerges as a strategic solution.

Multimodal transport refers to the seamless integration of various transportation modes within a single, unified system. Instead of relying on a single mode of transport, such as roads or railways, multimodal transport networks leverage a combination of modes, including road, rail, air, sea, and even non-motorized options like cycling and walking. The goal is to provide end-to-end connectivity, offering users a range of choices to navigate their journeys.

Considering multiple factors, this Microzone (See Figure 3.3.1) is chosen as the study area for CBA below,



(Figure 3.3.1 Microzone as study area)

Objectives

· Improve the efficiency of transportation systems to reduce travel times, increase speed, and optimize the use of infrastructure.

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· Increase accessibility by providing convenient and affordable transportation options for all members of the community.

· Enhance the safety of transportation systems to reduce accidents, injuries, and fatalities.

· Promote active transportation modes such as walking and cycling to improve public health outcomes.

· Support economic development by improving transportation infrastructure to facilitate the movement of goods and people.

Who benefits?

· Visitors (increased the number of tourists in the area)

· People living in the area

· Businesses operating in the area

· Local economy

· Land owners/Real estate owners / users

1 Identify Costs:

1.1 Construction costs

-Integrated Mobility Hubs:(bus station, tram station, metro station, bike station, monitoring real-time information and smart infrastructure, including digital signage and mobile apps, provides real-time information on transportation options, schedules, and traffic conditions)

-Tram line (40 million per kilometer)

-Bicycle parking rack (400€)

-Cycling path (a cycling path per kilometer approximately €500,000)

-Bus line (€2 million per kilometer)

1.2 Urban furniture

Urban furniture refers to the various elements and objects placed in public spaces within urban environments to serve functional, aesthetic, and social purposes.In our microzone we want to increase the area of public space.

-Benches: Provide seating for pedestrians and encourage social interaction in public spaces such as parks and sidewalks.

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Trash Bins: Public trash bins are strategically placed to encourage proper waste disposal and help keep urban spaces clean.

Street Lighting: Street Lights serve both functional and aesthetic purposes. They provide illumination for pedestrians and vehicles, enhance safety, and contribute to the overall ambiance of urban spaces.

Bus Shelters: Shelters at bus stops provide protection from the elements for waiting passengers. They include seating, information displays, and advertising spaces.

1.3 Environmental mitigation costs

-Trees (500 tree)

Multimodal Transport in microzone		TOTAL	1,400	Lenght (km)	Total area (r
Cost Category		(m²)/no	EUR		
HUB		13,200	500	6,600,000	
Square/Pedestrian 1		10,565	80	845,200	
Street		1,000	70	70,000	
Urban furniture Benches		50	150	7,500	
Urban furniture playground		20	100	2,000	
Urban furniture Trash Bins		100	200	20,000	
Urban furniture Bus Shelters		30	600	18,000	
Trees		500	150	75,000	
Streetlights		100	300	30,000	
Bus Stops		20	1,000	20,000	
Bicycle rack		10	400	4,000	
					€ 7,691,700.

2 Identify Benefits:

2.1 Benefit 1: Health benefits from improved air quality

The microzone project starts in 2023 and ends in 2038.From the implementation of the project we Improve air quality from reduce traffic in the area. We have used the number of cars passing through the microzone for each day, month and year. The main indicators to measure pollution are:PM10,PM2.5 and NO2.Without the project total pollution cost per year is 1 555 €.With the project, traffic will be reduced by at least 50%.Starting from year 5 total pollution cost per year is 788 €.

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Improved air quality fro	recurrent per year				
Total leng	6.00				
Cars flow					
number	165	https://www.muoversiatorino.it/it/numeri-mobilita/			
number	9892	https://www.eea.europa.eu/articles/forests-health-and-climate-change/key-facts/			
number	237,407				
number	5,222,954				
Total emissions					
PM10	0.000026	https://:	0.000156	**10**	kg PM10
PM2.5	0.00003		0.00018	**11**	kg PM2.5
NOx e	0.000017		0.000102	**6**	kg Nox
Prices					
kg	44.6	Environmental prices handboo		**436**	Eur per year
kg	79.5	Environmental prices handboo		**897**	Eur per year
kg	34.7	Environmental prices handboo		**222**	Eur per year
				1,555	Total pollution cost per year
	Hp: with the project, traffic will be reduced by at least 50% in the area				

(https://www.torinorespira.it/andamento/)

Table:1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Without	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	1,555	1,555	1,555	1,555	1,555	1,555	1,555	1,555	1,555	1,555	1,555	1,555	1,555	1,555	1,555
With				50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
	-	-	-	778	778	778	778	778	778	778	778	778	778	778	778
Net	(1,555)	(1,555)	(1,555)	(778)	(778)	(778)	(778)	(778)	(778)	(778)	(778)	(778)	(778)	(778)	(778)

2.2 Benefit 2: GHGs emission captured by increased green space

Increased green space (m2)

tree	500
1 tree absortion per year (kg)	22
Total GHGs absorbtion (ton/year	11

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Without	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
0	24	27	50	55	1785	243	275	306	337	367	429	459	488	518	548
With	15%	15%	25%	25%	80%	95%	100%	100%	100%	100%	100%	100%	100%	100%	100%
0	244	272	501	547	17846	2435	2750	3058	3366	3674	4290	4587	4884	5181	5478
Net	220	245	450	493	16062	2191	2475	2752	3029	3307	3861	4128	4396	4663	4930

Health benefits from increased green spaces

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Every 10% increase in green space is associated with a reduction in diseases equivalent to an increase of five years of life expectancy. The total area in microzonen is 5 962 275 m 2 where 1 181 310 m2 is green area. Total green space with the project is 1 500 000m2.

2.3 Benefit 3: Economic development and increased property values

One of the biggest benefits in this project is economic development and increased property values. To calculate this we have number of residential units , number of commercial units and prices.(https://www.immobiliare.it/agenzie-immobiliari/)

Increased value of properties	Units	Average Size (hp	Value
Residential	3000	75	1,300
Commercial	1000	30	3,000

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Without	value increase at 0.5% per year				0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
	382,500,000	382,500,000	382,500,000	382,500,000	382,950,000	384,864,750	386,789,074	388,723,019	390,666,634	392,619,967	394,583,067	396,555,983	398,538,762	400,531,456	402,534,114
With	increased value at 1% after project implemen			1%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
	382,500,000	382,500,000	382,500,000	386,325,000	388,256,625	390,197,908	392,148,898	394,109,642	396,080,190	398,060,591	400,050,894	402,051,149	404,061,404	406,081,712	408,112,120
Net	-	-	-	3,825,000	5,306,625	5,333,158	5,359,824	5,386,623	5,413,556	5,440,624	5,467,827	5,495,166	5,522,642	5,550,255	5,578,007

Value increase at 1% per year

2.4 Social Benefits

Benefit 4: New jobs created

Benefit 5: Improved accessibility and mobility

Benefit 6: Improved accessibility for people with disabilities

Benefit 7: Increased traffic safety

Benefit 8: Improved health benefits from cycling

3 Calculate Net Present Value (NPV):

Net Present Value (NPV) is a financial metric used to evaluate the profitability of an investment. It represents the difference between the present value of cash inflows and the present value of cash outflows over a period of time, typically the lifespan of the investment.

To calculate NPV we have: total benefits, total cost and we calculate Net Cash Flow.

Total Benefit : 5.913.098.666 €

Total cost: 2.213.087.433 €

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Net Cash Flow :5.913.098.666 € - 2.213.087.433 €=370.011.233 €

To calculate NPV we have used a 5% discount rate,5% of Net Cash Flow.

NPV =351.510.671€

B1_Benefit from Improved air quality		-	-	778	778	778	778	778	778	778	778	778	778	778	778
B2_GHGs captured by added g	220	245	450	493	16,062	2,191	2,475	2,752	3,029	3,307	3,861	4,128	4,396	4,663	4,930
B3_Health ben	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B4_Increased value of real est	382,500,000	382,500,000	382,500,000	386,325,000	388,256,625	390,197,908	392,148,898	394,109,642	396,080,190	398,060,591	400,050,894	402,051,149	404,061,404	406,081,712	408,112,120
B5_Create new jobs													-		
B6_Improved accesibility for people with disabilities													-		
B7_Improved acessibility and mobility													-		
B9_Increased traffic safety													-		

Discount Rate (SDR1)	5%
Social Discount Rate (SDR2)	3%
Appraisal period (years)	15

4. Risk Qualitative Analysis:

(1) Identify Risks

Potential risks in the CBA process for this project may be both internal and external. Internal may include financial, operational and regulatory aspects, while external may include technical and environmental aspects.

(2) Risk Assessment

Internally, financial constraints pose a challenge due to the high construction cost of the 15-year sustainable mobility project in Turin's urban regeneration period. Limited municipal financial support may impact the project's execution. Extended construction time raises monitoring and regulatory risks, risking lax oversight.

Externally, uncertainties in technical support and environmental impacts (construction waste, noise, emissions) are potential risks.

(3) Risk Mitigation Strategies

Internally, diversify sources of founding, control costs through collaboration with enterprises, and implement rigorous stage-by-stage planning.

Externally, engage sustainable transport professionals, collaborate with universities for technical support, manage construction waste, control emissions, establish quiet construction sites, and conduct regular environmental impact assessments.

(4) CBA Adjustment

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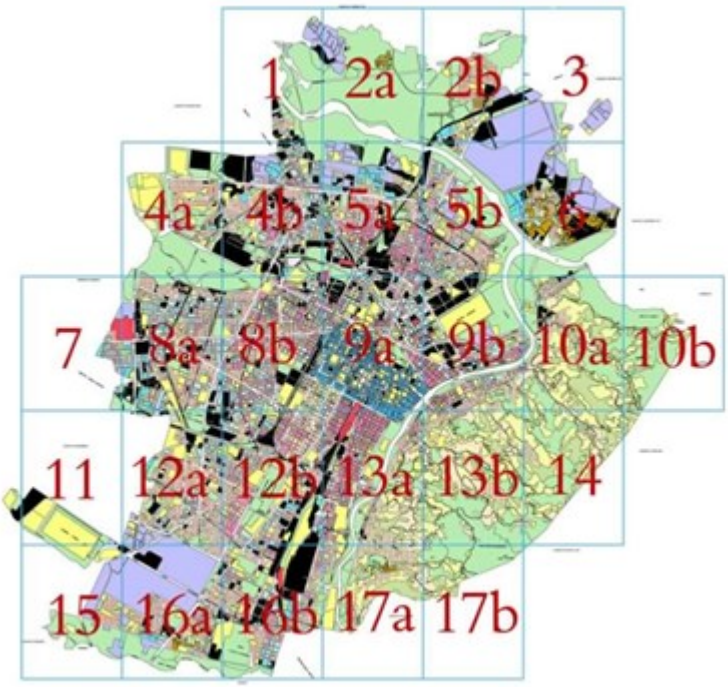
Adjustments will be made mainly in terms of costs, including actions to control construction costs, construction duration, allocation of facilities, and so on. There is also a need for a basic assessment of the environmental impact of construction (included in the cost part).

3.4 Land-Based financing for Climate Solutions *(max. 750 words)*

1. Study Site Selection

Considering the representative Microzone selected by the CBA, and based on the requirement that the study area selected for Land-Based financing be selected from the PRG development area, 8b was selected because it partially overlaps with the Microzone (See Figure 3.4.1).



(Figure 3.4.1 Development area of PRG,

Source: Tavole di piano | Geoportale - Città di Torino (comune.torino.it))

The Land Use Plan Map for 8b shows the largest proportion of residential land use, with commercial land use mainly as an ancillary facility to the residential properties, and it is apparent that there is less planned green space in the area. (See figure 3.4.2)

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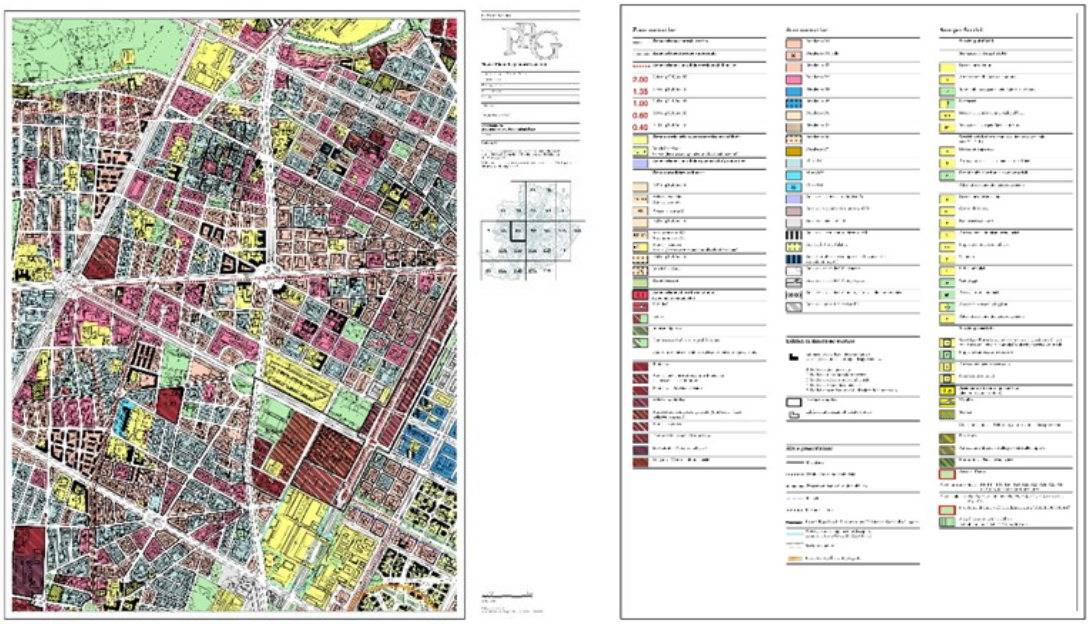

(Figure 3.4.2 Land use plan map from PRG,

Source: Tavole di piano | Geoportale - Città di Torino (comune.torino.it))

2. Land-Based financing Table

0_Development Revenues

Area for residential use (m²)	816.625
Area for commercial use (m²)	188.429
Total built area (m²)	1.005.054
Total revenues from residential use (€) A	816625*2120= 1.731.245.000
Total revenues from commercial use (€) B	188429*1300= 244.957.700

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Total revenues (€) A+B	1.976.202.700

1_Cost

Land Cost (version 1)	
Developed area (m^2)	1.005.054
Land price	600 €/m^2
Land Cost (version 2)	
Land cost based on development revenue	1.005.054*600= 603.032.400
Construction cost	
Total construction cost for residential use (€) A	816.625*480= 391.980.000
Total construction cost for commercial use (€) B	188.429 *480= 90.445.920
Total construction cost (€) A+B	482.425.920
Total development cost (land + construction)	1.085.458.320

2_Developer profit

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Requested developers profit (€)	325.637.496

3_Taxes

Impact fee (€)	No information
Registration tax (€)	603.032.400*9%= 54.272.916
Total taxes	54.272.916

Residual Land Value = 0-(1+2+3)

Total Residual Land Value (€)	510.833.968
RLV per m2 (€)	508.26
RLV per Development Revenues (%)	25.8%

3. Indicator explanation:

0_Development Revenues

Area for residential use (m^2): the surface area only for residential use（Data Source: BDTRE）

Area for commercial use (m^2): the surface area only for commercial use（Data Source: BDTRE）

Total built area (m^2): area for residential and commercial use

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Total revenues from residential use (€): properties price for residential use* area (Data Source: Italy: price of properties for sale in Turin 2022 | Statista)

Total revenues from commercial use (€): properties price for commercial use* area (Data Source: Commercial properties for sale - Immobiliare.it)

1_Cost

Developed area (m2): equal to total built area

Land price: 600€/m2 (Data Source:How to build a house in Italy from scratch, a guide to how much it costs and what permits are needed — idealista)

Land cost based on development revenue: Total built area* Land price

Total construction cost for residential use: The cost unit price is 480 €/ mq (Data Source: Regional reference legislation in the field of construction costs)

Total construction cost for commercial use: The cost unit price is 480 €/ mq, then multiply building area, then multiply building area.

2_Developer profit

Requested developers profit: 30% of development cost

3_Taxes

Impact fee (€):The fee imposed by local government for new development projects, but no information for Turin

Registration tax (€): 9%of the value of the building land purchased (Data Source:How to build a house in Italy from scratch, a guide to how much it costs and what permits are needed — idealista)

Total taxes: impact fee+registration tax

4. Discuss on the feasibility of the intervention based on the resulting findings

The estimates indicate that the residual value of the land is higher than the cost of development and 25% of Development Revenues which is financially viable.

Considering the sustainable mobility development related to the theme of project, the value of property will be raised, but the cost remains the same, which means the Development Revenues can be more. Expected increase of property value was calculated at CBA part as shown below. Value increase at 1% per year.

(Table 3.4.1 Statics of increasing value of properties)

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Increased value of properties	Units	Average Size (hp	Value
Residential	3000	75	1,300
Commercial	1000	30	3,000

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Without	value increase at 0.5% per year				0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
	382,500,000	382,500,000	382,500,000	382,500,000	382,950,000	384,864,750	386,789,074	388,723,019	390,666,634	392,619,967	394,583,067	396,555,983	398,538,762	400,531,456	402,534,114
With	increased value at 1% after project implemen			1%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
	382,500,000	382,500,000	382,500,000	386,325,000	388,256,625	390,197,908	392,148,898	394,109,642	396,080,190	398,060,591	400,050,894	402,051,149	404,061,404	406,081,712	408,112,120
Net	-	-	-	3,825,000	5,306,625	5,333,158	5,359,824	5,386,623	5,413,556	5,440,624	5,467,827	5,495,166	5,522,642	5,550,255	5,578,007

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3.5 Just Green Transition: between carbon-neutrality and re-industrailisation *(max. 750 words)*

1. Summary of the case study of Skellefteå

Skellefteå, the historic industrial and mining town. In the early 1990s, when industry moved out of Europe, it did not lose all of its industries, and since then, its forestry, metals and energy sectors have continued to develop rapidly. Today, it is entering a post-industrial era, and the city is pursuing the development of the IT and service sectors. However, the arrival of Northvolt Ett has given a strong impetus to its re-industrialisation.

Today, there is no doubt that the new energy sector, including electricity, is a driving force for economic and social development. Consumption of new energy-related products has exploded over the past two years. Especially the consumption of electric vehicles, in the future, the automobile market will be occupied by them. Northvolt Ett primarily produces lithium batteries, which are known for their use as a source of power for electric vehicles.

Northvolt Ett's site in Skellefteå was chosen for the following reasons: (1) The site has sufficient hydropower resources for electric power production; (2) Sufficient land for the construction of the plant; (3) The local infrastructure is superior; (4) It has a deep industrial heritage; (5) Strong local support for innovation and a mature system;(6) A well-established trust network.

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Skellefteå is now facing a decline in population numbers, and Northvolt Ett is bringing more jobs to Skellefteå to attract young people back.

At the same time, however, **this action faces a number of challenges**: (1) the difficulty of renting housing and the lack of affordable housing; (2) Due to the large influx of outsiders, local education and health facilities are in short supply; (3) Regional accessibility needs to be strengthened; (4) In addition to job opportunities, the local area needs to provide more attractive activities for young people; (5) There is a lack of skilled professionals who are skilled in technology.

In order to address these challenges, **Skellefteå proposes improvements with a view to providing residents with a more livable city and better daily life:** (1) Provide residents with public spaces for daily recreation;(2) Establish cultural centers to provide activities for people of all ages; (3) Build a large number of eco-friendly housing and set up temporary camps for daily use as hotels and rented apartments; (4) Improve local transportation, electrify public transportation and meet the 15-minute city principle, while at the same time promoting awareness of sustainable transportation; (5) Improve accessibility to the outside of the city; (6) Increase the emphasis on education and skills training, and set up and bring in more educational organizations.

Although there are many countermeasures, Skellefteå still faces many unknowns, and these are new challenges. Nevertheless, Skellefteå's responses to the challenges of reindustrialization are still worthy of study by many industrial cities.

2. Just Green Transition in Turin - From sustainable transportation and green infrastructure perspective

Through the study of the above case, Turin, which also has a long history of industrial industry, can be inspired by it. Although the focus of development varies from city to city in the post-industrial era, they all need to follow a green, sustainable and just development path.

With sustainable mobility and green infrastructure, Turin can go its own way. Inspired by the Skellefteå 15-minute city principle and considering the unbalanced situation of public transportation in Turin, **"Multipurpose Transportation Micro-zones"** can be created to achieve sustainable transportation in Turin. The micro-zones would be defined according to the population density, the frequency of public transportation, the availability of bicycle paths and the amount of green areas.

The benefits are multidimensional:

(1) Environmental level: New energy public transportation will be promoted and combined with micro-mobility such as bicycles and e- scooters, changing people's traditional automobile mode to green mobility, thereby r**educing emissions and promoting sustainable environmental development.**

(2) Social level: By improving low-carbon transportation options, residents in the region will be able to independently choose the mode of transportation that best suits them, thus respecting everyone's interests. At the same time, people's travel costs can be reduced considering that public transportation and

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micro-transportation are more affordable. **Transportation justice is achieved from the perspective of spatial justice and distributive justice.**

At the same time, a **"Green Corridor Network"** was advocated, a network that would contribute significantly to carbon sequestration, improved air quality, temperature regulation, flood mitigation and support for biodiversity. Various green amenities could be laid out on bike paths, bus stops, parking lots, etc., in keeping with sustainable transportation. Thus truly realizing a just green transition for Turin.

4 POLICY ADVICE AND RECOMMENDATIONS

1 Main Challenges

Amidst the challenges of Just Green Transitions in Turin, the city navigates intertwined hurdles in social, economic, and environmental realms. From reshaping urban planning to fostering behavioral change, Turin addresses multifaceted challenges, aiming to harmonize social inclusivity, economic resilience, and environmental sustainability in its transformative green initiatives.Here is a list of challenges:

Social Challenges:

1-Integrated Urban Planning:

Overcoming social resistance to collaborative urban planning efforts.

Adapting urban design principles to accommodate diverse social needs and preferences.

2-Incentive Programs for Behavioral Change:

Navigating resistance to behavioral change among individuals with different social attitudes.

Crafting public awareness campaigns that effectively engage and resonate with diverse demographics.

3-Job Transition and Skill Development:

Managing social resistance during the transition of workers to new, sustainable job opportunities.

Designing skill development programs that address the unique social needs of the workforce.

4-Affordability and Access:

Balancing economic considerations to make sustainable transportation socially accessible without compromising stakeholders' financial stability.

Evaluating and revising pricing structures with sensitivity to social inclusivity.

Economic Challenges:

1-Investment in Sustainable Infrastructure:

Securing adequate funding for sustainable transportation infrastructure amidst economic constraints.

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Establishing public-private partnerships that align economic goals while overcoming potential conflicts of interest.

2-Job Transition and Skill Development:

Managing economic challenges during the workforce transition to new, sustainable job opportunities.

Designing skill development programs that address the economic realities of the workforce.

3-Affordability and Access:

Balancing economic considerations to make sustainable transportation economically accessible without adversely affecting stakeholders' financial stability.

Evaluating and revising pricing structures with economic considerations in mind.

Environmental Challenges:

1-Integrated Urban Planning:

Overcoming environmental resistance to collaborative urban planning efforts.

Adapting urban design principles to enhance ecological considerations in public spaces.

2-Environmental Impact Assessments:

Conducting comprehensive environmental impact assessments amidst potential challenges in predicting and mitigating ecological repercussions.

Ensuring that assessments prioritize environmental sustainability and transparency to address concerns from environmental advocates.

3-Monitoring and Adaptive Management:

Establishing a robust monitoring and evaluation framework with a focus on environmental metrics.

Implementing adaptive management strategies that prioritize environmental conservation, even in a bureaucratic or political environment.

2 Overarching Objective

Within the realm of addressing challenges, the central objective of Just Green Transitions in Turin is to navigate intertwined hurdles across social, economic, and environmental dimensions. This comprehensive endeavor not only seeks to reshape urban planning but also prioritizes sustainable mobility and green infrastructure. From fostering behavioral change to addressing workforce transitions, the overarching goal is to harmonize social inclusivity, economic resilience, and environmental sustainability, thus guiding Turin towards a transformative and green future.

3 Specific Objectives

Affordability and Access:

1-Review pricing structures:

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Objective: Adjust pricing models for sustainable mobility considering income levels, ensuring affordability.

Definition: Modify pricing for eco-friendly transportation to make it economically accessible across socio-economic groups.

2-Implement targeted subsidies:

Objective: Introduce subsidies for sustainable transport, prioritizing marginalized communities.

Definition: Provide financial support to make green transportation affordable, particularly for underprivileged communities.

Monitoring and Adaptive Management:

1-Real-time monitoring system:

Objective: Launch a dynamic monitoring system for sustainable mobility projects with real-time environmental metrics.

Definition: Establish an agile monitoring mechanism for immediate assessment and action on the environmental impact of green transportation initiatives.

2-Cross-functional task force:

Objective: Form a task force for adaptive management, ensuring swift responses to emerging challenges in the sustainable mobility transition.

Definition: Create a responsive team for agile decision-making in the implementation of green infrastructure projects.

4 Strategies

Strategies are designed to effectively address challenges by identifying diverse development trajectories and opportunities to restructure the current development path. Each strategy is tailored to contribute to the resilience, adaptability, and sustainability of urban development, reflecting a comprehensive approach to navigate emerging challenges and foster positive transformation.

1-Dynamic Mobility Modeling:

Utilize advanced modeling for real-time assessment and prediction of mobility patterns, enabling proactive adjustments to development trajectories.

2-Innovation Incubators for Sustainability:

Establish hubs for sustainable development innovation, fostering collaboration and incubating solutions to address emerging challenges.

3-Data-Driven Decision Making:

Prioritize data-driven decisions, using real-time analytics to inform strategic choices and adapt development trajectories based on empirical evidence.

4-Citizen-Centric Co-Design:

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Adopt a co-design approach involving citizens in the development process, ensuring their needs shape the trajectory of sustainable projects.

5-Circular Economic Systems Integration:

Integrate circular economic principles into infrastructure planning to minimize waste and promote resource efficiency.

6-Collaborative Public-Private Initiatives:

Foster collaborative initiatives between public and private sectors to leverage expertise, resources, and innovative solutions for sustainable development.

5 Actions

Regarding to coherent actions that can support Turin's current transition here is a list of practical action that can be implemented:

1-Dynamic Mobility Modeling:

Establish a city-wide sensor network for real-time traffic and transportation data.

Collaborate with technology firms to develop a predictive analytics platform for mobility trends.

Implement dynamic traffic signal control systems to optimize flow based on real-time data.

2-Innovation Incubators for Sustainability:

Create a dedicated innovation hub focused on sustainable urban development.

Facilitate workshops and hackathons to encourage the ideation of sustainable mobility solutions.

Establish a mentorship program connecting established businesses with sustainability-focused startups.

3-Data-Driven Decision Making:

Invest in training programs for city staff on data analysis and interpretation.

Develop a centralized data repository to streamline data access for decision-makers.

Integrate data analysis tools into key decision-making processes, ensuring informed choices.

4-Citizen-Centric Co-Design:

Launch a user-friendly digital platform for citizen feedback on urban development initiatives.

Conduct regular town hall meetings to gather input on sustainable mobility projects.

Establish citizen advisory committees for ongoing consultation on urban planning decisions.

5-Circular Economic Systems Integration:

Collaborate with local businesses to create a circular economy coalition.

Develop policies that incentivize businesses to adopt circular practices in their operations.

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Implement awareness campaigns to educate businesses and citizens about the benefits of a circular economy.

6-Collaborative Public-Private Initiatives:

Establish a dedicated task force for ongoing dialogue and collaboration between public and private entities.

Offer incentives such as streamlined approvals or tax breaks for private sector involvement in sustainable projects.

Develop joint pilot projects that showcase the benefits of public-private collaboration in sustainable urban development.

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