SUMMARY OF THE FIRST ENVIRONMENTAL REPORT OF INFN
Reference years: 2021, 2022, and 2023.

Methodology

In the assessment of the environmental impacts of INFN, the material issues that represent the most significant aspects and need to be carefully monitored and managed have been identified: energy consumption, carbon footprint, waste management, water footprint, and ionizing radiation.
The analysis of the environmental impacts of INFN was calculated as the sum of the four national research laboratories [Laboratori Nazionali di Frascati (LNF), Laboratori Nazionali del Gran Sasso (LNGS), Laboratori Nazionali di Legnaro (LNL) and Laboratori Nazionali del Sud (LNS)] and the CNAF. This is because the National Laboratories represent the main structures of the Institute's activities and, together with CNAF, host large equipment and infrastructure made available to the national and international scientific community.

Highlights of 2023

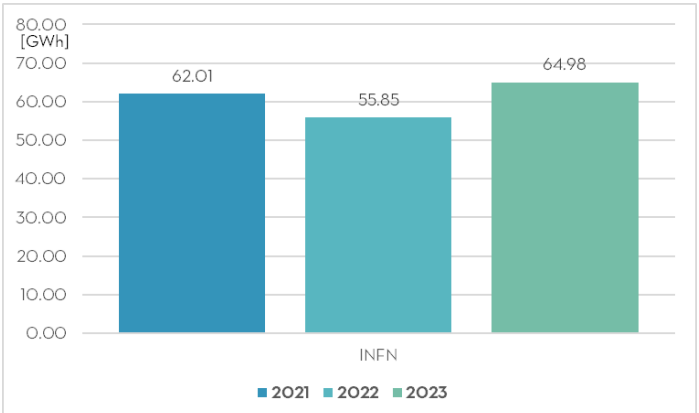
Focus on Environmental Indicators

1. ENERGY

Energy consumption is a key concern for the National Institute of Nuclear Physics (INFN). Research laboratories are among the most energy-intensive facilities, due to the specialized equipment and controlled environments essential for scientific research. High-performance computers, particle accelerators, analytical instruments, and climate-controlled spaces all contribute to substantial energy usage. **INFN has been monitoring energy consumption for years and is continuously committed to reducing waste and improving process efficiency.**

TOTAL ENERGY CONSUMPTION

The analysis conducted indicated that INFN's average energy consumption was approximately **61 GWh** over the three-year period considered. Specifically, a 10% reduction in consumption was observed in 2022 compared to the previous year, primarily due to a necessary slowdown in activities to mitigate the energy crisis. Conversely, in 2023, energy consumption rose by 5% compared to 2021, still influenced by the ongoing effects of the pandemic.

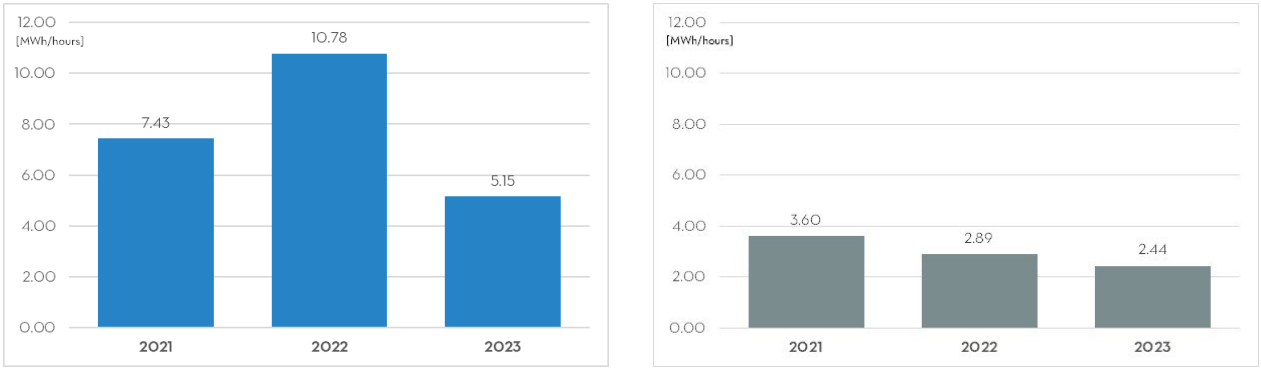


Trend of INFN's Total Energy Consumption over the three-year period.

Most of INFN's environmental impact is due to electricity consumption, which on average represents about 90% of total energy consumption, due to the use of high-performance equipment. Other sources, such as thermal energy and fuels for transportation, have a negligible impact. Regarding thermal energy consumption, a decrease was observed in both years: -17% in 2022 compared to the previous year, and -5% in 2023 compared to 2022.

PERFORMANCE INDICATORS

The energy intensity per operating hour of the particle accelerators has been calculated at the Laboratori Nazionali di Frascati (LNF) and the Laboratori Nazionali di Legnaro (LNL).



Trend of Energy Intensity per Operating Hour of Particle Accelerators LNF (on the left) and LNL (on the right).

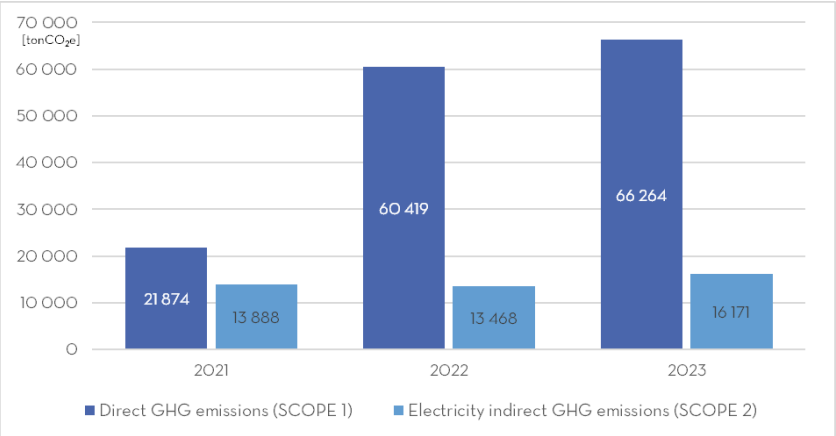
As illustrated, **the ongoing efforts to reduce waste and enhance process efficiency are yielding encouraging results. In both Laboratories, 2023 has seen a substantial reduction in energy consumption, with the number of operating hours of the accelerators remaining consistent.** Specifically, in the last year, there was a 52% decrease compared to 2022, and a 30% decrease compared to 2021 at LNF. LNL shows a consistent downward trend in values over the three years, reflecting a continuous reduction in energy intensity per operating hour of the particle accelerator (an average annual reduction of 18%).

2. CARBON FOOTPRINT

The calculation of the carbon footprint is crucial in the contemporary environmental debate, as it underpins efforts to combat climate change and promote sustainability. The analysis encompassed the calculation of greenhouse gas (GHG) emissions resulting from the activities of the Laboratories and CNAF, including both direct emissions from on-site operations and indirect emissions associated with electricity consumption. The calculation was performed in accordance with the principles of relevance, completeness, consistency, accuracy, and transparency.

TOTAL CARBON FOOTPRINT

The total greenhouse gas emissions generated by INFN in 2023 amounted to **82 435 tCO2e**, showing an increase compared to the previous year. Direct GHG emissions (Scope 1) are higher than indirect emissions (Scope 2) and show a significant increase each year.



Trend of greenhouse gas emissions in absolute terms over the three-year period.

The main contribution to direct emissions (Scope 1) comes from fugitive emissions, which constitute 94-98% of the total direct emissions over the three years. These are primarily caused by SF6 emissions, which are necessary for the operation of electrostatic accelerators. **The INFN is committed to working in the coming years to drastically reduce this contribution.**

3. WATER FOOTPRINT

The management of water resources is a crucial issue for the INFN. Water is an essential resource in research laboratories, used in various processes and cooling systems. Efficient use and proper management of water are vital for minimizing the environmental impact of laboratory operations and for conserving this precious resource.

TOTAL WATER FOOTPRINT

The analysis conducted revealed that the total water consumption of INFN averages around **108 000 cubic meters of water.** Analyzing the source of supply, it emerges that the largest share is drawn from the public water supply network, while that coming from groundwater or wells represents a negligible share.
INFN discharges wastewater into the public sewer system, which handles the subsequent treatments before being returned to receiving water bodies. A small portion (on average 2%) is treated internally by the Institute through various purification processes, allowing the water to be reintroduced into the receiving body, often of a higher quality than the water initially extracted.
The analysis conducted allowed the institution to carry out some checks on its consumption, setting strong improvement objectives for the coming years.

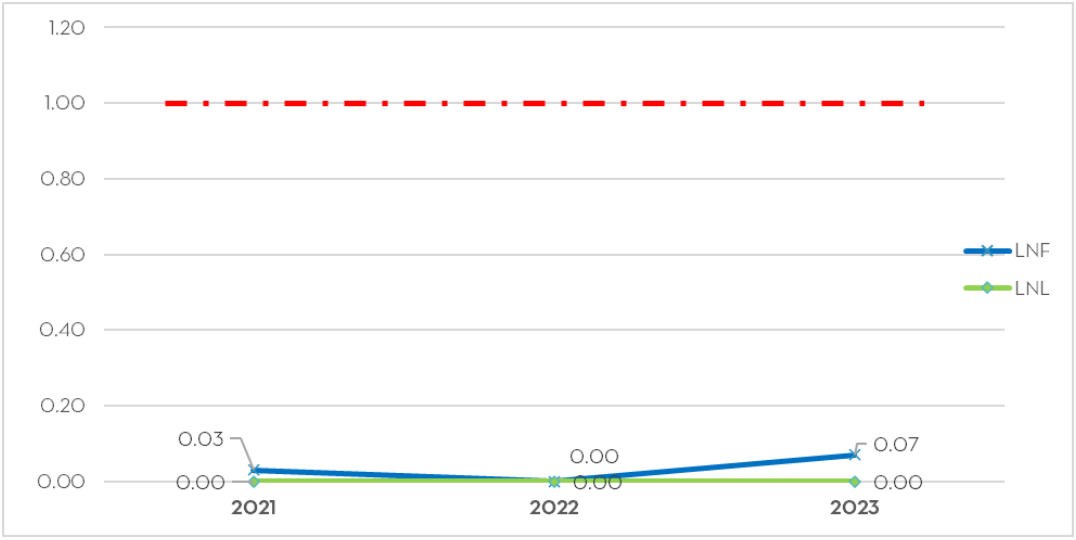
4. WASTE

The research laboratories of the National Institute of Nuclear Physics (INFN) generate various types of waste, including hazardous waste and electronic waste. Proper management of these waste streams is essential to minimize environmental damage and ensure compliance with regulations.

INFN is committed to reducing waste production through sustainable procurement and usage practices, the implementation of effective waste separation and recycling programs, and ensuring the safe and compliant disposal of hazardous waste.

5. IONIZING RADIATION

The National Institute of Nuclear Physics conducts research that uses particle accelerators, radiogenic machines, and radioactive sources that generate ionizing radiation. The use of these sources takes place within buildings equipped with the necessary prevention, protection, and alarm systems.
In Italy (and in Europe), the annual dose limit for public exposure to artificial sources of ionizing radiation is 1 mSv. **INFN conducts continuous monitoring of environmental doses in its national laboratories** where particle accelerators operate (LNL, LNF, and LNS), and historically, the measured environmental dose has been 0 mSv.
In the last three years, the highest dose measured was 0,07 mSv in 2023 at LNF, which is about 50 times lower than the natural dose in Italy. In the LNL area, monitoring indicates the absence of ionizing radiation over the three years considered, while the particle accelerators at LNS are currently shut down, making further monitoring unnecessary. The dose received by an individual representative of the population living near the laboratories or visiting INFN is estimated to be less than 0.01 mSv per year (approximately 330 times lower than the average natural radiation dose in Italy and a thousand times lower than the dose received from an abdominal CT scan).
Finally, at INFN, there are about 1000 workers classified as susceptible to receiving a dose higher than 1 mSv per year for work-related reasons. In the last three years, no more than 200 workers have received a dose higher than 0 mSv, and only one employee per year has exceeded 1 mSv.



Ionizing radiation emissions in the last three years [mSv].