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The University of Genova Climate Policies

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Abstract. The University of Genova (UniGe) has undertaken a significant commitment against climate change, with the goal of becoming climate neutral by 2030. The commitment began in 2014 with the calculation of its carbon footprint and has developed through several stages. In 2019, it joined "The Sustainable Development Goals Accord" and declared a Climate Emergency, also joining the United Nations' "Race To Zero for Universities and Colleges" campaign. In 2022, it approved its Climate Neutrality Strategy 2022-2030, and in 2025, it will implement its Climate Action Plan. UniGe's Climate Action Plan includes two main sections: mitigation and adaptation. The mitigation plan, based on annual greenhouse gas (GHG) inventory, outlines the path to climate neutrality, with intermediate and long-term goals to reduce direct emissions (from fossil fuels), indirect emissions linked to energy consumption, and indirect emissions related to mobility, waste, water consumption, and procurement. Residual emissions will be offset through the purchase of certified credits. The adaptation plan aims to increase UniGe's resilience to climate change: it is based on the Liguria Region strategy, integrated with internal policies and procedures for risk management (weather alerts, hydrogeological risks, exposure to extreme temperatures, etc.) and actions for educating and raising awareness within the academic community.

Keywords:

Climate Change, GHG inventory, Emissions, Energy Plan, Mobility Plan

1. Introduction

Climate change is viewed as a systemic risk that intersects with nearly all the Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development, affecting human health, water and food security, biodiversity, and geopolitical stability [14]. Among the top priorities of the Agenda 2030, the reduction of greenhouse gas (GHG) emissions has emerged as a defining objective of the international community. This priority reflects the scientific consensus that unchecked global warming, driven largely by anthropogenic emissions of CO_2 and other greenhouse gases, poses a threat of irreversible and potentially

catastrophic impacts on the climate system [15–17]. Rising temperatures are already amplifying the frequency and intensity of extreme weather events, altering precipitation patterns, accelerating sea level rise, and contributing to the loss of biodiversity and ecosystem services [18].

Today, the global transition toward low-carbon and sustainable energy systems is widely recognized as one of the most powerful and necessary levers for effective climate action [1, 2]. Decarbonizing energy systems, increasing the share of renewable energy, improving energy efficiency, and promoting behavioral change are central components of this transformation. Such a transition is not only necessary to meet climate targets, but also represents an opportunity to create jobs, stimulate innovation, and improve public health through cleaner air and more sustainable urban environments. This commitment to transformative change is further reinforced at the continental level by the European Green Deal, the European Union's flagship initiative to make Europe the first climate-neutral continent by 2050 [19]. The Green Deal outlines a comprehensive set of policies and investment strategies aimed at reducing emissions, promoting circular economy practices, conserving biodiversity, and fostering environmental justice [3]. Achieving these goals will require unprecedented collaboration across sectors and governance levels—including strong involvement from academic and research institutions.

In this context, universities are increasingly called upon to play a leading and proactive role. Their capacity to produce interdisciplinary knowledge, engage in international collaboration, and maintain strong connections with both public institutions and private stakeholders makes them uniquely positioned to support the societal transition toward sustainability [4]. Universities can act as incubators of innovation and change, not only through their core missions of education and research, but also through a broader social engagement agenda. This includes their "third mission," which encompasses the transfer of scientific and technological knowledge to society, the dissemination of sustainability practices, and the promotion of inclusive and resilient communities. Moreover, university campuses themselves can become testing grounds for sustainable innovation, functioning as "living laboratories" where theoretical solutions are applied in real-world settings. Through initiatives such as Living Labs, universities can foster open innovation processes that bring together students, researchers, local authorities, businesses, and civil society to co-design and implement sustainable solutions. These environments are particularly effective in demonstrating the feasibility and scalability of interventions in areas such as green infrastructure, sustainable mobility, energy efficiency, and circular resource use [5].

The University of Genova (UniGe), located in the northwestern Italian region of Liguria, exemplifies this integrated approach. The university has formally identified sustainability as one of the five strategic pillars of its Strategic Plan 2021–2026, alongside digitalization, inclusion, internationalization, and quality in education and research. This institutional vision reflects a deep awareness of the university's role in responding to both local and global challenges and is explicitly embedded in the university’s Charter. UniGe acts as a bridge between knowledge production and territorial development, playing a pivotal role in connecting communities, policy-makers, and industries with the broader sustainable development agenda. In this framework, UniGe is committed to promoting sustainability across all aspects of academic life. It engages in partnerships with public authorities, private companies, non-governmental organizations, and other academic institutions to share successful practices, co-develop innovative solutions, and promote high-impact research projects. The university is a member of several national and international sustainability

networks, including the International Sustainable Campus Network (ISCN) and the Italian University Network for Sustainable Development (RUS), which support peer learning and collaboration on sustainability reporting, climate action, and institutional strategies. Its performance is also monitored through international assessments such as the UI GreenMetric World University Ranking and the QS Sustainability World University Ranking. The institutional commitment to sustainability at UniGe was previously coordinated by a dedicated Commission on Environmental Sustainability, which had been active for nearly a decade. In 2024, this body was replaced by the Sustainability Commission, which now addresses not only environmental issues but also social aspects of sustainability. This Commission, coordinated by a Pro-Rector for Sustainability, includes the Energy Manager and the Mobility Manager, and is composed of both academic and technical staff, as well as a student representative. It is supported by a Sustainability Office and works in close cooperation with the university's governance bodies, faculties, working groups and technical units to define priorities, monitor progress, and support the mainstreaming of sustainability principles in teaching, research, and campus operations.

Building on these foundations, UniGe has recently adopted a comprehensive Climate Neutrality Strategy for 2022–2030. This strategy outlines the university's roadmap to achieve a substantial reduction in GHG emissions, with the goal of becoming climate-neutral within the next decade. In 2025, the strategy is being translated in a specific Climate Plan, which includes both mitigation measures—such as the decarbonization of energy use and sustainable mobility policies—and adaptation actions aimed at increasing the resilience of university infrastructure and activities to climate risks. It also includes clear targets, a governance structure, and a set of monitoring indicators aligned with national and European frameworks. The current Climate Strategy and the upcoming Climate Plan are based upon results from the GHG inventory periodically conducted, which allows the university to monitor its carbon footprint and identify priority areas for intervention. Particular attention is given to the areas of energy and mobility management, which are seen as strategic domains for innovation and impact.

Through this path, the University of Genova reaffirms its commitment to sustainability as a cross-cutting priority and positions itself as a key actor in the broader climate transition. By integrating sustainability into its institutional strategy, fostering partnerships, and implementing concrete actions, UniGe contributes meaningfully to the achievement of the SDGs and to the implementation of the European Green Deal at the territorial level.

2. Scenario of UniGe Climate Change Strategy

Climate change management and greenhouse gas (GHG) emissions reduction represent one of the most pressing challenges for sustainability today. Over the past thirty years, growing scientific consensus has increased public awareness of this issue, and this awareness is now influencing policymakers and shaping the future direction of the global economy, as well as individual behaviors. In this context, public institutions have a crucial role to play. By voluntarily adopting emission reduction programs and developing clear regulatory frameworks, they can lead the way in setting standards and verifying actual reductions. Universities can contribute significantly through two main avenues: direct emission reductions – even medium-sized institutions can generate thousands of tons of CO_2 annually from energy use alone, and education and cultural influence – students should be exposed to good practices in emissions management within their own campuses, preparing them to apply such principles in their future professional and personal lives.

2.1. ISO-Compliant Carbon Footprint Accounting

Developing a comprehensive GHG inventory is a key step toward understanding and managing emissions. For universities, this not only supports transparent reporting but is also becoming a strategic tool in engaging stakeholders and responding to emerging environmental policies. Although universities are not typically subject to strict environmental regulations, high GHG emissions can lead to increased operational costs. A clear emissions reporting system can help identify opportunities for energy efficiency and drive the adoption of low-impact practices. Therefore, carrying out a rigorous inventory is essential for setting reduction targets and tracking progress over time.

Following the definition of the organizational boundaries, the operational boundaries of the GHG inventory for the University of Genova were established, in accordance with ISO 14064 1:2019 [6]. This standard requires organizations to classify GHG emissions and removals into three main categories: direct emissions, indirect emissions from energy consumption, and other indirect emissions. The operational boundaries determine which sources and sinks of GHGs are to be included, based on a multi-criteria assessment. The operational boundary definition process involved a preliminary identification of all potential emission sources and sinks related to the university's activities. Emissions were estimated using a data-driven approach, where activity data—such as fuel consumption, electricity usage, kilometres travelled, and volumes of waste—were combined with appropriate emission factors. In cases where complete datasets were unavailable, conservative assumptions were applied to avoid underestimation. The inventory encompasses a broad range of emissions sources, including direct emissions from fuel combustion and refrigerant leaks, indirect emissions from purchased electricity, and other indirect emissions such as waste management, business travel, water use, and daily commuting. Although some relevant sources, such as emissions from remote working or procurement activities, were not included due to current data limitations, the resulting inventory is considered representative of the University's main emission pathways and offers a robust starting point for climate action planning.

2.2. Climate Actions

Climate action planning represents a commitment which is based on a "Climate Strategy" and a subsequent Climate Action Plan identifying the path and the actions to be done for the targeted Climate Neutrality. In this context, direct GHG emission reductions on campus can represent a tangible and effective demonstration of sustainability policies, fostering a shared pathway toward a broader global and community goal. Within the framework of these commitments, climate neutrality is defined as achieving net-zero GHG emissions by minimizing direct emissions and offsetting or mitigating the remaining ones. To meet this goal, institutions must address all Scope 1 and 2 emissions, as well as Scope 3 emissions from air travel funded by the university and commuting by staff and students. To guide mitigation planning, the University of Genoa has adopted a GHG management hierarchy summarized by the principle: "Reduce what you can, offset what you can't." This approach prioritizes avoiding and reducing emissions through energy savings and efficiency, eliminating emissions by switching to carbon-free energy sources, and finally offsetting any remaining emissions through carbon sequestration or compensation measures.

Particular attention is given to the areas of energy management, which is seen as

strategic domains for innovation and impact. UniGe has implemented several mitigation actions to improve energy efficiency and reduce consumption. In 2021, the university joined the national energy service framework (SIE4), which delegates the integrated management, operation, and maintenance of heating and cooling systems to a single provider. This includes energy supply, system upgrades, and achieving energy performance targets while maintaining occupant comfort and complying with regulatory standards. The service focuses on reducing primary energy consumption, cutting pollutant emissions, and enhancing the overall environmental performance of university buildings [7, 8]. The energy efficiency program includes upgrades such as thermal insulation, window replacement, high-efficiency boilers, thermostatic valves, inverter-driven pumps, solar thermal systems, replacement of inefficient equipment (e.g., with LED lighting), and advanced monitoring and control technologies. A dedicated Energy Saving Working Group at UniGe has also introduced real-time energy monitoring systems and adaptive climate control systems like the PREDICT project, which adjusts indoor temperatures based on weather forecasts and occupancy levels. A key example of innovation in energy management at UniGe is the Savona Campus, which has emerged as a center of excellence for research, education, and technology transfer in the fields of Smart Cities, renewable energy, and energy storage [9, 10, 11]. Here, interdisciplinary research teams collaborate on pilot projects, engage students in real-world problem-solving, and test advanced solutions for urban sustainability.

While conservation and efficiency are key, achieving climate neutrality also requires a transition to renewable energy. UniGe's climate strategy involves both increasing on-site renewable energy production—such as solar photovoltaic systems—and purchasing certified green energy through Guarantees of Origin or Power Purchase Agreements (PPAs). Technical guidelines are being developed to support annual procurement processes, while installation and automation of renewable energy systems are being carried out to further reduce electricity consumption.

Sustainable mobility is another essential aspect of UniGe's approach to mitigation, especially regarding Scope 3 emissions. The University of Genoa has implemented a Home–University Travel Plan (PSCU), first adopted in 2022 and updated in 2024. The plan outlines a series of initiatives that cover all key areas of intervention: promoting local public transportation, also through discounted or free transit passes, discouraging private car use and supporting car sharing, reducing travel-related emissions from commuting and business trips, and supporting cycling through the installation of racks and facilities and the promotion of bike sharing. The targeted results are pursued also through regional, national, and international partnerships, such as the Ulysseus Green Deal Mobility Scheme. Awareness-raising campaigns and public engagement events are also part of the plan: recently, participative methodologies have been tested as part of the PRINCE project (Incentives and Rewards for Modal Shift), with the aim of engaging students and academic community for developing co-responsibility on sustainable mobility topics.

UniGe is gradually integrating green public procurement (GPP) principles to promote environmental sustainability in goods and services to mitigate indirect emissions (Scope 3). This includes the awareness campaign to encourage the academic community to reduce the use of single-use plastics: reusable water bottles have been freely distributed to students and staff. Free filtered drinking water dispensers have been also installed at various locations. Waste reduction and sorting also play a key role in minimizing the university's carbon footprint [12], since every product consumed generates emissions, from production to transport to disposal. UniGe has adopted a dedicated waste management manual and

regulation, aiming to improve waste handling practices among staff and students. Building on existing measures, the university continues to implement a strategy based on the "5 Rs": reduce, reuse, recycle, collect, and recover. In this context, UniGe also promotes specific circular economy projects, such as the creation of hand-sewn accessories—bags, pencil cases, and book sleeves—made from repurposed UniGe banners, available for purchase at the Campus Store.

Following the adoption of its Climate Strategy, the University of Genoa is developing a Climate Action Plan to translate strategic goals into concrete actions. The Plan includes two main components: mitigation and adaptation. The mitigation plan, aligned with ISO 14068:2023 [13], sets a target date for climate neutrality, intermediate milestones, and monitoring mechanisms. It prioritizes reducing emissions within the university's operational boundaries through efficiency, renewable energy, and only as a last resort, offsetting residual emissions—those remaining after all feasible reduction measures have been implemented. Carbon removal within campus boundaries is not considered a viable strategy due to the highly urban context.

The climate adaptation plan aligns with the broader regional vision, establishing clear targets, interim milestones, and mechanisms for monitoring progress both within the university and in collaboration with the local community [20]. The University of Genoa, in fact, has taken an active role in contributing to the development and implementation of the Regional Strategy for Climate Change Adaptation (SRACC) in Liguria. This strategy outlines the policy framework for sectoral and territorial planning, aiming to increase the region's resilience to climate change while ensuring alignment with sustainable development goals.

Additionally, the Climate Action Plan outlines actions to integrate climate neutrality, resilience, and sustainability into student education and academic experiences, and to expand research, outreach, and community engagement.

2.3. Methods Used for Features Selection

The ability to automatically detect features that strongly influence predictions, especially in the high-dimensional datasets where relationships are not obvious, is one of the advantages of ML methods. Linear models and tree-based models are currently the most used approaches for evaluation of the feature importance. The Lasso (least absolute shrinkage and selection operator) and random forest methods are chosen to extract the important indicators affecting the environmental indicator, such as total CO_2 emissions. The Lasso method assigns zero to unimportant features in the dataset and keeps only the most informative features. This method evaluates the features by adding the L1 regularization term to the cost function of the model, which is usually linear.

Another model used in this work for extraction of most important features affecting climate change parameters is the random forest method. It is an ensemble learning algorithm, which builds multiple models for classification and regression tasks, where outputs are combined using majority voting or mean value for improvement of accuracy, overfitting elimination and effectively handling high-dimensional data. The random forest method evaluates the features based on their contribution to the improvement of the model's accuracy. This method calculates feature importance scores based on criteria like impurity reduction or permutation impact. Consequently, parameters strongly affecting target variables (in the current dataset total CO_2 emissions or CO_2 emissions from transport) based on ML algorithms are determined. XGBoost algorithm is another ensemble learning algorithm, which is preferred for its speed and performance. The main advantage of this

method is that it builds trees sequentially by correction of errors in each iteration.

2.4. Time Series Analysis for Prediction Climate Change Indicators

However classical statistical methods have become a standard benchmark for analysing historical data and predicting future patterns, deep networks such as LSTM are more useful for modelling highly non-linear relationships [27]. The ability to maintain memory of the input of LSTM which is a powerful type of neural network makes it suitable for solving problems involving sequential data like a time series. LSTM architecture consists of three gates: the input gate, the forget gate and the output gate, which control the memory cell. Determination of data which must be added, removed or sent as output are also realized by these gates. In this work, LSTM is used for learning patterns in collected data to predict target indicators.

HMM is one of the basic examples of variable-based machine learning models which is very suitable for processing discrete time series using transition and emission probabilities [28, 29]. The implementation of HMM for time series analysis to predict CO_2 emissions is sufficiently valuable in terms of discovering underlying emission states, prediction of state shifts and forecasting of the target assuming current policy and situation. Comparison of performance metrics' values as result of mentioned models for the testing step of the collected data demonstrates the potential superiority of HMM model with the ability of identification of hidden patterns and detection of unusual situations.

3. Discussions and Implementation

In 2022, UniGe reported total GHG emissions of 17,803.2 tonnes of CO_2 equivalent, calculated using the market-based approach. Direct emissions—classified as Scope 1—amounted to 3.296,2 tonnes of CO_2 equivalent. These were primarily associated with the combustion of natural gas and diesel for heating and with fuel consumption by the university's vehicle fleet, as well as with refrigerant gas leaks from cooling systems. Among the greenhouse gases considered, carbon dioxide was by far the most significant, with minor contributions from methane, nitrous oxide, and specific refrigerants such as R422D, R410D, and R407C.

Indirect emissions from purchased electricity, or Scope 2 emissions, were estimated at 105,4 tonnes of CO_2 equivalent using the market-based method. While this figure was slightly higher than in 2021, it remained below pre-pandemic levels, suggesting a cautious return to normal energy demand in university buildings and infrastructure.

The most substantial share of emissions was attributable to Scope 3 categories, which include all other indirect emissions not covered in Scope 2. In 2022, Scope 3 emissions reached 14.401,5 tonnes of CO_2 equivalent, with commuting emerging as the dominant component (**Table 1**). Main contributions to Scope 3 came from business travel, waste disposal, and water use. The inventory also includes biogenic emissions, specifically from waste sent to landfill, which were estimated at 70,04 tonnes of CO_2 equivalent, every emission source is categorized according to six categories in compliance with ISO 14064 standard (**Table 2**). However, the University does not currently account for any biogenic removals, as no offsetting mechanisms such as forestation projects or soil carbon sequestration are implemented or quantified within its system boundaries. In total, Scope 3 emissions represent the majority of emissions for UniGe standing at 80,9%, followed by Scope 1 emissions at 18,5% and the remaining 0,6% attributable to Scope 2 emissions (**Figure 1**).

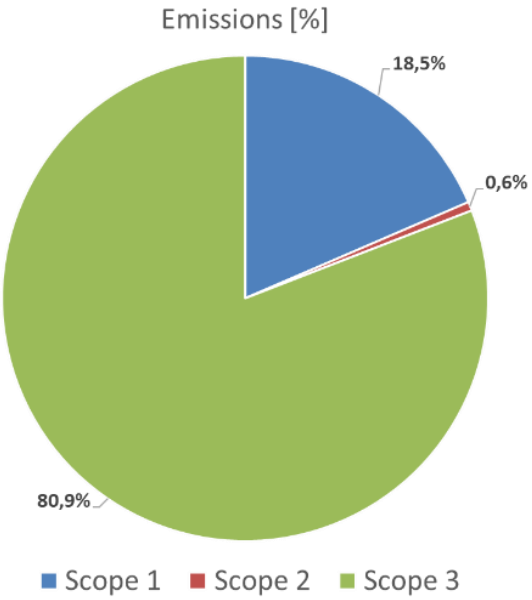

Figure 1. Share of emissions by Scopus for UniGe

The main source of emissions associated with UniGe's activities is student and staff mobility (Scope 3), which accounts for over 60% of total emissions. This is followed by natural gas consumption for building heating (Scope 1). Scope 2 emissions, related to electricity consumption, represent a smaller share of the university's emission profile, as these are largely offset through the purchase of green certificates (**Figure 2**).

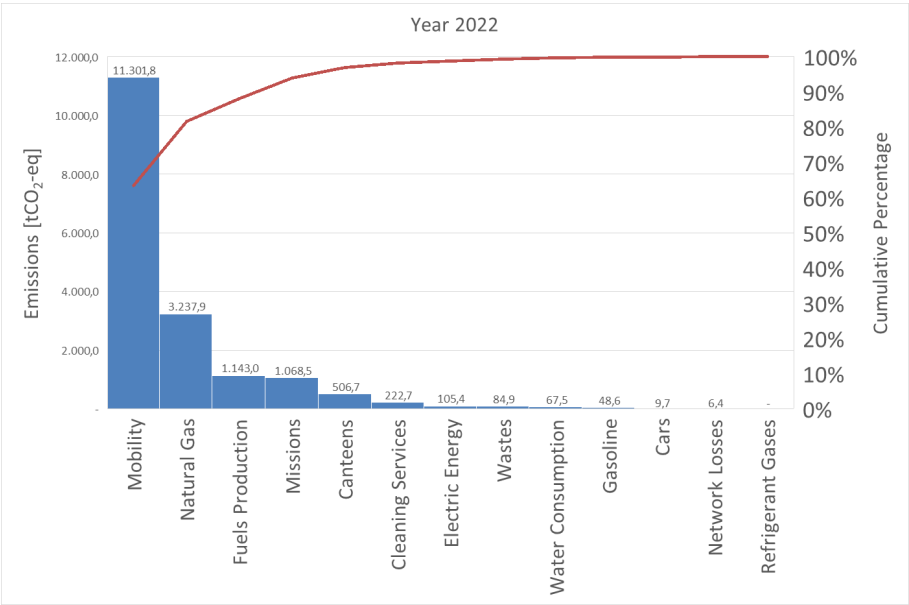

Figure 2. Pareto distribution of main emissions sources within UniGe boundaries

To contextualize these figures, the University applied two performance indicators (**Table 1**). The first, a qualitative indicator measuring emissions per enrolled student, was 0,559 tonnes of CO_2 equivalent per student in 2022, based on a total of 31.860 students. The second, a control indicator based on emissions per square metre of managed space, was calculated as 0,049 tonnes of CO_2 equivalent per square metre, considering a total built area

of 364.430 square metres.

Table 1. Emissions by Scopus and Qualitative and Control Indicators

Emissions by Scope [$tCO_{2\text{-}eq}$]	
Scope 1	3.296
Scope 2	105
Scope 3	14.402
Indicators [$tCO_{2\text{-}eq}$]	
Per student	0,559
Per square meter	0,049

From a geographical standpoint, most emissions—17.109,6 tonnes of CO_2 equivalent—originated from university operations within the city of Genova. Additional emissions were recorded in the Savona campus (329,6 tonnes), La Spezia (86,9 tonnes), and Imperia (34,7 tonnes), in proportion to the relative size and activity levels of those facilities. In compliance with ISO 14064:2018, Scope 1, 2 and 3 are divided into six categories (**Table 2**). Among the most relevant emission sources natural gas for buildings heating is in category 1 (direct GHG emission), mobility is in category 3 (indirect GHG emissions from transportation) and electrical energy consumption (indirect GHG emissions from imported energy) coincides with Scope 2 emissions.

Table 2. Emissions by Categories in Compliance with ISO 14064:2018

Emissions Categories 2022 [$tCO_{2\text{-}eq}$]	
Category 1: direct GHG emissions and removals	3.296,2
Category 2: indirect GHG emissions from imported energy	105,4
Category 3: indirect GHG emissions from transportation	12.376,8
Category 4: indirect GHG emissions from products used by organization	1.939,9
Category 5: indirect GHG emissions associated with the use of products from the organization	84,9
Category 6: indirect GHG emissions from other sources	-
Total	**17.803,2**

Considering the information gathered through the GHG inventory, the mitigation section of the Climate Action Plan, developed following the ISO 14068 framework, outlines UniGe's adoption of a mitigation hierarchy that prioritizes emission avoidance and reduction through efficiency measures, the transition to renewable energy sources, and, as a last resort, the compensation of residual emissions. The current approach emphasizes minimizing reliance on offsets by maximizing direct reduction actions within the organization's boundaries.

A significant milestone was reached in 2021 with the adoption of the national energy service contract, which enabled centralized, performance-based energy management and

facilitated retrofit interventions across several buildings. The energy efficiency measures already implemented or planned include the installation of thermal insulation in five buildings, replacement of windows in one building, upgrading of heating systems in sixteen buildings, installation of thermostatic valves in twenty-seven buildings, and replacement of electric pumps with inverter models in twenty-one buildings. Additional interventions involve the installation of solar thermal systems in one building, the implementation of building-wide supervision and monitoring systems, the replacement and installation of air handling units and chillers in ten buildings, and the deployment of thermal storage systems and end-use terminal units. Among the most advanced initiatives stands the transformation of the Technical Area building into a Nearly Zero Energy Building (nZEB). This intervention, promoted as part of the Italian strategy for public building renovation, entailed a full deep retrofit of the building envelope and systems. Key actions included the replacement of all windows and doors with high-performance fixtures, the addition of thermal insulation on walls and roofs, the modernization of the heating, ventilation, and air conditioning (HVAC) system, and the integration of heat pumps and photovoltaic technologies. This nZEB conversion exemplifies the operationalization of UniGe's climate strategy at the infrastructure level. The building now reaches extremely low energy demand levels, with residual needs covered by renewable sources, complying with European directives and Italian national plans for energy efficiency in public administration. As a result, it serves both as a functional office space and a demonstration case for replicable energy transition models in higher education.

The climate adaptation section of the Climate Action Plan of the University of Genoa is closely aligned with the goals of the Ligurian Regional Strategy for Climate Change Adaptation (SRACC) and contributes actively to its implementation. The university's commitment focuses on achieving tangible results through a structured set of operational tools, integrating climate resilience into its institutional mission while also supporting the regional governance system. Among the expected outcomes, a primary objective is the integration of climate risk considerations into the university's planning and management processes. Equally important is the strengthening of climate knowledge and awareness within the university community and beyond. Through education, training, and outreach activities, UniGe aims to empower students, staff, and local stakeholders to understand climate risks and to adopt adaptive behaviours. This approach is essential to foster a culture of resilience that can support autonomous, long-term adaptation pathways. The university has developed specific procedures to be adopted in the event of climate-related hazards such as weather-hydrological risk, intense rainfall, heatwaves and sea storms, the increasing frequency of which represents one of the main effects of ongoing climate change in the region. The procedures have been based on a detailed assessment of the vulnerability of UniGe infrastructure and operations to those climate-related hazards. These assessments form the basis for identifying and prioritizing actions, supported by climate scenario analysis and monitoring systems. Collaboration with regional technical bodies ensures that these tools are consistent with broader planning frameworks and based on the latest scientific evidence. At the governance level, the university plays an active role in fostering institutional coordination. By acting as a knowledge broker and participating in regional working groups, UniGe contributes to aligning scientific knowledge with policy design and implementation. The co-design of adaptation measures with local authorities, researchers, students, and civil society further ensures that actions are context-specific, feasible, and socially accepted. This integration enables a systemic response to climate change that extends beyond the academic sphere and contributes to the long-term goals of the SRACC. Through this combination of

targeted actions, knowledge dissemination, and institutional cooperation, the University of Genoa aims to generate measurable and lasting outcomes for climate adaptation. Its strategy demonstrates how academic institutions can act as catalysts of territorial resilience, providing both the expertise and the operational capacity needed to support the transition towards a climate-ready society.

4. Conclusions

UniGe 2022 greenhouse gas (GHG) inventory provides an extensive and up-to-date picture of the University of Genoa's climate footprint and its evolving response to measures in mitigation and adaptation. The overall emissions in the reporting year amounted to 17,803.2 tonnes of CO_2 equivalent, which represents a recovery of normal business activity after the COVID-19 pandemic. This growth—primarily the result of the return of students and workers commuting—is revealing about the nature of institutional emissions and barriers to alignment with sustainability goals and day-to-day campus operations. Disaggregation on the basis of scope reveals a characteristic trajectory for colleges and universities. Scope 3 emissions, including all indirect emissions except for purchased electricity, accounted for over 80% of aggregate emissions, of which commuting alone accounted for over 60%. This finding emphasizes the leadership position of system and behavioural determinants, more so mobility patterns, in influencing university-level climate footprints. Scope 1 emissions, mainly due to natural gas use for heating and refrigerant leakage, constituted approximately 18.5% of emissions, while Scope 2 emissions, estimated using the market-based approach, were minor (0.6%), due to the purchase of green electricity certificates. The relatively low intensity of Scope 2 emissions compared to other scopes reflects the university's proactive move in decarbonizing its electricity supply, a strategic choice that sets its mitigation profile apart. Another level of meaning is provided by the performance indicators employed. Student emissions (0.559 tCO_2-eq) and per square metre of area managed (0.049 tCO_2-eq) facilitate institution-wide and time-series benchmarking and highlight the need to deal with high-impact activities, particularly mobility and heating systems. Geographically, the majority of emissions originated from Genova, with proportionally smaller portions in UniGe's other locations—Savona, La Spezia, and Imperia—indicating the spatial accountabilities of a multi-campus university organization.

The university policy on climate takes its cue from the ISO 14068 standard for climate change mitigation, which promotes a hierarchical model of action: avoidance, reduction, and compensation as a last resort. UniGe has prioritized direct emission reduction over offsetting. Among the most potent initiatives in this direction has been the centralized, performance-based management of energy interventions in its buildings. Retrofit activities so far undertaken have not only reduced direct energy use and related emissions but also increased indoor comfort and operational efficiency. One of the flagship projects in this field is the redeveloping of the UniGe Technical Area building as a Nearly Zero Energy Building (nZEB). This deep renovation, following European and national energy-efficient design standards for public buildings, presents university infrastructure as a model of low-carbon renovation. The project combined advanced envelope insulation, energy-efficient lighting and appliances, state-of-the-art HVAC systems, and climate-friendly technologies such as photovoltaics and heat pumps. The resulting building is used in both its operational role as an office facility and its demonstrative function as a centre of teaching and learning for the execution of climate-resilient infrastructure solutions in institutions of higher education. From an adaptation perspective, UniGe is voluntarily aligning itself with the Ligurian Regional Strategy for Climate

Change Adaptation, thus placing its local role within a global governance framework. The response of the university includes infrastructural actions and operational responses: from the integration of climate risk into rehabilitation planning to developing methodologies for the analysis of vulnerability and scenario building. No less important is the university's dedication to building the adaptive capacity of students, employees, and local stakeholders. Through training activities, outreach, and participation in regional working groups, UniGe is building a culture of resilience that goes beyond technical adjustment and encompasses changes in behavior and social innovation. Within its role the university is the key actor in linking climate science and territorial action.

The uniqueness of the case is that it addresses mitigation and adaptation together, a concept still rarely converted into practice institutionally in Italy. In addition, the methodological consistency employed—in GHG accounting to scenario planning—is an example replicable for other universities aiming to develop evidence-based climate strategies. The dual emphasis on operational excellence (e.g., energy infrastructure) and governance innovation (e.g., SRACC membership) also generates added value, showing the degree to which climate action can be mainstreamed in university operations and missions. Upcoming efforts should highlight expanding the Scope 3 GHG inventory boundaries, with such categories as procurement, food systems, and digital infrastructure set to gain traction in the coming years. Quantification of avoided emissions and the inclusion of potential carbon sinks like urban foresting or soil carbon projects would bring more solidity to the climate strategy. Furthermore, development of common indicators across Italian universities can make inter-institutional benchmarking possible and will lead to the creation of sector-best practices.

In summary, UniGe's experience illustrates the potential for universities to act as living laboratories and policy-relevant players in climate governance. Coupling technical innovation, institutional leadership, and civic engagement, the University of Genova is forging a model for climate neutrality and resilience that is not only possible but also socially just and territorially rooted. As climate issues become more pressing, such holistic and actionable models will be ever more vital in shaping the shift toward a sustainable and climate-resilient society.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Authors Contribution

All authors contributed substantially to the work. **F.D.** conceived the research idea. **A.D.B.** designed the methodology. **S.S.** carried out the experiments and data collection. **P.L.** and **V.M** conducted the data analysis and interpretation. **S.S., P.L.** and **V.M**. contributed to the manuscript writing and critical revision. All authors reviewed and approved the final version of the manuscript.

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