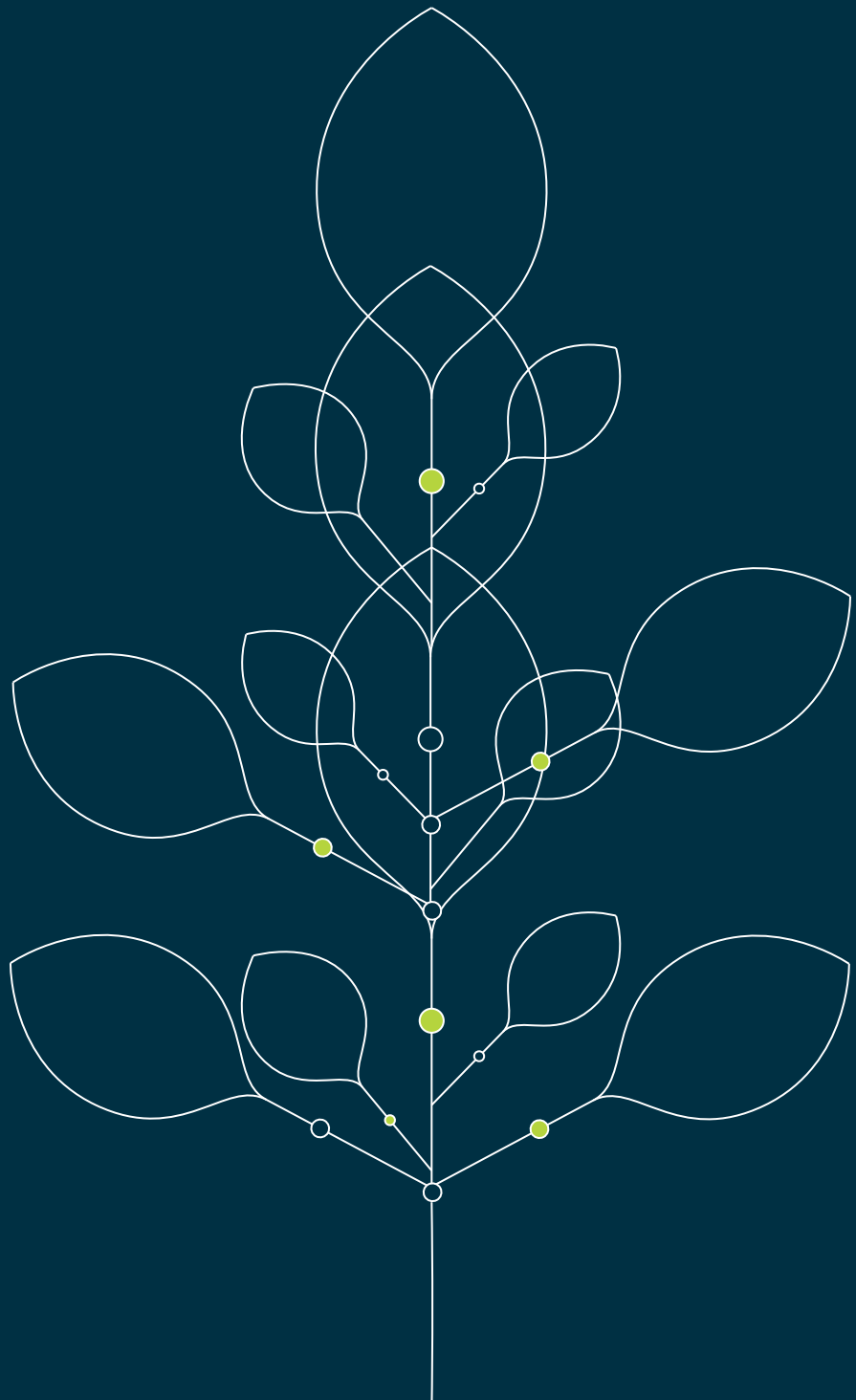
EXCUTIVE SUMMARY OF INFN **ENVIRONMENTAL REPORT**

YEAR 2024

INFN

Istituto Nazionale di Fisica Nucleare



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This document provides an executive summary of the 2024 **Environmental Report**, prepared with the aim of measuring and reporting the environmental footprint of the activities carried out.

This is the second edition of the report, which presents the results achieved by the Institute, highlighting improvement objectives and outlining the actions taken to reduce environmental impact.
The report reflects the laboratories' proactive approach to environmental protection, confirming their ongoing commitment to promoting sustainable practices and ensuring the responsible management of resources.

The analysis focuses on five material topics identified as priorities for environmental management. These areas reflect the main impact factors of scientific activities and are monitored through key indicators, in compliance with current regulations and international best practices.

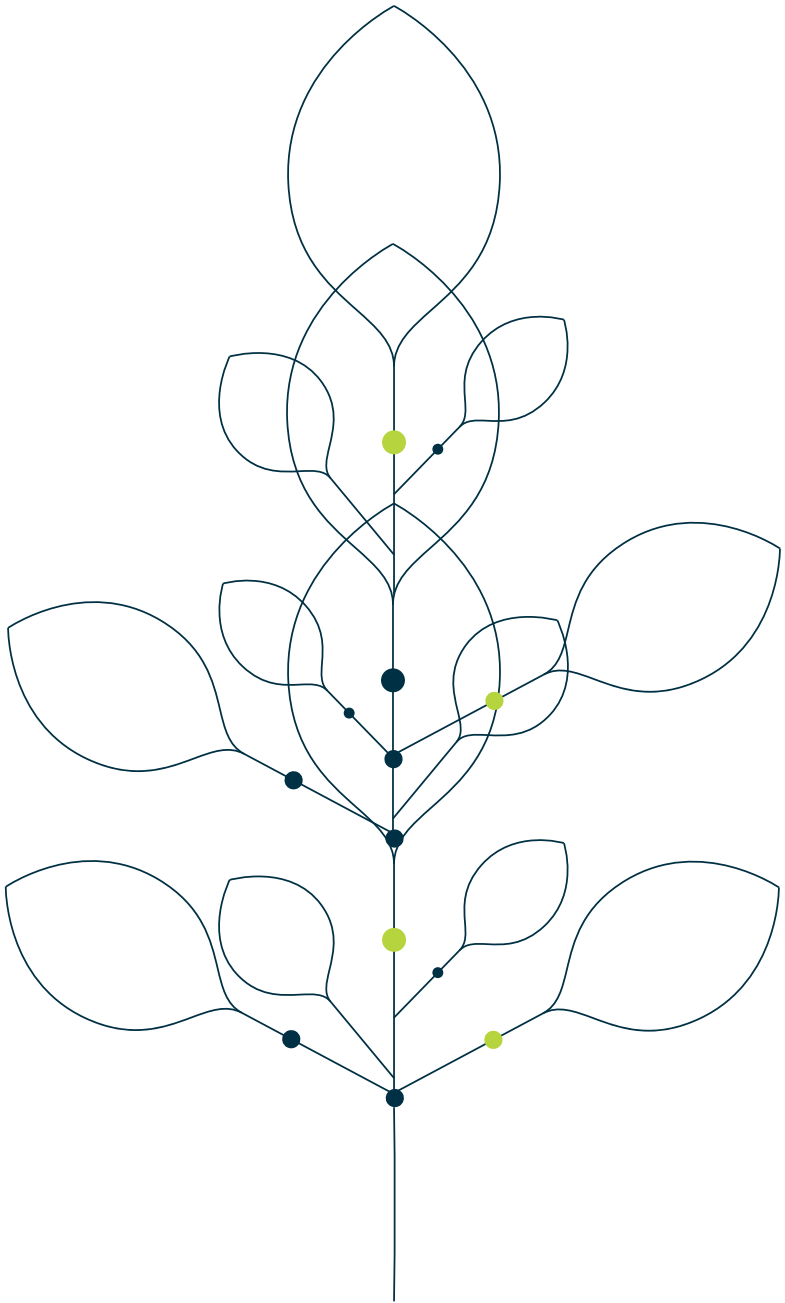
Beyond reporting 2024 data, the document adopts a strategic perspective aimed at ecological transition and scientific responsibility, aligned with stakeholder expectations and European sustainability policies.

This approach aligns with the **United Nations Sustainable Development Goals (SDGs)**, particularly:

The impact assessment focuses on five strategic areas for environmental management: **energy consumption, greenhouse gas (GHG) emissions, water use, waste management, and exposure to ionizing radiation**. These areas were selected as they represent the primary impact factors associated with the Institute's scientific and infrastructural activities.

INFN is an Italian research institute structured into two main types of facilities: national laboratories and divisions, distributed throughout the country. Its research activities also extend abroad through collaborations with major international research centers.

The data presented in the report refer exclusively to the environmental impact of the main research centers: Laboratori Nazionali di Frascati (LNF), Laboratori Nazionali del Gran Sasso (LNGS), Laboratori Nazionali di Legnaro (LNL), Laboratori Nazionali del Sud (LNS) and CNAF. This approach reflects the central role of the National Laboratories and CNAF in INFN's scientific activities, as they host highly complex infrastructures and equipment used by the national and international scientific community for large-scale experiments and projects.

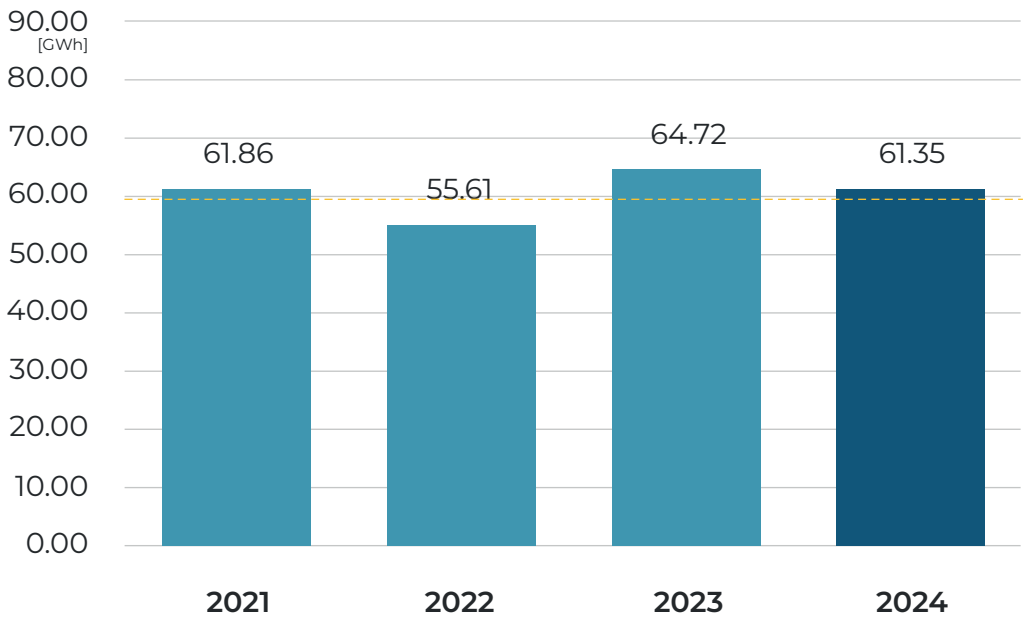


ENERGY

Energy consumption is a matter of primary importance and constant attention for INFN, as research laboratories rank among the most energy-intensive facilities due to highly specialized equipment and controlled environments essential for scientific activities.

Aware of this impact, the Institute has long implemented continuous monitoring of its energy use and is systematically committed to reducing waste and optimizing process efficiency.

The analysis of the Institute's energy consumption shows an overall reduction in energy demand in 2024, returning to average values aligned with previous years.
After the increase observed in 2023, when total consumption rose from 55.61 GWh to 64.72 GWh, 2024 recorded a decrease partly due to reduced operating hours of accelerators, with total consumption amounting to 61.35 GWh.

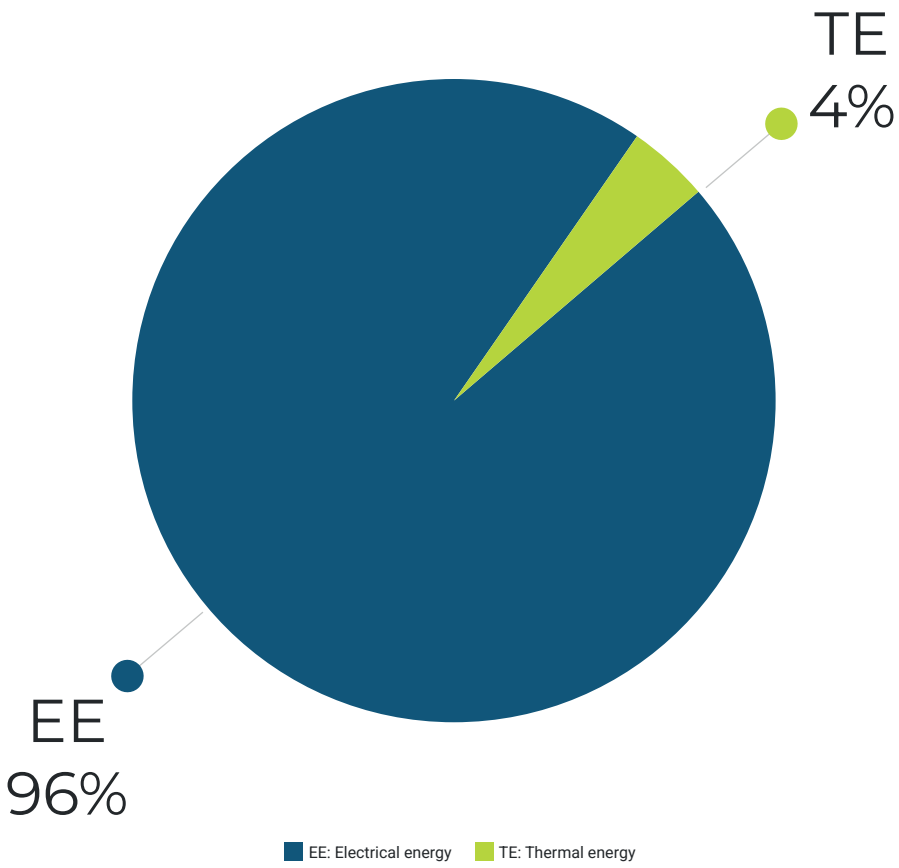


Total energy consumption of INFN [GWh].

Note: dashed line indicates the average energy consumption value calculated for the period 2021-2023.

ENERGY

Electricity (EE) is the main component of consumption, accounting about for 96% of the total. In 2024, this figure recorded a 6% reduction, confirming the effectiveness of the optimization measures introduced and the progressive shift toward more efficient resource management.



Breakdown of energy consumption – 2024.

CARBON FOOTPRINT

The calculation of the carbon footprint is an essential component, as it provides a key tool for supporting climate change mitigation policies and advancing the transition to sustainable development models.

Moreover, greenhouse gas (GHG) emissions constitute one of the main environmental impact factors associated with INFN's scientific activities. Monitoring and reducing these emissions are therefore a strategic priority for the Institute, fully aligned with international sustainability commitments.

To ensure comprehensive and transparent reporting, the scope has been expanded to include, for the first time, Scope 3 emissions — indirect emissions from activities not directly controlled by the Institute but linked to its value chain. This methodological enhancement offers a more integrated and realistic view of the overall environmental footprint, in line with European recommendations and leading reporting practices.

The analysis was conducted with strict accuracy and comparability criteria, aiming to provide reliable, meaningful data to guide mitigation strategies and track progress toward sustainability goals.

CARBON FOOTPRINT

The **Scope 3** categories analyzed are:

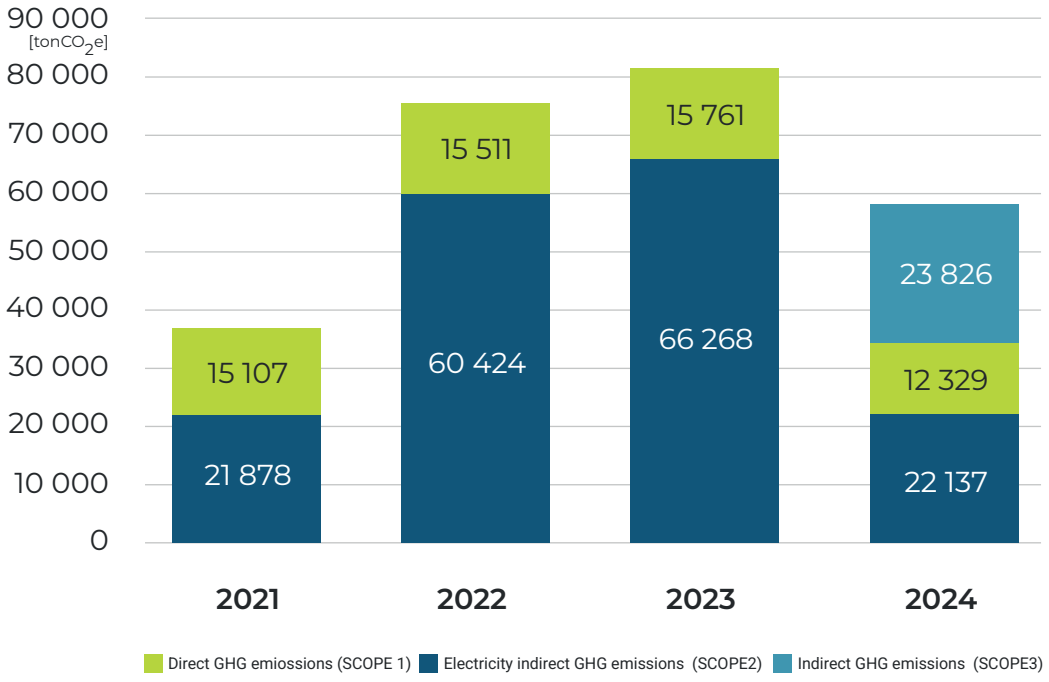
- **PROCUREMENT OF GOODS AND SERVICES:** includes emissions related to the production and delivery of all goods and services purchased by the organization (e.g., supplies, equipment, raw materials, outsourced services). The estimate was carried out using a spend-based approach, multiplying the monetary value of purchases by sector-specific emission factors derived from environmental input–output models.
- **UPSTREAM ACTIVITIES FOR FUEL EXTRACTION AND ENERGY GENERATION:** includes emissions arising from the extraction, production, and transport of fuels and energy before their use by the organization. The estimate was based on a quantitative approach, using the actual volumes of fuels and electricity consumed.
- **MANAGEMENT AND DISPOSAL OF OPERATIONAL WASTE:** refers to emissions generated from the treatment and disposal of waste produced by activities. A quantity-based method was used, multiplying the weight of each waste type by disposal-specific emission factors.
- **BUSINESS TRAVEL:** includes emissions generated by transportation used for professional activities (excluding commuting), such as flights, trains, rental cars, and taxis, as well as those associated with overnight stays and meals. The estimate was based on data related to overnight stays (number of nights and country), distances travelled by car, and expenses for air, train, bus, and rental car travel.
- **EMPLOYEE COMMUTING:** includes emissions generated by daily home-to-work travel and those associated with remote working. The estimate was based on structured surveys conducted among employees of the national laboratories and CNAF, considering the modes of transport, average distances, and frequency of on-site presence.

CARBON FOOTPRINT

In 2024, total greenhouse gas emissions attributable to INFN amounted to 58 292 tonnes of CO_2 equivalent, distributed unevenly across the three activity areas considered in the inventory.

Indirect emissions falling under Scope 3 account for approximately half of the total, highlighting that the main source of climate impact stems from activities not directly controlled by the organization, such as the procurement of goods and services, business travel, and waste management.

Emissions from sources directly managed by INFN (Scope 1), such as those related to fuel use and industrial processes, represent 38% of the total. Added to these are the indirect emissions associated with electricity consumption (Scope 2), which account for 21%.



Total GHG emissions of INFN [ton CO2e].

CARBON FOOTPRINT

Compared to the past four years, the 2024 carbon footprint decreased following the high levels recorded in 2022 and 2023.

This improvement is largely attributable to the significant reduction in fugitive emissions, particularly those associated with SF_6, a direct consequence of the lower number of maintenance interventions on electrostatic accelerators carried out during the year.

A decline in indirect emissions from electricity consumption was also observed, driven both by the overall reduction in energy use and by improvements in the national energy mix.
It is also important to note that, despite the expansion of the system boundaries in 2024 to include Scope 3 emissions, the total greenhouse gas emissions remained relatively contained compared with the two previous years.

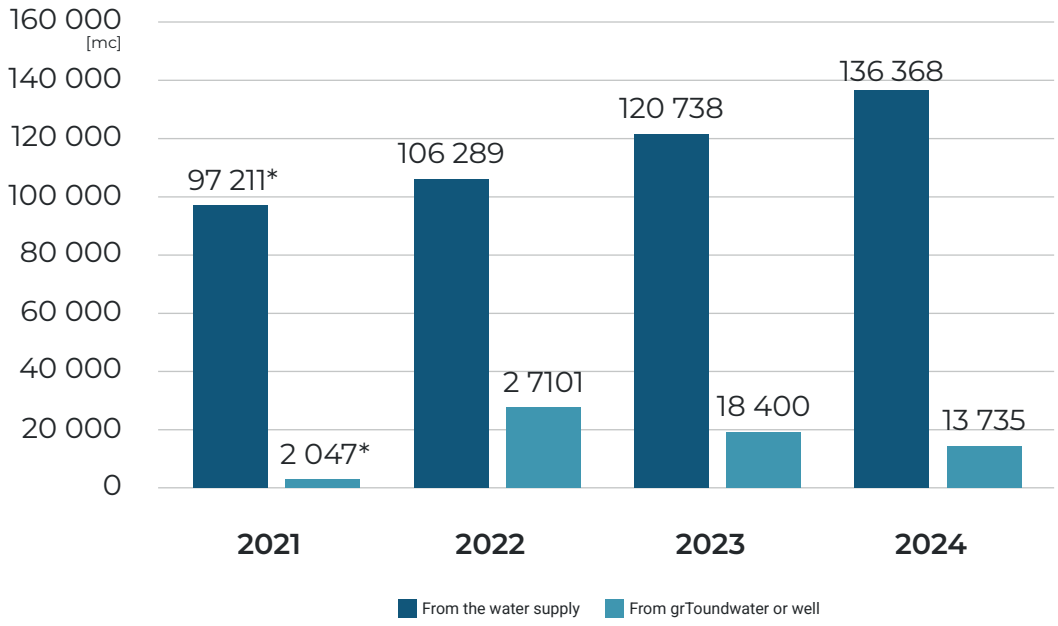
IMPROVEMENT TARGETS

In line with its sustainability and resource optimization policy, INFN has set specific targets to reduce CO_2 emissions.
Since Scope 1 accounts for a significant share of the Institute's carbon footprint, INFN is committed to cutting direct CO_2 emissions by 25% by 2026, compared to the average of the past three years.

As fugitive emissions — primarily from SF_6 — are the main source of these emissions, achieving this goal will require targeted measures to limit SF_6 use, a gas with a very high global warming potential. Dedicated actions will be implemented at the LNF, LNL, and LNS laboratories, including comprehensive monitoring plans and restrictions on SF_6 usage.

WATER FOOTPRINT

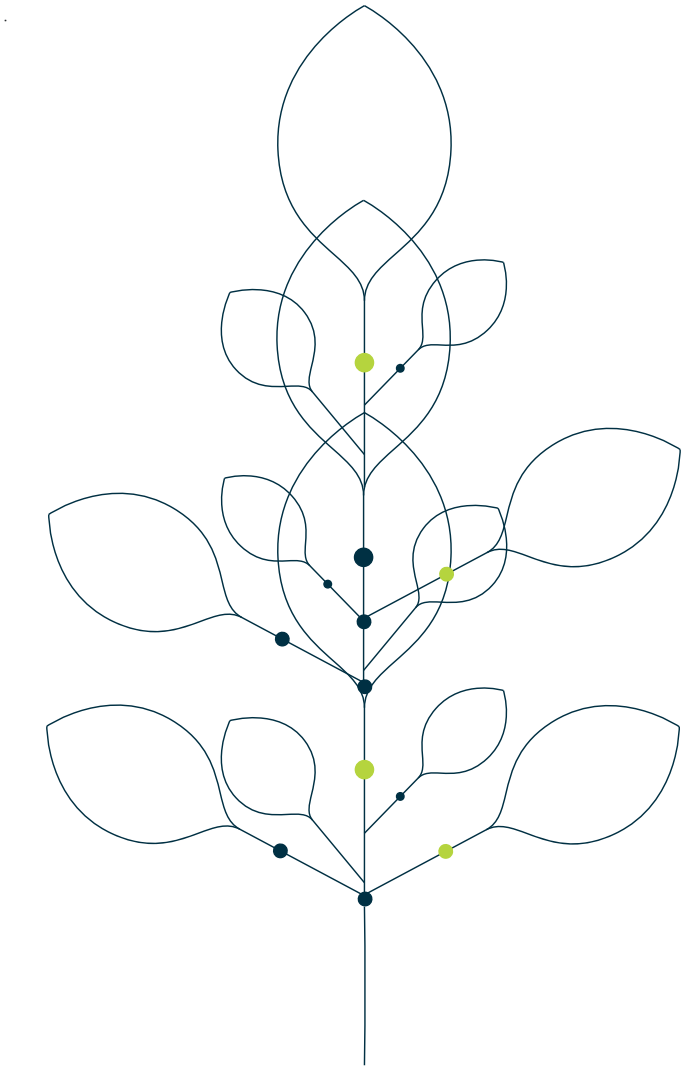
The use of water resources is a matter of primary importance for the Institute. Water is an essential resource in research laboratories, used both in operational processes and in cooling systems. To monitor the Institute's water footprint, the total volume of water consumed was assessed, along with the various sources of supply.
In 2024, INFN recorded an increase in water consumption of approximately 8% compared with the previous year, confirming a growing trend already observed in previous years. Total volumes withdrawn rose from 133 390 cubic meters in 2022 to 150 103 cubic meters in 2024, outlining a consistent upward trend. At the same time, a shift in the composition of supply sources can be observed: water supplied by the public water network, already largely predominant in 2022 at 80% of the total, reached 91% in 2024, further strengthening its share. Conversely, the contribution of well or groundwater decreased progressively, both in absolute and percentage terms, dropping from 27 101 cubic meters (20%) to 13 735 cubic meters (9%).



Total water consumption [mc].

Note: * Data does not include water consumption of LNS

WATER FOOTPRINT



IMPROVEMENT TARGETS

As part of its broader strategy to optimize processes and safeguard the environment — combining advanced scientific research with a strong commitment to environmental responsibility — INFN aims to reduce water consumption from the supply network to 2022 levels by 2027.

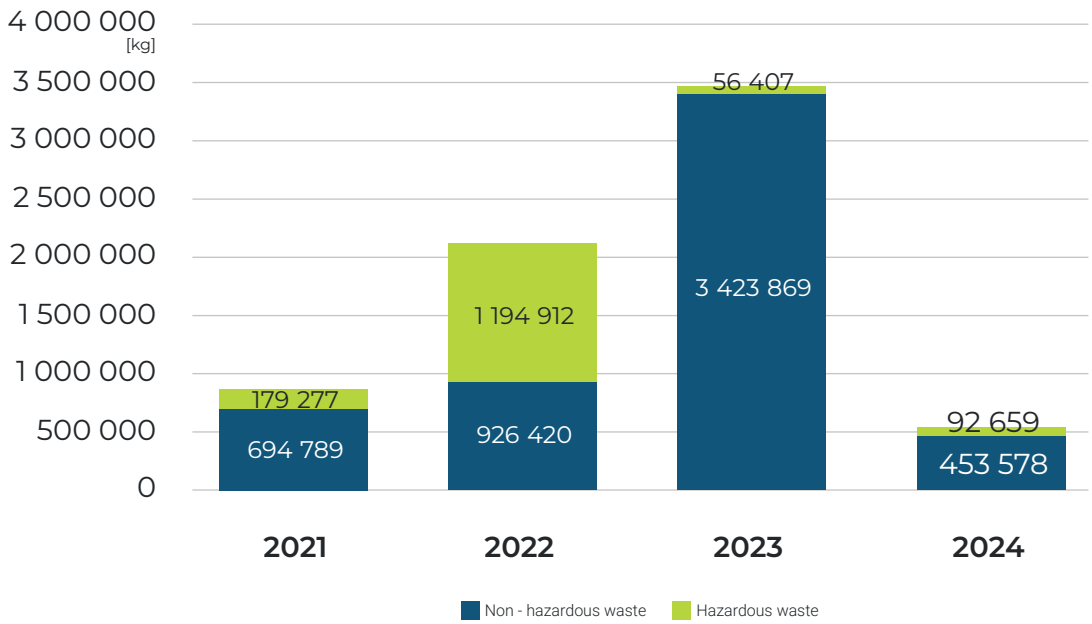
This target represents an estimated 22% reduction compared to current usage, significantly contributing to the sustainability of the Institute's operations. Planned actions include a comprehensive assessment of existing water networks to identify and promptly address any leaks.

WASTE

Waste management is a material issue, essential for minimizing environmental impact and ensuring full compliance with regulations. INFN's research laboratories generate various types of waste, including hazardous waste and electronic waste, which require particular attention in their management.

The analysis of waste generation data for the period 2021–2024 shows a highly variable trend, with a significant peak in 2023 followed by a marked decrease in 2024. In this latter year, total waste production amounted to 546 237 kg, representing a clear decline compared with the previous two years.

This figure represents a return to levels comparable to 2021, following the exceptionally high volumes recorded in 2022–2023, primarily due to the decommissioning of the Borexino experiment at the LNGS. The composition of waste in 2024 shows a predominance of non-hazardous waste, accounting for 83% of the total, while hazardous waste represents the remaining 17%.



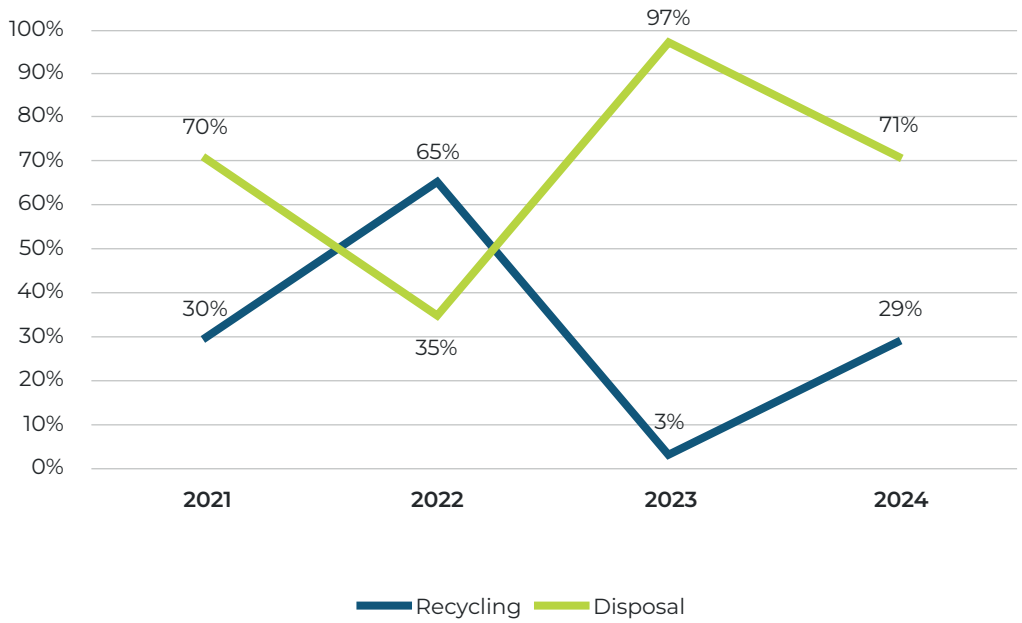
Total amount of waste produced [kg].

WASTE

In 2024, waste management reflects a more controlled profile compared with previous years, with a significantly lower total volume of waste and a distribution between recycling and disposal that, although not optimal, is closer to the levels observed in 2021.

Specifically, 71% of the waste was sent for disposal, while 29% was destined for recycling. Although these figures indicate a predominance of disposal, they represent an improvement compared with 2023, an exceptional year in which recycling was almost negligible and 97% of waste was sent to disposal.

When compared with 2021, it is clear that both years show relatively low volumes and a similar distribution between the two management methods, although with differences in absolute values.

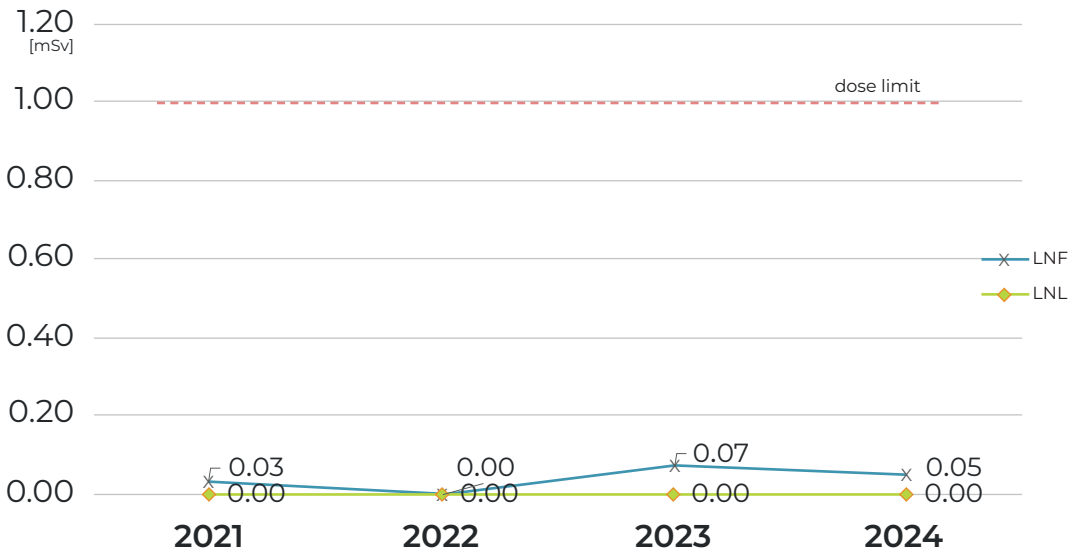


Waste management methods as a share of total waste generated.

IONIZING RADIATION

This indicator assesses the environmental impact of ionizing radiation emissions, taking into account the nature of the Institute's scientific activities and the public interest, particularly among residents living near the laboratories.
The analysis of the data confirms an overall stable and well-controlled situation, with extremely low emissions that remain far below regulatory and safety thresholds. Among the sites analyzed, only the LNF recorded non-zero values, with slight variations in ionizing radiation emissions over the four-year period: zero in 2022, a peak of 0.07 mSv in 2023, and a decrease to 0.05 mSv in 2024. These fluctuations are linked to intensified experimental activities and greater accelerator use in 2023. Despite this increase, the values recorded remain far below the average annual natural radiation dose in Italy (approximately 3.3 mSv/year), and the estimated exposure for residents or visitors is below 0.01 mSv/year, around 330 times lower than natural background radiation and 1 000 times lower than an abdominal CT.

At the LNL, radiation levels remained consistently at zero throughout the period, as confirmed by monitoring conducted using eight perimeter detectors and supported by a decade-long historical dataset. The absence of detectable emissions demonstrates the effectiveness of the containment and radiological safety measures adopted.



Emissions of ionising radiation [mSv].

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