



# **CERN's strategy for an environmentally responsible research**

Benoît Delille & Sonja Kleiner – On behalf of CERN

International Conference on High Energy Physics – July 2024 – Prague, CZ

# About CERN

Four pillars underpin CERN's mission

EDUCATION  
& TRAINING



TECHNOLOGY  
& INNOVATION



RESEARCH



COLLABORATION



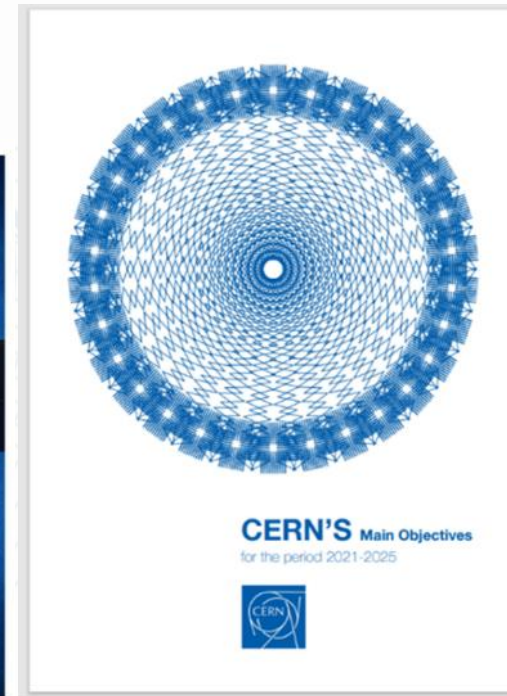
Our mission is to:

- perform world-class research in fundamental physics.
- provide a unique range of particle accelerator facilities that enable research at the forefront of human knowledge, in an environmentally responsible and sustainable way.
- unite people from all over the world to push the frontiers of science and technology, for the benefit of all.
- train new generations of physicists, engineers and technicians, and engage all citizens in research and in the values of science.

# Current strategy for environment and sustainability

Three main lines of actions (2021-2025):

- ❑ **Minimise** the Laboratory's impact on the environment
- ❑ Pursue actions and technologies aiming at **energy savings and reuse**
- ❑ Identify and develop CERN's **technologies** that may contribute to mitigating the impact of society on the environment



**Environment and sustainability** are crucial aspects of projects and activities in the High Energy Physics field. Any future project should have minimal environmental footprint.



# CERN & United Nations SDGs



## SDG 3 - HEALTH

CERN helps to develop technologies that contribute to better healthcare for all, such as medical imaging and hadron therapy.



### THERAPY

Accelerators provide particle beams for more targeted cancer treatment.

## SDG 4 - EDUCATION

Education is one of CERN's core missions. We offer high quality programmes that inspire thousands of students, teachers and young researchers each year.



### BEAMLINE FOR SCHOOLS COMPETITION

Students from the two winning teams spend a week at CERN to carry out their experiment using a CERN accelerator.

## SDG 5 - GENDER

Diversity is a core value for CERN. Our diversity policy aims at leveraging the added value that comes from bringing together people of different nationalities, genders, professions and ages.



### 25 BY 25 DIVERSITY & INCLUSION INITIATIVE

First ever targets-based strategy to boost the nationality and gender diversity within the Staff and Fellows population.

## SDG 7 - ENERGY

CERN develops strategies for minimise the increase of energy consumed by the installations, increase energy efficiency and implement energy recovery.

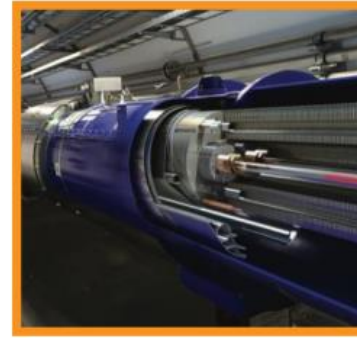


### HEATING LOCAL HOUSING

Heat recovered from CERN's accelerator cooling systems to heat a new residential area in the town of Ferney-Voltaire, benefiting up to 8000 people.

## SDG 9 - INNOVATION

CERN inventions are brought to industry through knowledge transfer, to have a positive impact on society and innovation.



### A MAGNET IN THE LHC TUNNEL

Exploring the universe requires new technologies and ingenious engineering to build the machines that explore physics at a new frontier.

## SDG 16 & 17 - INTERNATIONAL COOPERATION







CERN is a successful model for international collaboration. CERN gathers researchers from all over the world, contributing to human knowledge and peace, for the benefit of all.



### SESAME

This new synchrotron light source in Jordan started operation in 2017. It is a unique collaboration between eight Middle East members, modelled on CERN's governance structure.

# CERN High priority environmental objectives – Horizon 2025

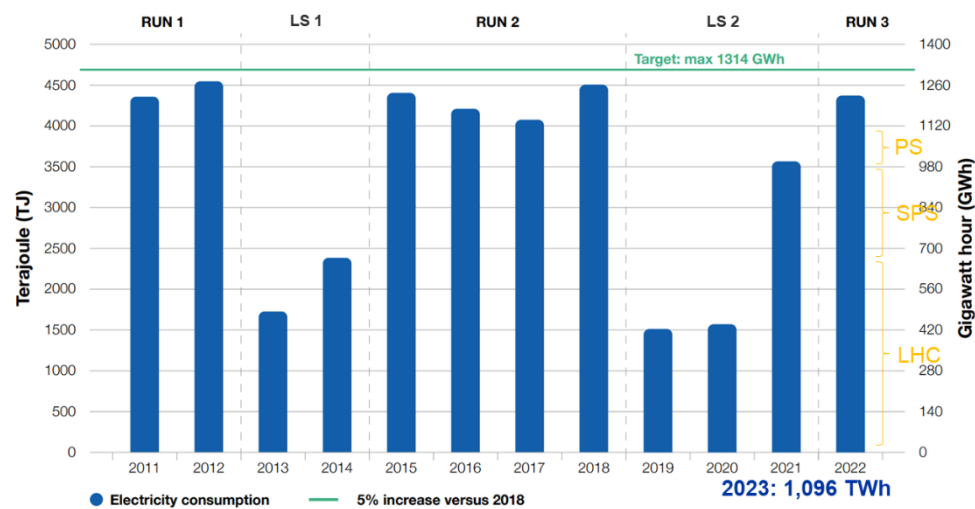
-  **ENERGY**  The laboratory is committed to limiting rises in electricity consumption to 5% up to the end of Run 3 (baseline 2018) – Target max 1314 GWh/y
-  **EMISSIONS**  CERN's objective is to reduce direct CO<sub>2</sub>e emissions by 28% by the end of Run 3 (baseline 2018) – Target max 138 300 tCO<sub>2</sub>e
-  **WATER AND EFFLUENTS**  The laboratory is committed to keeping the increase in its water consumption to 5% up to the end of Run 3 (baseline 2018) – Target max 3651 ML

*No showstopper to achieving these objectives by the first year of the next long shutdown (LS3) 2026 - 2028*

Three public facing Environment Reports published, following the Global Reporting Initiative (GRI) Standards – available [here](#)



# Energy



## CERN'S ELECTRICITY CONSUMPTION 2011–2022

Run periods refer to the years in which the accelerators are in operation, with occasional technical stops as and when necessary. Outside these periods, the accelerator complex enters 'long shutdowns' for essential maintenance and consolidation.

## CERN is awarded the ISO 50001 energy certification

8 FEBRUARY, 2023



The CERN Meyrin site in 2020 (Image: CERN)

As part of CERN's commitment to responsible energy management, the Organization began the ISO 50001 certification process in 2022. The certification was officially awarded on 2 February 2023 for a period of three years, i.e. until 1 February 2026.

## Managing energy responsibly: CERN passes ISO 50001 audit

CERN is one of the first scientific laboratories to have obtained ISO 50001 certification for energy management. Following our first surveillance audit, find out how we can all play a role in improving energy management

14 MAY, 2024 | By HSE unit



The CERN Meyrin site. Continual improvement of energy management is one of the key pillars of the Organization's strategy to minimise its impact on the environment. (Image: CERN)



## CERN Energy Policy

CERN, an intergovernmental organization for fundamental research in particle physics, defines and implements an Energy Policy. This policy covers all the energy sources needed for its activities and installations, whether they are based in France or in Switzerland. The policy is periodically reviewed.

### 1. Objectives

In line with the CERN Safety Policy, the Energy Policy is designed to continuously improve the Organization's energy performance and minimise the impact of its activities on the environment. Its specific goals are to:

- keep the energy required for its activities to a minimum,
- improve energy efficiency, and
- recover waste energy.

### 2. Means

The Organization makes the necessary means available, in particular funding and personnel, needed to meet its Energy Policy objectives.

In particular, the Organization:

- implements structured, efficient and sustainable measures to ensure the continuous improvement of its energy performance,
- ensures that the Energy Policy objectives are integrated into the design of its sites and facilities and taken into account in the definition and execution of its activities,
- establishes appropriate internal regulations, keeps them up to date and monitors compliance with them,
- communicates proactively with all persons participating in its activities or present on its site, as well with as the Host States and the public,
- collaborates with the Host States.

# Energy

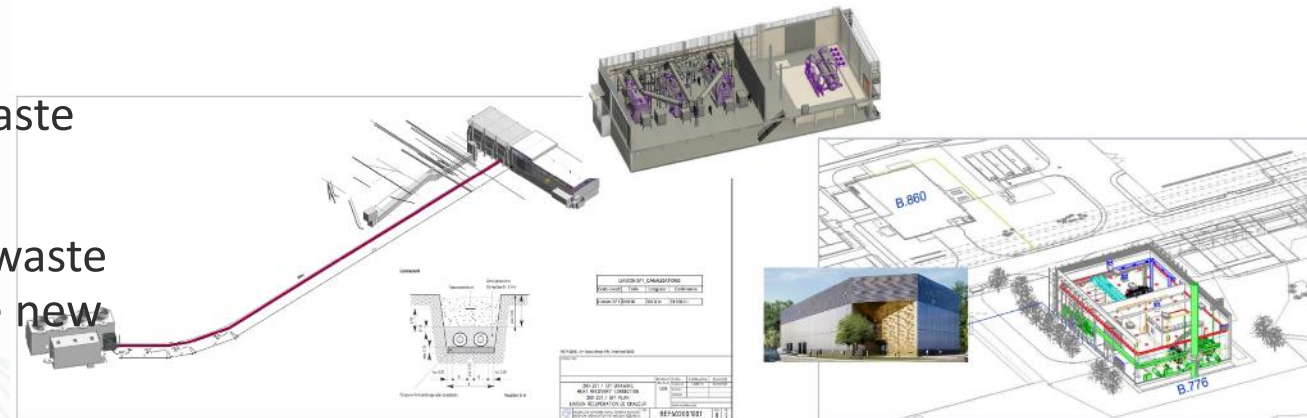
## Improve energy efficiency – example of CERN Data Centres

- ❑ CERN new Data Centre on the Prévessin site (F) PUE target of 1.1 – recently inaugurated (ramp-up to 12 MW over the next 10 years)
- ❑ Existing Data Centre on the Meyrin site (CH) 2023 Annual PUE of 1.42 (4 MW – 35 GWh/y)



## Recover waste energy – ongoing projects

- ❑ One project for heating new housing in a surrounding municipality (~ 8000 people) – 20 GWh/y recovered waste heat from LHC PA8 cooling tower units
- ❑ Two projects for heating CERN main sites – recovered waste heat from cooling tower units (LHC PA1) and from the new Prévessin Data Centre



Heating plant – Meyrin site (CH)

Heating plant – Prévessin site (F)

➤ *An outstanding step for CERN to depart from fossil fuel*

# Emissions

- ❑ CERN's greenhouse gas emissions reported according to the **Greenhouse Gas Protocol**
- ❑ Direct emissions/scope 1 mainly linked to LHC experiments and the use of fluorinated gases – **CERN F-Gas Policy** recently approved
- ❑ Indirect emissions/scope 2 linked to the supply of electricity – **CERN Energy Policy** published in 2022
- ❑ Indirect emissions/scope 3 mainly resulting from procurement (92%) – **CERN Environmentally Responsible Procurement Policy** effective since 2024 + Guidelines for duty travel published early 2024



## CERN Fluorinated Gases (F-Gas) Policy

CERN, an intergovernmental organization for fundamental research in particle physics, defines and implements a fluorinated gases policy (hereafter "F-Gas Policy"). This policy covers all installations (including equipment) and activities on the CERN site containing or using fluorinated gases, i.e., human-made greenhouse gases that contain fluorine (F-Gases). The policy is periodically reviewed.

### 1. Objectives

In line with the CERN Safety Policy, the F-Gas Policy is designed to minimize the impact on the environment of the Organization's installations and activities containing or using F-Gases.

In particular, the F-Gas Policy aims at a reduction of the use of F-Gases and of related emissions.

### 2. Means

The Organization makes the necessary means available needed to meet the F-Gas Policy objectives.

In particular, the Organization commits to:

- minimize the use of F-Gases at CERN, in particular through:
  - o the promotion of research and development into F-Gas alternatives,
  - o the replacement, to the extent possible, of F-Gases already used in its installations and activities with gases with no or less impact on the environment, and
  - o the minimization, to the extent possible, of the use of F-Gases in new installations and activities;
- limit its emissions of F-Gases, in particular through:
  - o the prohibition of intentional releases,
  - o the detection and reduction of leaks,
  - o appropriate training of personnel concerned;
- monitor and manage the use and emissions of F-Gases within the Organization, establish and update appropriate internal procedures and regulations and monitor compliance with them,
- communicate proactively,
- collaborate with the Host States.



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## CERN Environmentally Responsible Procurement Policy

The objective of the CERN Environmentally Responsible Procurement Policy is to minimize the environmental impact throughout the lifecycle of the goods or services that are purchased by the Organization. CERN shall define and implement its Environmentally Responsible Procurement Policy by embedding environmental considerations as standard in its procurement activities.

This Policy is aligned, and designed to work in conjunction, with the CERN Procurement Rules. It constitutes an integral part of CERN's endeavour to achieve identified objectives in relation to the environment and sustainability.

This Policy commits CERN to environmentally responsible procurement and to achieving sustainable results both internally and throughout its supply chains.

The Organization undertakes to:

- integrate environmentally responsible procurement practices into current and future supply chains;
- measure the impact of environmentally responsible procurement;
- communicate with, and give guidance to, the CERN community on implementing, monitoring and reporting on environmentally responsible procurement;
- demonstrate and share, where appropriate, best practices for environmentally responsible procurement with its Member States and other organisations, particularly other research laboratories.

CERN will embed environmental responsibility where appropriate throughout all phases of the procurement process, including all the design phases. Careful and reasoned attention will be given to the need for the procurement, the specificities of the goods or services being procured, the choice of the supplier, the terms of procurement and the principle of continuous improvement.

The Director-General assigns responsibility for the implementation of the Environmentally Responsible Procurement Policy to the following parties:

Parties	Responsibilities
Director for Finance and Human Resources	• Leads the effective implementation of this Policy and ensures that its strategic context is appropriate and meets CERN's needs.
Head of industry, Procurement and Knowledge Transfer (IPK)	• Ensures that CERN complies with the Policy and that the appropriate management/reporting systems are in place and working effectively, including training, awareness raising and communication.
Head of procurement, procurement action leaders, procurement officers, Department heads	• Works with technical officers to ensure adherence to good practices and to ensure compliance with the Policy. • Foster collaboration between IPK and procurement officers to identify and develop environmentally responsible suppliers for CERN. • Conduct procurement activities in accordance with the aims of the Policy. • Seek opportunities to include the reduction of environmental impact in procurement. • Ensure and report on the implementation of the Policy to their respective departments.



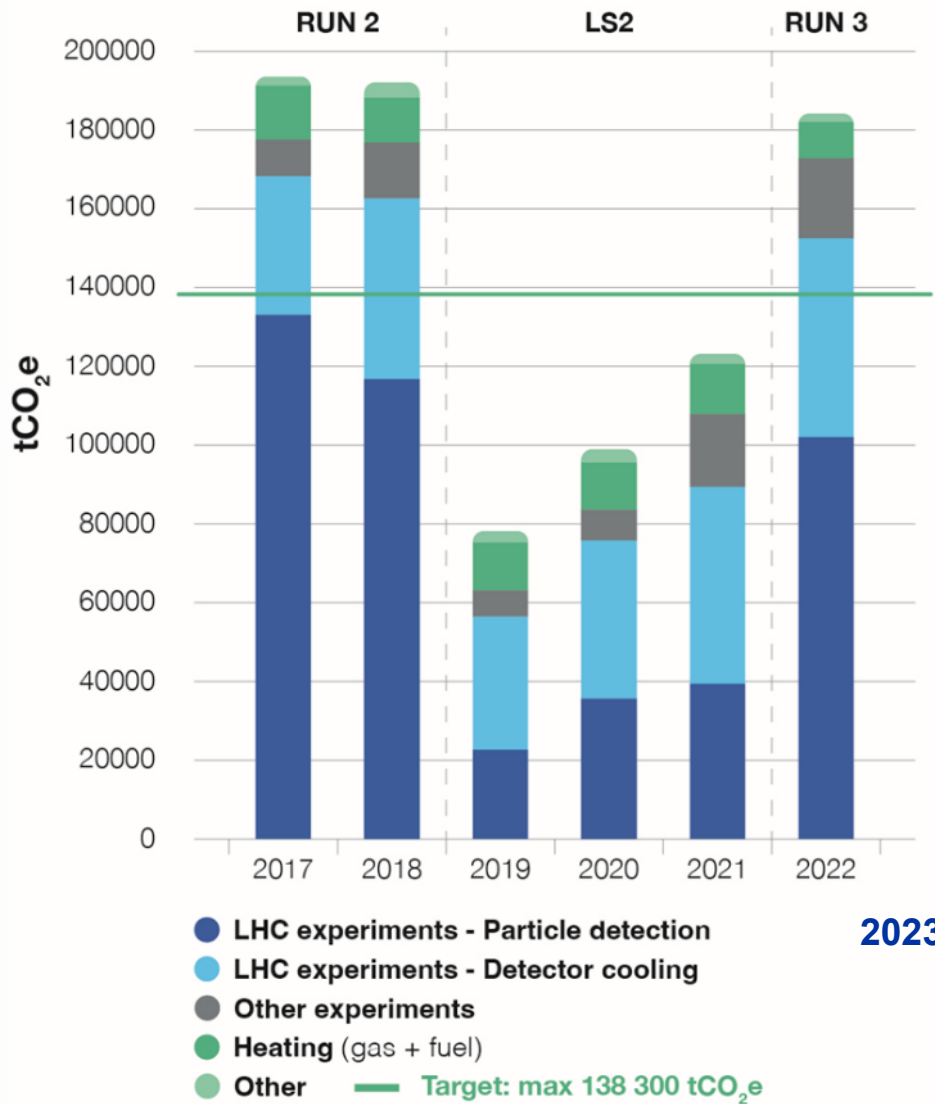
## GUIDELINES FOR CERN DUTY TRAVEL WITH A VIEW TO MINIMISING ITS ENVIRONMENTAL IMPACT

Abstract  
This document describes the requirements and proposed activities to be implemented by the work and conduct of the energy group to reduce its carbon footprint. These measures will be applied to the CERN internal duty travel. CERN's emissions will include: 1) The emissions of the host countries of the participants and 2) the emissions of the participants for the flight to the host country.





# Emissions



## Scope 1 – direct emissions

Detector cooling  
Reduction potential for RUN4 vs 2018  
of ~ 40'000 tCO<sub>2</sub>e

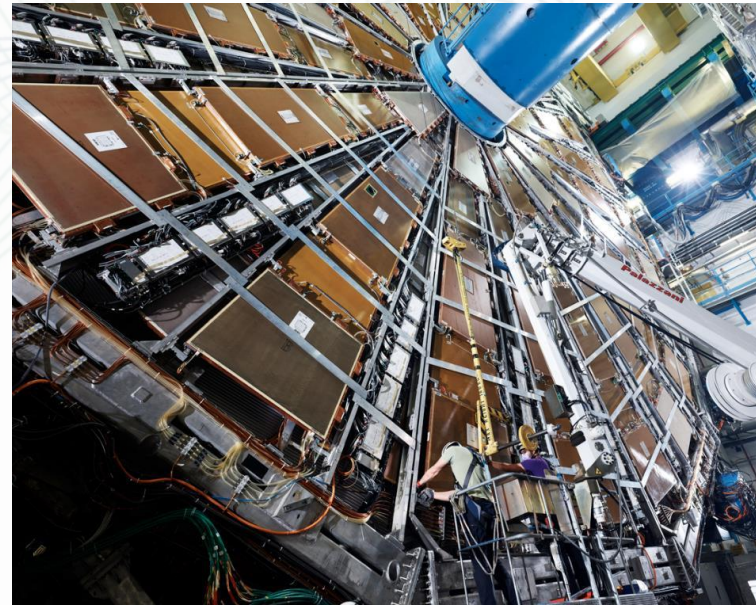
Particle detection  
Reduction potential for RUN4 vs 2018  
of more than 13'000 tCO<sub>2</sub>e

- Main source of scope 1 emissions linked to F-gases used for detector cooling (mostly PFCs such as C<sub>6</sub>F<sub>14</sub> and C<sub>3</sub>F<sub>8</sub>) and for particle detection (mostly HFCs such as HFC-134a)

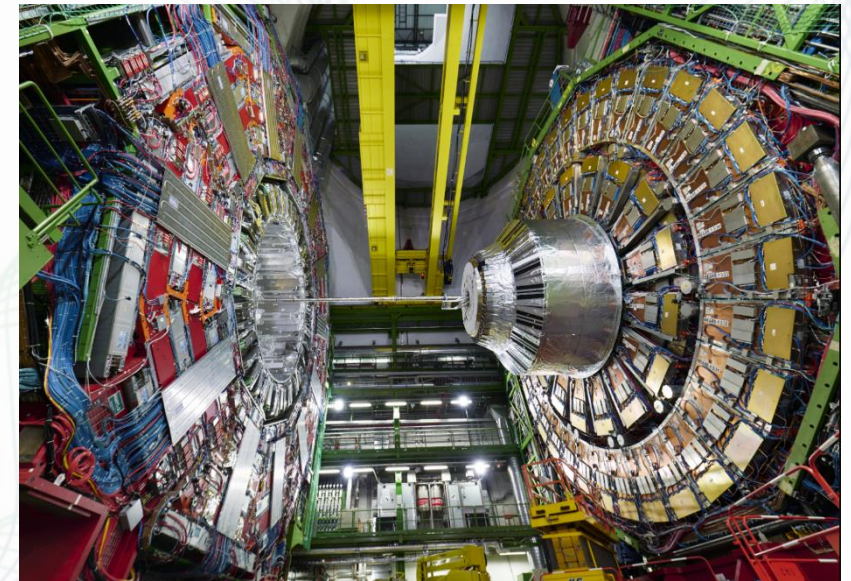
# Emissions

## Scope 1 – direct emissions

- ❑ Within LHC experiments - 3 pillar R&D strategy to minimize emissions of fluorinated gases: **recirculation and optimisation, gas recovery** and the search for **more environmentally friendly alternatives**
- ❑ **ATLAS and CMS**: continued investment in R&D to reduce detector leaks and prepare for a transition from Perfluorocarbons (PFCs) to CO<sub>2</sub> cooling
- ❑ Since beginning of August 2023, **ATLAS** operates the RPC detectors with a new gas mixture – lowering CO<sub>2</sub>e emissions from the RPC detectors



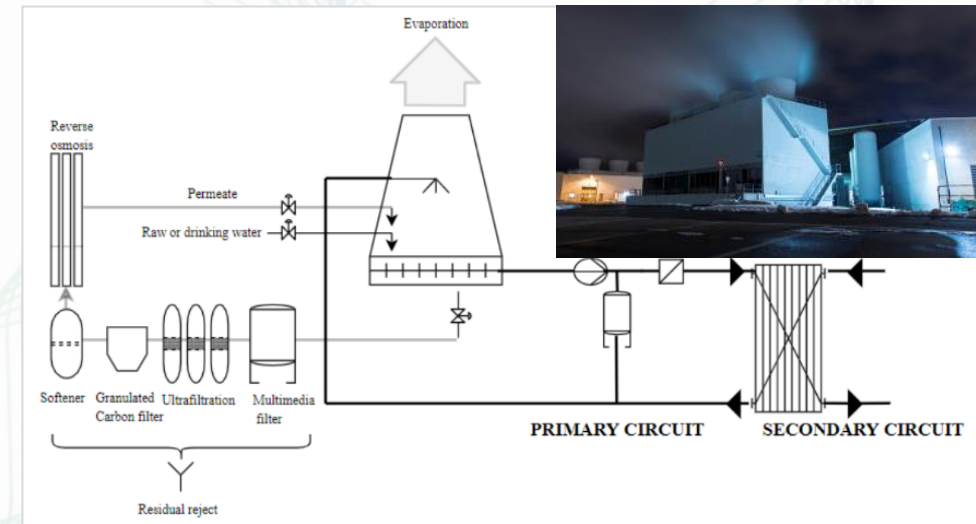
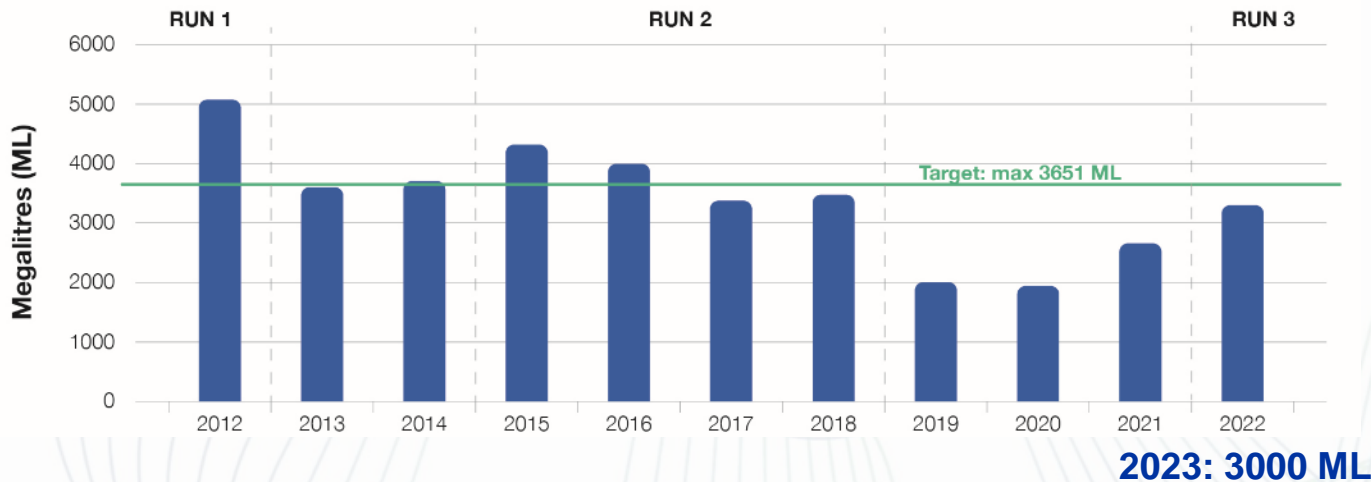
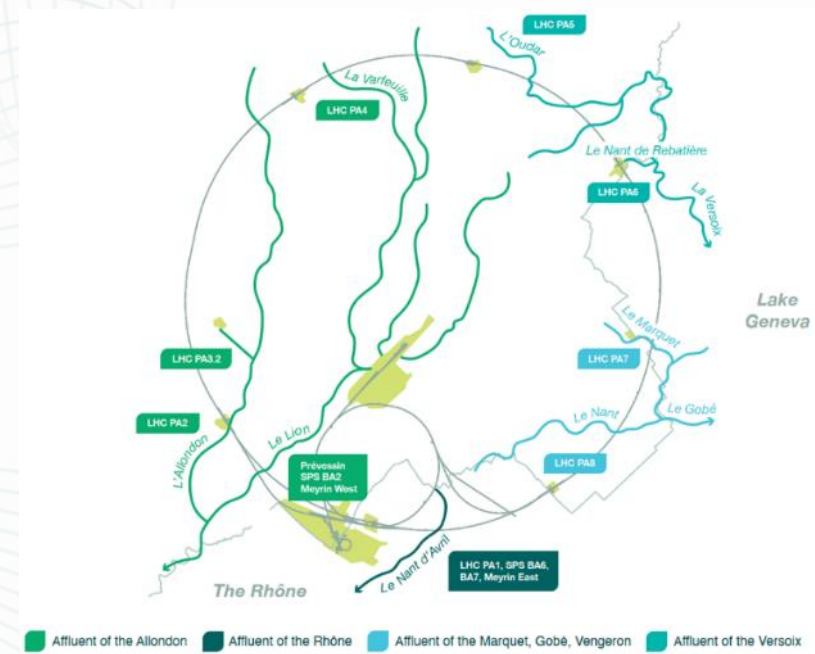
Final LS2 upgrade work to the ATLAS detector before cavern closure



CMS during the final stages of LS2

# Water and effluents

- ❑ CERN strives to minimise its water consumption through continuous consolidation and improvement of its cooling and sanitation infrastructures - **Since 2000**, water consumption has **decreased by some 80%**, from 15'000 megalitres to 3'234 megalitres in 2022
- ❑ Ambitious project for reducing the current impact linked to the blowdown of the LHC & SPS cooling tower circuits (released into a local stream: about - 90% of effluent water volume and pollutants load from 2027/2028)



*Future cooling water recycling plant under study*

# Horizon 2030

## ENERGY

While the number of collisions will be multiplied by a factor of 5 to 7.5 during RUN4 (2029-2032) with respect to the nominal LHC design, CERN commits to limiting its electricity consumption to 1.5 TWh/y, which equates to an increase of 11%

## EMISSIONS

Direct CO<sub>2</sub>e emissions are linked to CERN's core operations. CERN's objective is to reduce them by 50% vs baseline 2018

## WATER AND EFFLUENTS

Despite a growing demand for cooling water, CERN will strive to keep the water consumption below 3600 ML

**3 high priority objectives out of 9**

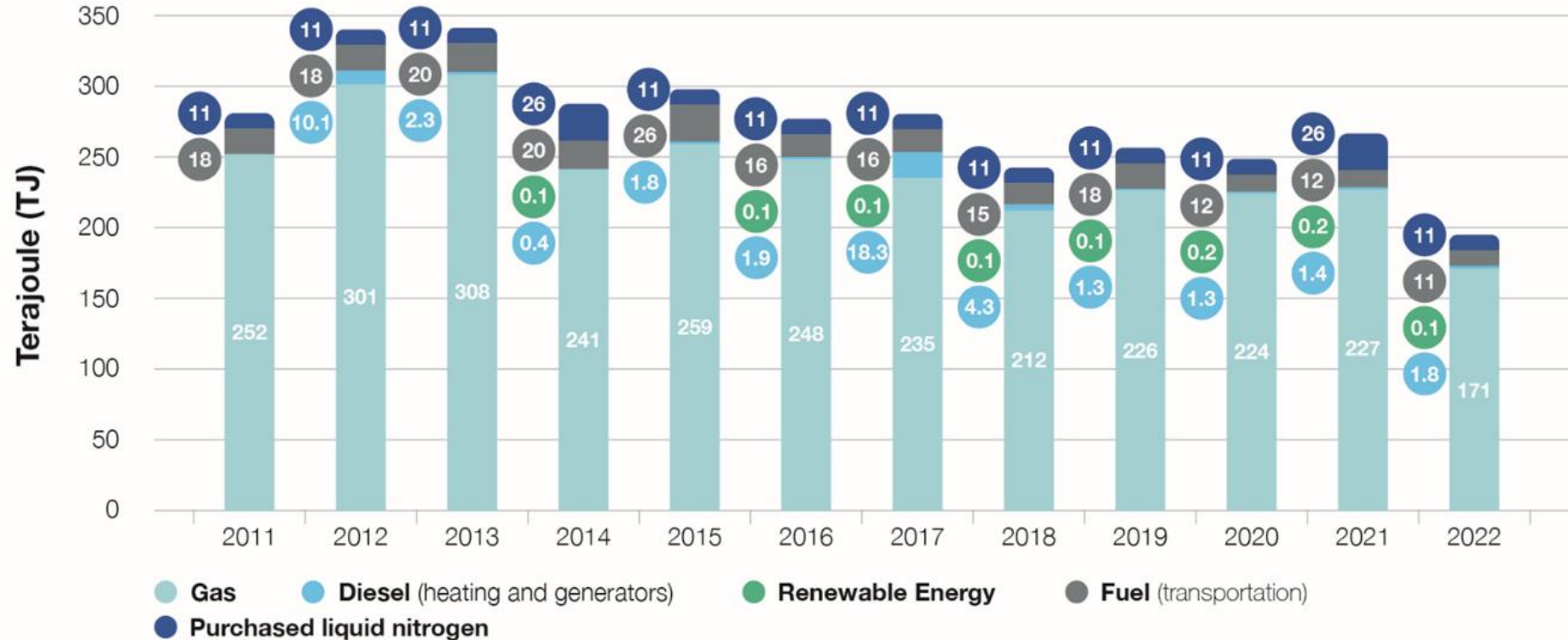
# Challenges ahead

*Environment and sustainability constitute a focus area for CERN now and in the future*

- ❑ The next long shutdown (LS3 – 3 years from 2026 on) is a key milestone to conclude essential projects (e.g. GHG emissions) in CERN's efforts to minimise its impact on the environment
- ❑ Horizon 2030 environmental objectives were recently approved. A set of projects and the corresponding budget has been integrated in CERN's Medium-Term Plan and was approved by the CERN Council in June this year
- ❑ A revised strategy beyond 2030 will be driven also by expectations of CERN Member States, Host States and by the needs of the HEP community



# Energy – Other categories



- ❑ Campus energy saving actions in 2022: Delayed start-up of heating in buildings & reduced temperature of the heating boilers
- ❑ Meyrin and Prévessin sites heating mostly provided by heat recuperation from CERN infrastructures as from 2026/2027: **Two heat recovery projects approved** (from LHC Point1 cooling towers and the new data centre in Prévessin)
- ❑ CERN investigated solutions to incorporate more renewable energy sources in the future

# Emissions - Scope 1 (direct) – breakdown by gas type

- Main source of scope 1 emissions linked to F-gases used for detector cooling (mostly PFCs such as C<sub>6</sub>F<sub>14</sub> and C<sub>3</sub>F<sub>8</sub>) and for particle detection (mostly HFCs such as HFC-134a)
- CO<sub>2</sub> emissions highlighted in the table are resulting from on-site combustion processes (heating plants, emergency generators, CERN vehicle fleet)

GROUP	GASES	tCO <sub>2</sub> e 2021	tCO <sub>2</sub> e 2022
Perfluorocarbons (PFCs)	CF <sub>4</sub> , C <sub>2</sub> F <sub>6</sub> , C <sub>3</sub> F <sub>8</sub> , C <sub>4</sub> F <sub>10</sub> , C <sub>6</sub> F <sub>14</sub>	55 921	68 989
Hydrochlorofluorocarbons (HFCs)	HFC-23 (CHF <sub>3</sub> ) HFC-32 (CH <sub>2</sub> F <sub>2</sub> ) HFC-134a (C <sub>2</sub> H <sub>2</sub> F <sub>4</sub> ) HFC-404a HFC-407c HFC-410a HFC-507	36 557	86 211
Other F-gases	SF <sub>6</sub> , NF <sub>3</sub>	16 838	18 355
Hydrofluoroolefins (HFO)/HFCs	R-449 R1234ze NOVEC 649	86	199
	CO <sub>2</sub>	13 771	10 419
<b>Total Scope 1</b>		<b>123 174</b>	<b>184 173</b>

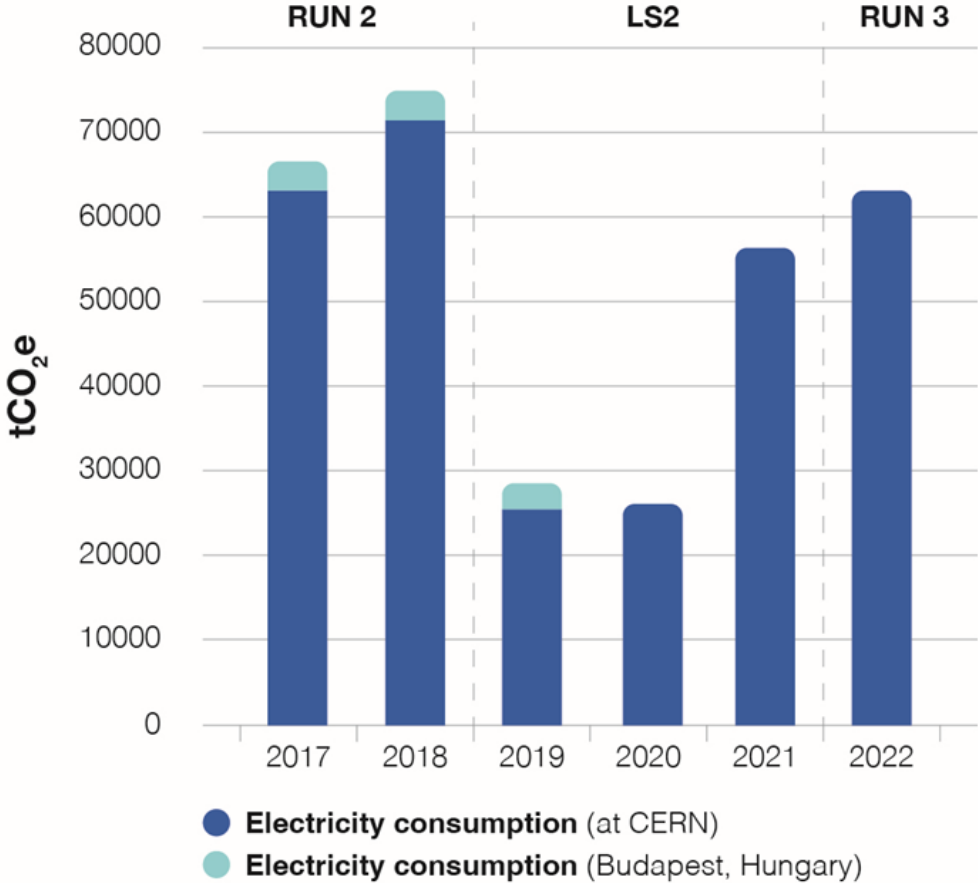
## BREAKDOWN OF SCOPE 1 EMISSIONS BY GAS TYPE 2021–2022

The tCO<sub>2</sub>e values have been calculated based on the real consumption of the different gases, weighted by their GWP. The GWP is based on the IPCC Fourth Assessment Report, 2007 (AR4), which is also the reference used in EU Regulation 517/2014 on fluorinated greenhouse gases.



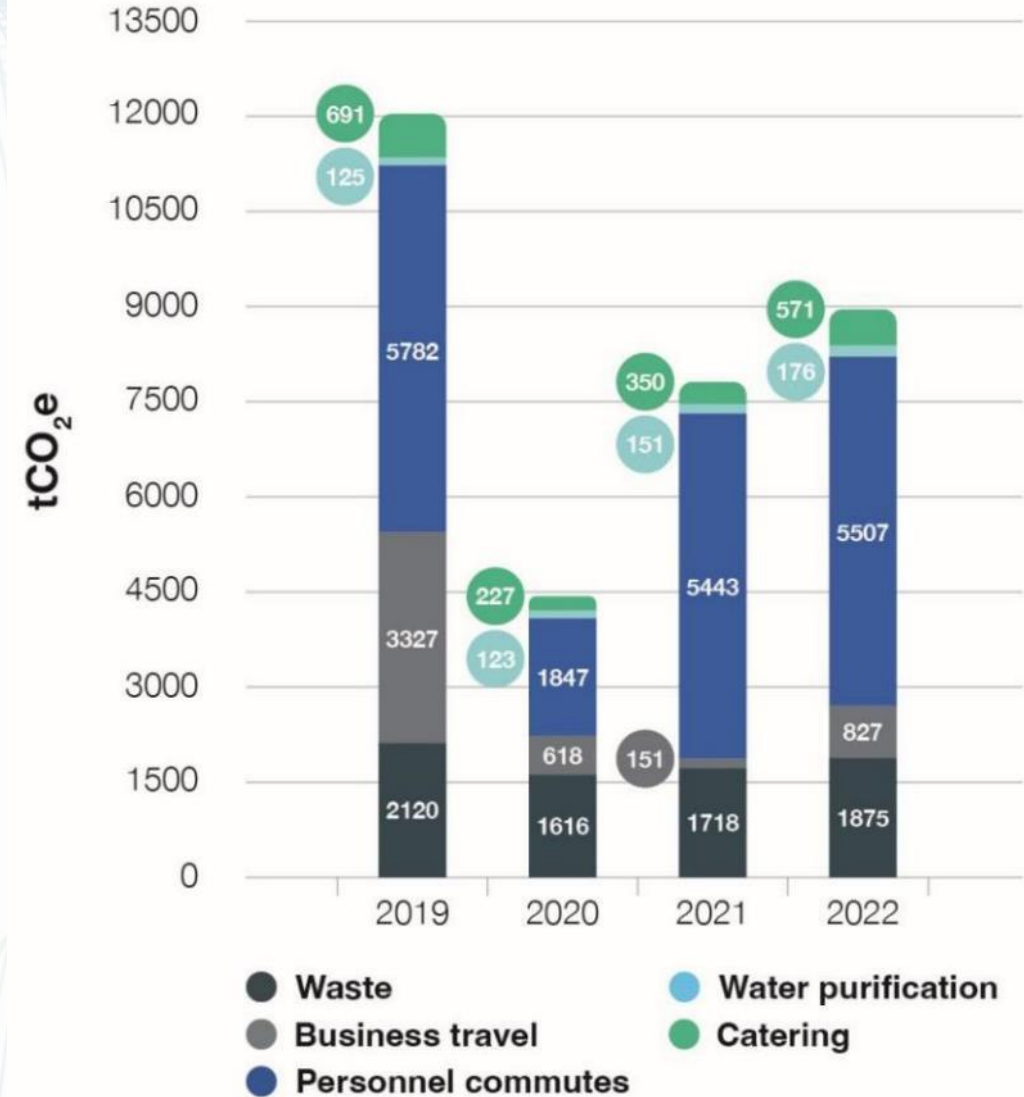
# Emissions – Scope 2 (indirect)

- ❑ CERN’s principal electricity supplier (EDF – France) generates low-carbon electricity mainly of nuclear origin. French energy mix contributes to keeping energy-related CO<sub>2</sub> emissions low
- ❑ Review of CO<sub>2</sub> emission factors linked to electricity supply, to ensure that the figures quoted remain as accurate as possible



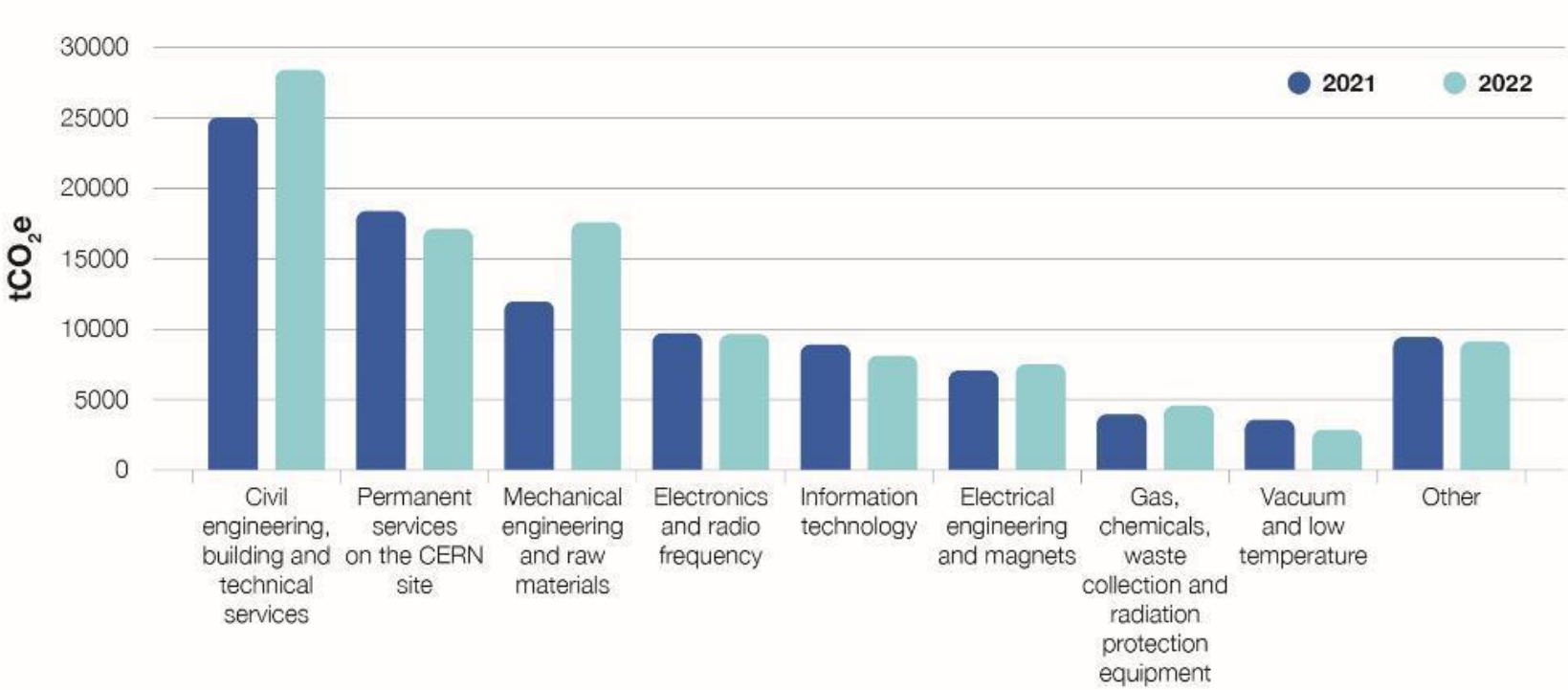
# Emissions - Scope 3 (indirect)

- ❑ **Duty travel:** Working Group set up in April 2022 to develop CERN-wide duty travel guidelines with the goal of reducing the emissions from CERN-related duty travel
- ❑ **Mobility:** Goal for 2025 is to keep individual motorised vehicle commuting constant. Encourage alternative modes of transportation, such as cycling, public transport and carpooling
  - Survey of the mobility habits of CERN personnel (2022):
    - 61% of CERN personnel use individual motorised vehicles for commuting (68% in 2018)
    - Walking and cycling increased: 24% of all commutes (17% in 2018)



# Emissions: scope 3 (indirect) - procurement

- ❑ **CERN Environmentally Responsible Procurement Policy Project (CERP3) launched in September 2021**
  - Environmentally Responsible Procurement Policy drafted
    - Better understand the most CO<sub>2</sub>e emitting procurement families
    - Develop and prioritise action plans
  - Development of a supplier engagement programme (for suppliers representing top 80% of CERN emissions)



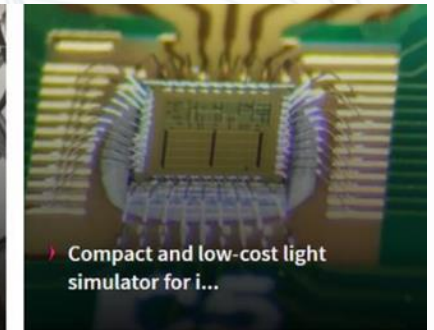
**2021: 98 030 tCO<sub>2</sub>e**

**2022: 104 974 tCO<sub>2</sub>e**

# Knowledge and technology for the environment - Highlights

## 2022: CERN Innovation Programme on Environmental Applications (CIPEA) endorsed by the CERN

### Management



### + Others



#### CERN to partner with industry on innovation to reduce environmental impact of large-scale facilities

In its commitment to minimising its environmental impact and developing technologies that can help society towards a better planet, CERN has formed an innovation partnership with ABB, with the aim of reducing the Laboratory's energy consumption

Environment | 14 June, 2022



#### CERN and Airbus partnership on future clean aviation

CERN and Airbus UpNext sign a collaboration agreement to assess the use of superconducting technologies for future low-emission aeroplanes.

AerospaceEnvironment | 01 December, 2022

