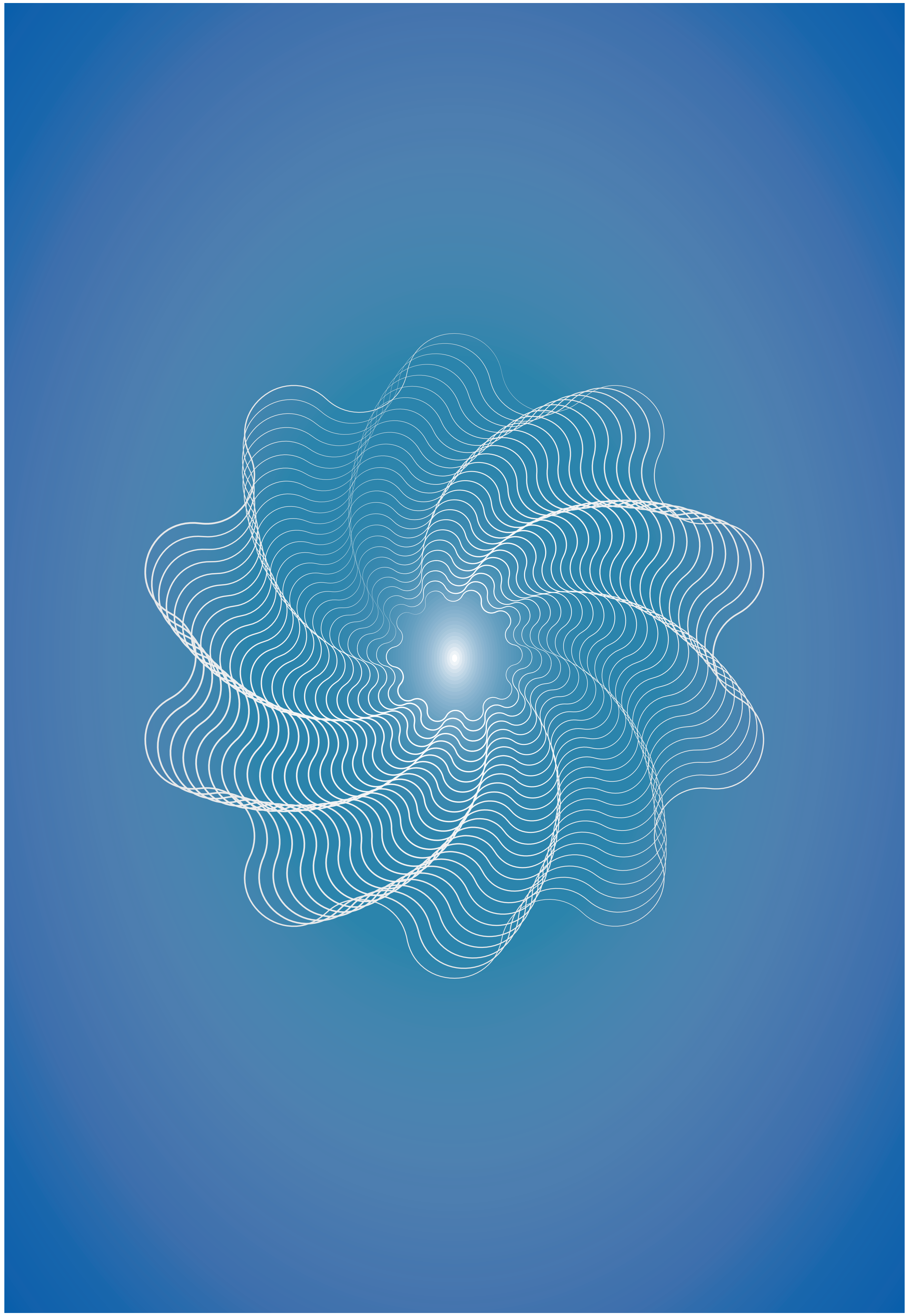
Environment Report

2019 - 2020



CONTENTS

Photos, clockwise from top left: Power transmission line, water measurements, civil engineering works, sheep grazing.

FOREWORD

PUTTING THE ENVIRONMENT AT THE HEART OF CERN

Welcome to CERN's second public environment report, covering the period 2019-2020. This was a challenging time for all of us, as the COVID-19 pandemic brought much of the world to a halt. For CERN, it was also the second long shutdown (LS2) of the Large Hadron Collider (LHC) and our entire accelerator complex – an extended period of maintenance and upgrades across the Laboratory. From an environmental-management perspective, long shutdowns are particularly intense periods, as equipment at the end of its life is replaced, thereby offering opportunities to align with the latest environmental standards. The COVID-19 pandemic meant that we had to adapt our plans, and I'm pleased to report that we managed to do so with just a few months' delay to the schedule.

LS2 saw the completion of the LHC Injectors Upgrade project (LIU), which has readied the injector chain for the high-luminosity phase of LHC operation (HL-LHC), scheduled to get under way in 2028. The oldest accelerator still in operation at CERN dates back to 1959, and others to the 1970s. LIU was an opportunity not only to enhance their performance, but also to improve their environmental credentials. During the LHC's first long shutdown, a new powering scheme for the Super Proton Synchrotron (SPS) accelerator allowed the machine's energy consumption to be reduced by 40 GWh/year, and during the period covered by this report, a similar scheme was deployed as part of the refurbishment of our East Area experimental hall, which has led to a 90% reduction in energy consumption.

LS2 was also an occasion for maintenance and upgrades of our experiments. In our last environment report, we undertook to reduce scope 1 emissions of greenhouse gases by 28% by 2024. Although the pandemic prevented us from advancing as much as we had planned, we were able to start installing new cooling systems for major particle detectors to replace high-global-warming-potential gases with more environment-friendly ones. The experiments have also been repairing leaks in their gas-based detectors and investigating environmentally friendly gas mixtures.

An important milestone in 2020 was the publication of an update to the European Strategy for Particle Physics, which puts environmental protection at the heart of particle physics in Europe and of any future project at CERN. It states: "*The environmental impact of particle physics activities should continue to be carefully studied and minimised. A detailed plan for the minimisation of environmental impact and for the saving and re-use of energy should be part of the approval process for any major project.*"

One tangible example of this principle in action is the completion in 2020 of a plant to recover waste heat from the LHC to heat a new residential development in nearby France. This will not be a one-off: plans for a new computer centre include heat recovery to heat the buildings of CERN's Prévessin site, and studies are under way to evaluate the heat-recovery potential of other points around the LHC. Heat recovery will be built into any designs for future facilities at CERN.

The production of CERN's first public environment report in 2020 enabled us to establish reporting frameworks and set concrete goals. This second report is about turning words into action. Over the 2019-2020 period, initial objectives identified by the CERN Environmental Protection Steering Board (CEPS) were formalised, financed and implemented – one example being the construction of a retention basin for the Prévessin site to protect local watercourses from accidental pollution and to mitigate the consequences of extremely heavy rainfall.

In this document, we report on our scope 3 emissions for the first time, presenting data relating to business travel, personnel commutes, catering, waste treatment and water purification. Procurement is expected to constitute the largest part of the Organization's scope 3 emissions. A procedure for evaluating scope 3 emissions due to procurement, along with a project to assess how to green CERN's procurement, are in preparation. This will be covered in a future report. This represents an important step in understanding and controlling our overall emissions.

At CERN, we aspire to contribute to the achievement of some of the environment-related UN Sustainable Development Goals (SDGs) by improving our performance and forging partnerships with others. Among the goals we have identified as areas where CERN can make an active contribution are Affordable and Clean Energy (SDG 7) and Industry, Innovation and Infrastructure (SDG 9).

We are actively working on new technologies, such as superconducting power transmission lines, that could make a significant contribution to achieving these goals.

Due to the COVID-19 pandemic, CERN's way of working changed dramatically over the period covered by this report, with most personnel working from home and our usually highly mobile user community unable to travel to CERN. While everyone is looking forward to the end of the pandemic, the positive environmental benefits of less travel and traffic will feed into new methods of working for the long term.

CERN is fully committed to environmental protection and transparent reporting. It is also committed to developing technologies that could help society to improve the health of the planet. This document provides a record of our performance, describes our objectives for improvement and reflects a proactive approach to environmental protection across the Laboratory and among CERN's worldwide scientific community. That the environment is a CERN priority has been clear since we committed to public reporting, and this has been consolidated since the publication of our first report last year. In particular, a materiality analysis helped us to identify and prioritise goals for improvement. It is an exercise that we will revisit regularly, ensuring that protecting the environment remains at the heart of CERN's decision making and all aspects of everyday life at the Laboratory.

Fabiola Gianotti, Director-General

Fabiola Gianotti

HIGHLIGHTS

CERN AND THE ENVIRONMENT IN 2019

During the period covered by this report, 2019-2020, CERN's accelerator complex was in its second long shutdown. Due to this shutdown, several environmental indicators show a different pattern from the previous reporting time frame of 2017-2018. These highlights only include 2019 indicators, given that 2020, with the COVID-19 pandemic, was not representative of a normal year.

Energy

428 GWh

In 2019, CERN consumed **428 GWh** of electricity and **68 GWh** of fossil fuel. CERN's electricity consumption during the period was about 64% lower than when the accelerator complex is running.

The Laboratory is committed to **limiting rises in electricity consumption to 5%** up to the end of 2024 (baseline year: 2018), while delivering significantly increased performance of its facilities. CERN is also committed to increase energy re-use.

Waste

57% recycled

In 2019, CERN eliminated 5589 tonnes of non-hazardous waste, of which **57% was recycled**. The Laboratory also eliminated 1868 tonnes of hazardous waste.

CERN's objective is to increase the current recycling rate.

Emissions

78 169 tCO_2e

In 2019, CERN's direct greenhouse gas emissions (scope 1) were **78 169 tonnes of CO_2 equivalent** (tCO_2e), which is less than half of the amount emitted annually over the period 2017-2018 when the accelerators were running.

Indirect emissions arising from electricity consumption (scope 2) were **10 672 tCO_2e**. In addition, indirect emissions from water purification, waste treatment, business travel, personnel commutes and catering (scope 3) were **12 098 tCO_2e.**

CERN's immediate target is to **reduce direct emissions by 28%** by the end of **2024** (baseline year: 2018).

Water

2006 ML

In 2019, CERN drew **2006 megalitres (ML)** of water, mostly from Lake Geneva. This is about 47% less than in operational years.

The Laboratory is committed to **keeping its increase in water consumption below 5%** up to the end of 2024 (baseline year: 2018), despite a growing demand for water cooling of upgraded facilities.

Biodiversity

16 species of orchids

In 2019, a new species of orchid was discovered on CERN's sites, bringing the total to **16 species**. CERN land includes **258 hectares** of cultivated fields and meadows, **136 hectares** of forest and three wetlands.

ABOUT CERN

STUDYING THE ELEMENTARY PARTICLES

CERN, the European Organization for Nuclear Research, is the world's leading laboratory for accelerator-based particle physics. Its mission is fundamental research: finding out what the universe is made of and how it works. CERN operates a unique network of particle accelerators that collide various particle beams head on or direct them onto fixed targets. Particle detectors record the results of these collisions, providing data to thousands of physicists from all over the world for analysis.

A WORLDWIDE LAB

Founded in 1954, CERN is an intergovernmental organisation headquartered in Meyrin, in the Canton of Geneva, Switzerland. It is governed by its 23 Member States. CERN also brings together nine Associate Member States (as of the end of 2020) and six Observers. The Laboratory has become a prime example of international collaboration, uniting people from all over the world to advance the frontiers of science and technology for the benefit of all.

CERN has two main campuses: the original Meyrin site on the French–Swiss border and the Prévessin site in France. There are also several smaller sites situated in both countries around the 27-kilometre ring of the Large Hadron Collider (LHC) and the 7-kilometre ring of the Super Proton Synchrotron (SPS).

Close to 17 000 people from around the world take part in the Organization's work. These include around 2600 staff members and a similar number of fellows, associates, students and apprentices. They support a vast community of users who carry out their research at CERN, comprising over 11 300 scientists of 110 nationalities from institutes in more than 76 countries.

TAKING PART IN SCIENTIFIC ASSOCIATIONS

CERN cooperates with a number of national and international scientific institutions and organisations and is represented in several scientific associations, such as the European Intergovernmental Research Organisation forum (EIROforum). CERN also has Observer status at the United Nations General Assembly.

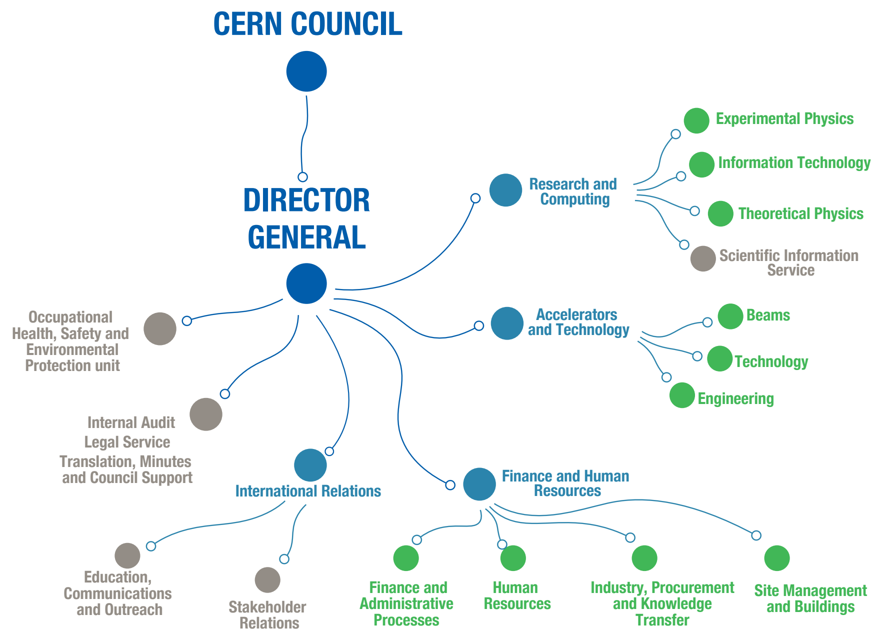
A ROADMAP FOR PARTICLE PHYSICS IN EUROPE

The European Strategy for Particle Physics, first mandated by the CERN Council in 2005, was updated in 2020 following almost two years of discussions and deliberations with particle physicists from Europe and beyond. The strategy guides CERN's work and sets out a coherent and globally coordinated approach to the development of the field in Europe and at CERN.

The updated strategy highlights the importance of the environment, stating that the environmental impact of particle physics should continue to be carefully studied and minimised. It recommends that the approval process for major projects should include a detailed plan for minimising their environmental impact and that wider environmental applications for technologies developed in particle physics should actively be sought.

PROCUREMENT

Procurement has been identified as an important subject for CERN's environmental stewardship. In 2019 and 2020 respectively, CERN spent around 532 MCHF and 441 MCHF



CERN's organisational structure in 2019-2020.

on materials, including goods, services and supplies. This represents 43% and 38% of the Organization's expenses respectively.

CERN shapes its own procurement rules and processes due to its status as an intergovernmental organisation. These currently involve competitive tendering and the adjudication of contracts to the lowest compliant bidder or the bidder offering best value for money. CERN strives to ensure a balanced industrial return for all its Member and Associate Member States. In 2020, CERN placed over 30 000 purchase orders. A policy on greening CERN's procurement is being developed.

ETHICS AND INTEGRITY

CERN is committed to pursuing its mission of research, innovation, training and collaboration while observing the highest ethical standards of behaviour. The CERN Staff Rules and Regulations define the roles and responsibilities of the Organization and its personnel.

In addition, the Laboratory has a full-time Ombud, a Diversity and Inclusion office and a Code of Conduct. Based on integrity, commitment, professionalism, creativity and diversity, the Code serves to promote excellence and respect across the Organization.

CERN also subscribes to a number of external initiatives, such as the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers.

GOVERNANCE

The CERN Council is the highest authority of the Organization and decides on CERN's activities in scientific, technical and administrative matters. The Council is assisted by the Scientific Policy Committee and the Finance Committee. Each Member State has a single vote and most decisions require a simple majority.

Appointed by the Council, usually for five years, the Director-General manages CERN and reports directly to the Council. The Director-General is assisted by a Directorate composed of members proposed by the Director-General and appointed by the Council. In addition, CERN has an Enlarged Directorate, which consists of all the Directors and Department Heads.

IN FOCUS

Jasper Kirkby, spokesperson for the CLOUD experiment at CERN.

— What is the CLOUD experiment?

JK: In a nutshell, CLOUD is a large chamber where we recreate a chosen parcel of the atmosphere. A key aspect of CLOUD is that we can control all the experimental parameters very precisely at atmospheric conditions, where key vapours are found at ultra-low levels of fewer than 1 molecule per trillion. By sampling air from the chamber with state-of-the-art instruments, we observe the formation of atmospheric aerosol particles and how they grow to become the seeds for cloud droplets or ice particles. This is useful for climate science. The formation of aerosol particles and their effect on clouds is recognised as the largest source of uncertainty in current climate models. CLOUD is providing important measurements that are helping to sharpen the predictions of climate models.

MANAGEMENT APPROACH

A STRATEGY FOR THE ENVIRONMENT

CERN strives to be a role model for environmentally responsible research and is committed to minimising its environmental impact. CERN's Safety Policy covers all matters relating to health, safety and environmental protection, and includes the explicit goal of limiting the impact of the Organization's activities on the environment. The Occupational Health and Safety and Environmental Protection unit (HSE) is CERN's centre of competence in environmental matters and the driving force behind the Safety Policy. In addition to the Safety Policy, CERN has adopted an Environmental Protection Strategy that continuously identifies and sets out action plans for prioritised environmental protection domains.

CERN applies the precautionary principle in all aspects of environmental management, taking action to avoid the possibility of serious environmental impact. This applies under all circumstances: if the scientific data does not permit a complete evaluation of the risk, precautionary measures are nevertheless deployed.

SPECIALISED BODIES AND TOOLS

CERN has established a range of bodies to manage its environmental footprint. As part of the Environmental Protection Strategy, the Organization launched the CERN Environmental Protection Steering Board (CEPS) in 2017. CEPS's mandate is to identify and prioritise environmental areas to be addressed and to propose programmes of action. Objectives are approved at the highest level of management at CERN, the Enlarged Directorate. CEPS follows up on the implementation of the programme after endorsement and allocation of resources by the Directorate. During 2019 and 2020, CEPS steered the action plan related to objectives set in 2017 and established working groups on the management of biodiversity, waste and fluorinated gases at CERN. As with any other objective of the Organization, milestones and deadlines for environment-related projects may be delayed due to unforeseen circumstances. This was the case for some of CEPS's recommendations due to the COVID-19 pandemic. For example, during the second long shutdown (LS2), the experiments launched a leak repair campaign. Not all planned repairs could be executed but the campaign remains a priority.

The Energy Management Panel (EMP) was established in 2015. It examines CERN's energy consumption, identifies measures to improve efficiency and promotes energy re-use.

CERN has developed several environmental management tools, including the Radiation Monitoring System for the Environment and Safety (RAMSES) (p. 20) and the CERN Chemical Register for Environment, Health and Safety (CERES) (p. 31).

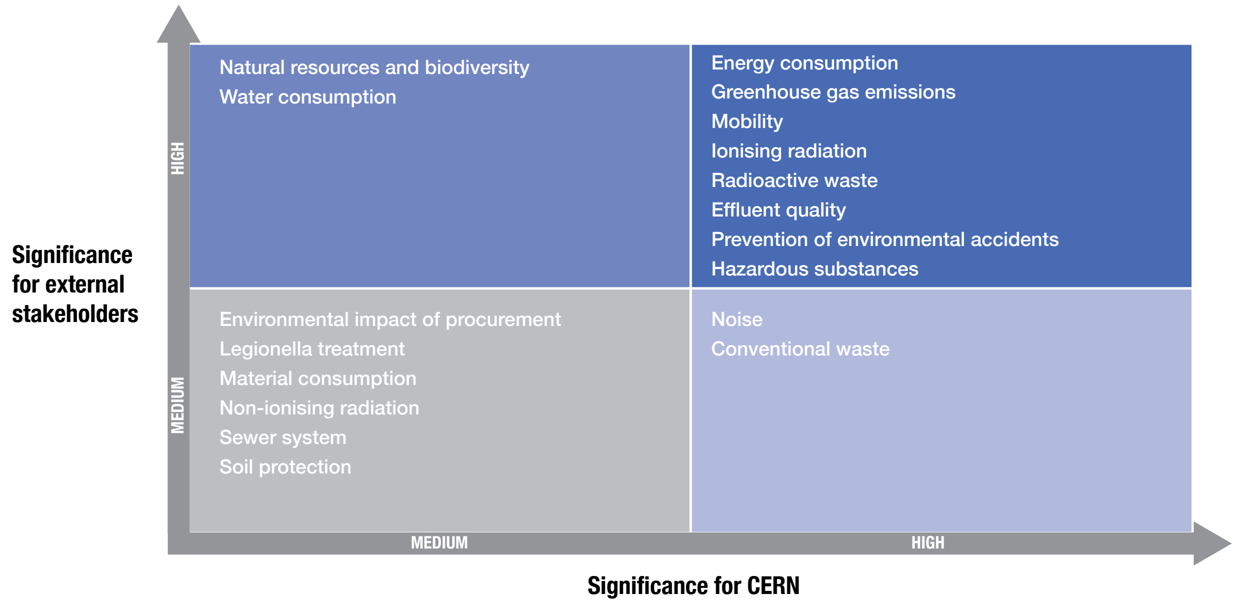
In 2020, the EIROforum created an ad-hoc group on the environment, which is chaired by CERN. This group aims to review the environmental activities carried out by each EIROforum member and to identify areas of common interest where synergies could be developed.

COLLABORATION WITH HOST STATES

CERN works closely with its Host States in matters of environmental protection. As an organisation straddling two countries, CERN develops its own regulations, based on and in agreement with those of the Host States. Where no specific CERN regulation exists, the most relevant regulation of the two Host States is adopted.

Together with the Canton of Geneva, Switzerland, and the Prefecture of Ain, France, CERN established a tripartite committee for the environment under a memorandum of cooperation on non-radiological environmental aspects in 2007. It holds two plenary meetings per year as well as regular technical meetings.

The Laboratory signed a tripartite agreement on radiation protection and radiation safety in 2010 with the Swiss Federal Office of Public Health (OFSP) and the French Nuclear Safety Authority (ASN). This replaced previously existing bilateral agreements and created a legal framework for discussing topics related to radiation protection. The agreement provides for regular technical meetings as well as high-level plenary meetings chaired by CERN's Director of Accelerators and Technology. In addition, the Organization formally reports to the OFSP and ASN on matters of radiation protection and, in particular, the environmental aspects thereof.



CERN MATERIALITY MATRIX. *The topics identified as being of lower significance to all stakeholders are not comprehensively covered in this report but are subject to stringent environmental monitoring by CERN (GRI 102-47).*

MATERIALITY

In preparation for its first environment report, CERN carried out a materiality analysis based on internal and external stakeholder dialogues. The result was a set of topics and disclosures that are also covered in this report and are drawn from the GRI Sustainability Reporting Standards, as well as some CERN-specific topics not covered by the GRI Standards but deemed by CERN and key stakeholders to be of material importance in the CERN context.

The process began with topic-prioritisation focus group meetings with internal stakeholders chosen to represent the diversity of viewpoints at CERN. External stakeholders were identified based on the insight from these meetings, and they were then interviewed (GRI 102-43). A full list of the stakeholders consulted can be found in the CERN Environment Report for 2017-2018.

The materiality matrix (GRI 102-44) shows the resulting list of topics deemed of high significance to CERN by internal and external stakeholders (GRI 102-47). These are the focus of the report.

Following the publication of CERN's first public-facing environment report, a question was raised in CERN's Scientific Policy Committee in 2020 about helium consumption, along with a request to report on the subject in this report (p. 31) (GRI 102-44).

Topic boundaries
CERN is an intergovernmental organisation that also functions as a user facility for people and equipment from universities and institutes around the world. The data presented in the report refers exclusively to the impact of CERN's facilities in the Geneva region, unless stated otherwise. The production of research equipment under the responsibility of collaborating institutes is not considered here (GRI 102-46).

CERN's main product is data, which is transformed into knowledge by scientists around the world using the Worldwide LHC Computing Grid (WLCG) (p. 14). This is a distributed network and is covered here only insofar as the facilities are owned or operated by CERN.

DISCOVERY MACHINES

CERN provides a unique range of particle accelerator facilities, enabling research at the forefront of human knowledge. In 2019 and 2020, CERN's flagship accelerator, the Large Hadron Collider (LHC), was in its second long shutdown (LS2), and many of the Laboratory's accelerator, detector and computing infrastructures underwent a period of consolidation and upgrades. Due to this shutdown, several environmental indicators show a different pattern from the previous reporting timeframe of 2017-2018. LS2 was an important step on the way to the high-luminosity phase of LHC running (HL-LHC), which is scheduled to begin in 2028 and will deliver 10 times more data than the LHC era. This will allow scientists to search for extremely rare phenomena and perform measurements with greater precision, increasing our understanding of the fundamental processes of the universe and unleashing new discovery potential.

CERN'S ACCELERATOR COMPLEX

CERN's unique complex of accelerators supplies a variety of experiments and facilities. CERN is home to a large range of experiments, covering a wealth of topics in physics ranging from studies of the fundamental constituents of matter to the search for particles that were only present in the very early universe. The flagship LHC is the world's largest and most powerful particle accelerator. It collides beams of protons or heavy ions, and the results of these collisions are recorded by several particle detectors.

SECOND LONG SHUTDOWN

After a first long shutdown during 2013 and 2014, followed by four years of operation (Run 2), CERN's accelerator complex entered its second long shutdown at the beginning of 2019. LS2 is a two-year maintenance, consolidation and upgrade programme during which the accelerators and detectors are not in operation. Even though the facilities are not running, physics research continues through the analysis of data gathered during earlier running. Services such as cooling and ventilation also continue through the long shutdowns, accounting for the continued, albeit much reduced, consumption of commodities such as energy and water.

During LS2, many projects preparing for Run 3 of the LHC and for the future HL-LHC phase were carried out. One main focus of the shutdown was the LHC Injectors Upgrade (LIU) project, which saw the entire accelerator chain upstream of the LHC refurbished to provide the more intense beams that the HL-LHC will need. Work on the LHC itself, and the remaining upgrades to the LHC experiments, will take place during the third long shutdown scheduled from 2025 to 2027.

Environmental management of excavation works

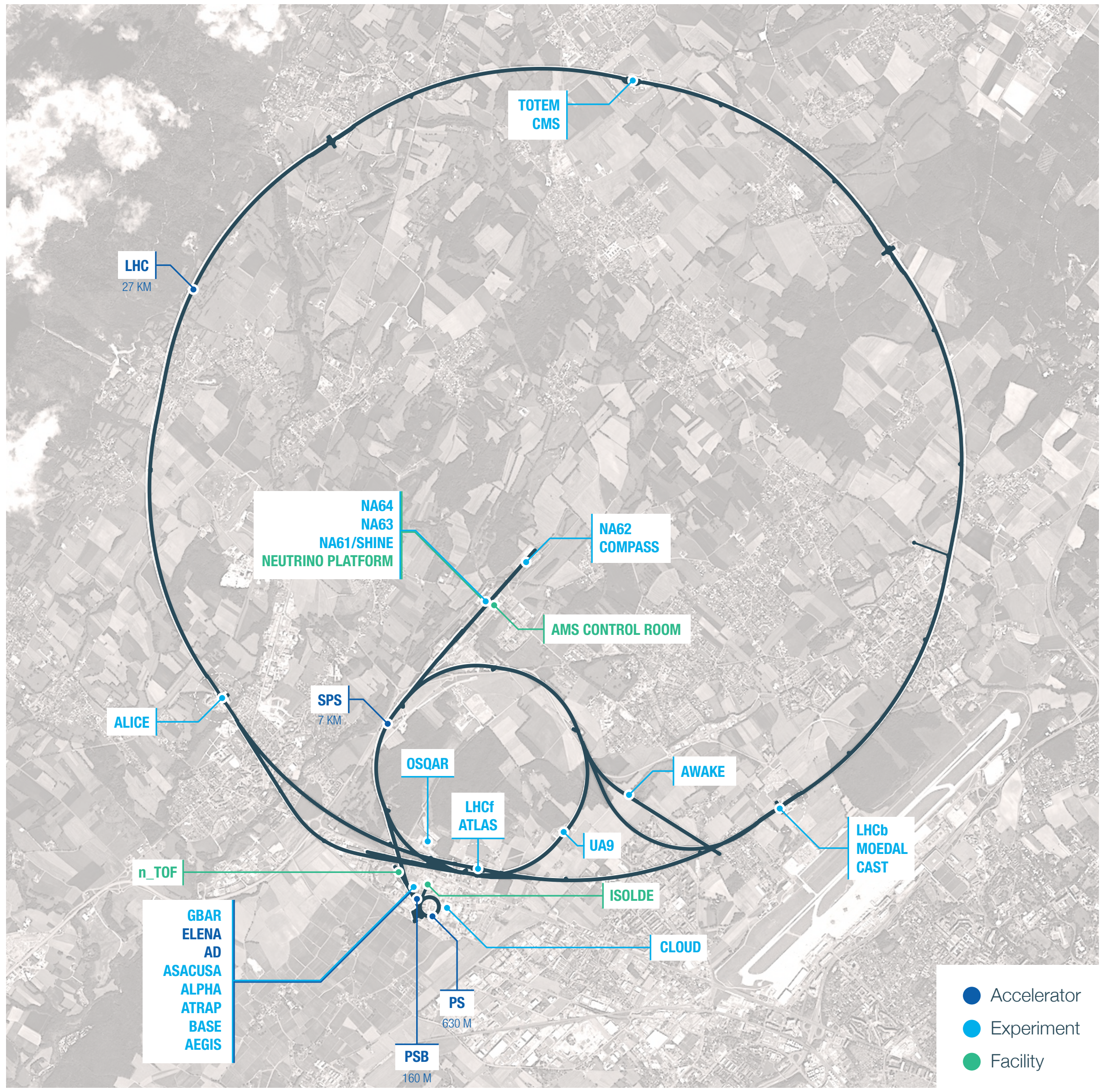
The new equipment for the HL-LHC required significant civil engineering works to be undertaken at the LHC's Point 1 in Meyrin, Switzerland, and Point 5 in Cessy, France. An environmental engineer, under the responsibility of the contractor in charge of the project, followed the progress of the construction work, as required by CERN in the conditions for the award of the contract. Excavation works to create new underground caverns and tunnels were carried out at both sites, generating around 100 000 m^3 of excavated material. This material was analysed to ascertain its quality, consequently determining whether it should be re-used or eliminated through appropriate pathways. On the Meyrin site, much of the excavated material will be re-used to create a platform for new buildings. On both sites, the topsoil will be re-used for landscaping.

CERN also required the contractor to draw up water management plans for the worksites to prevent pollution of surrounding watercourses, for instance the *Nant d'Avril* in Switzerland and the *Oudar* in France.

HIGH-LUMINOSITY LHC

The HL-LHC will be the culmination of the LHC project, running from 2028 to about 2040. To develop new components for the collider, CERN is pushing several technologies to their limits, notably in terms of superconductivity, computing and electronics. In the long term, these innovations could bring considerable benefit to society as a whole. An example of this is the innovative superconducting electrical transmission lines for the HL-LHC magnets (see *In focus*).

With the HL-LHC's higher performance in terms of particle collisions and consequently discovery potential comes increased resource consumption. An optimisation plan has therefore been developed, with a commitment to limit the increase in energy consumption, as discussed in the energy chapter (p. 14), which describes the energy efficiency of CERN's accelerator complex. The use of cooling water is discussed in the water and effluents chapter (p. 26).



CERN's accelerator complex and its experiments in 2019-2020.

IN FOCUS

Amalia Ballarino, designer and project leader for the new superconducting electrical transmission lines at CERN.

— What is this new transmission line?

AB: It is a direct-current superconducting electrical transmission system, which has been developed at CERN, based on magnesium diboride (MgB_2) and high-temperature superconducting (HTS) ReBCO materials. It will connect the power converters to the magnets of the HL-LHC. Eight systems of two different types are needed for the HL-LHC. Each system is composed of up to 19 MgB_2 superconducting cables inside a compact and flexible cryostat and is about 100 metres long. Superconductors conduct electricity with no resistance, allowing the transport of much higher current densities than ordinary cables without losses. With its 120 kA feeding several circuits at 25 K, the HL-LHC transmission system is the most powerful ever built and operated.

— Does this have any application outside CERN?

AB: Lines like these offer unrivalled solutions for high-power transmission. Huge electrical currents can be transported within cryostats with compact diameters. If you think about renewable energy sources, for instance, the production is often located far away from the point of consumption: future transmission grids will have to transfer high electric power over distances of hundreds of kilometres. Compact superconducting lines, with their high-capacity transmission and low losses, could become an enabling technology for an overall more sustainable transmission of electric energy.

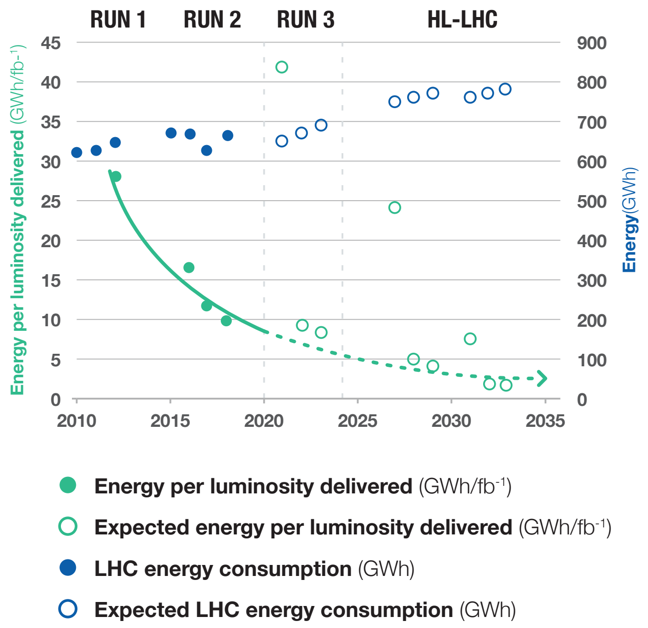
ENERGY

At CERN, accelerators are responsible for most of the Laboratory's energy consumption. As powerful research instruments, these machines make a unique scientific programme possible and support a global community of scientists. CERN makes every effort to run them in the most energy-efficient way possible.

ENERGY CONSUMPTION

Electricity is the main source of energy used at CERN. It is mainly procured from France, whose energy grid mix is 87% low-carbon. In 2019 and 2020, CERN consumed 428 GWh (1541 TJ) and 442 GWh (1591 TJ) of electricity respectively. During this period, the LHC was in its second long shutdown (LS2), and CERN's electricity consumption was about 64% lower than when the machine is running.

In addition to electricity, CERN also uses natural gas for heating, petrol for its fleet of vehicles and diesel for emergency generators. In 2019 and 2020, CERN consumed 68 GWh (246 TJ) and 66 GWh (238 TJ) of fossil fuels respectively. Energy procurement represents around 5% of CERN's annual budget, with this percentage being lower during periods of shutdown.
The LHC experiments produce around 90 petabytes (90 x 10^{15} bytes) of data per year. An additional 25 petabytes of data are produced per year by non-LHC experiments. The data is stored, distributed and analysed by scientists around the world using the Worldwide LHC Computing Grid (WLCG). The WLCG is one of the world's largest computing infrastructures, managed and operated by a worldwide collaboration between the LHC experiments and the participating computer centres. The WLCG's energy consumption detailed here only relates to the facilities owned or operated by CERN. At the end of 2019, CERN ended its seven-year collaboration with the Wigner Data Centre in Hungary, which had been hosting a significant amount of computing equipment providing additional capacity to the CERN Data Centre. The Wigner Data Centre consumed 9.7 GWh (35 TJ) of energy in 2019.



ENERGY INTENSITY OF THE LHC. *Quantity of energy used to fuel the LHC per unit of luminosity delivered by the LHC, showing that increasingly less energy has been needed over time to produce the same amount of data and hence scientific output. During the year after each long shutdown, the luminosity delivered is not at its maximum - as seen in 2021 and 2027 - while the machines are brought back online and progressively ramped up.*

HIGHER LUMINOSITY, HIGHER PERFORMANCE

CERN's main product is data produced by particle beam collisions and recorded by experiments. The Organization constantly strives to make its accelerators more energy efficient. The LHC is responsible for about 55% of CERN's energy consumption during times of operation. In the coming years, the number of collisions produced by the LHC, denoted by a parameter known as luminosity, which is measured in units of inverse femtobarns (fb^{-1}), will almost triple. Higher luminosity equates to more data for the experiments, giving them greater precision and more potential for new discoveries, but it usually comes at the cost of greater energy consumption.

CERN has developed a metric to illustrate the quantity of energy used per unit of luminosity delivered, expressed as Gigawatt hours per inverse femtobarn (GWh/fb^{-1}). During Run 1 of the LHC, the best performance was 27 GWh/fb^{-1}. As shown in the graphic, the LHC delivered twice as much data per unit of energy in Run 2 compared to Run 1. This ratio is expected to improve again for Run 3 and even further for the High-Luminosity LHC (HL-LHC). CERN anticipates the performance ratio at the start of HL-LHC running to be around 5 GWh/fb^{-1} and improve to 2.5 GWh/fb^{-1} later on. With respect to Run 1, the HL-LHC will increase the energy efficiency of CERN's flagship facility by a factor of ten over 20 years.

INCREASE EFFICIENCY, USE LESS, RECOVER MORE

CERN is committed to limiting its increase in energy consumption to 5% up to the end of 2024 (baseline year: 2018). Longer-term objectives will be set in future reports. In order to do so, the Energy Management Panel (EMP) has deployed three main strategies for energy: increase efficiency, use less, and recover waste energy.

In managing the use of energy, the focus is on the accelerators and new projects, such as the HL-LHC. The Laboratory will also study the energy use during LS2 to evaluate what CERN could do to optimise energy consumption during these periods in the future.

Although energy used in buildings is only a small fraction of the Laboratory's total energy consumption, all new buildings at CERN – such as Science Gateway, CERN's new centre for science education and outreach – are designed to be energy efficient. When older buildings are renovated, it is done with energy efficiency in mind.

Since 2018, CERN has been carrying out a major renovation of the Proton Synchrotron's East Area. The first phase of the project, which was completed in 2019, involved the restoration of the building's envelope to improve energy efficiency. During the second phase, beamlines were renewed and old power converters were replaced with new ones designed to supply the magnets on a cyclical basis, with an energy-recovery stage between each cycle. With this renovation project, electricity consumption for the East Area is expected to fall from 11 GWh/year to around 0.6 GWh/year. During the first long shutdown, a similar powering scheme was introduced at the Super Proton Synchrotron (SPS) accelerator, which reduced the machine's energy consumption by 40 GWh/year.

In 2019, CERN signed an agreement with the local French authorities regarding the collection of heat from its facilities at Point 8 of the LHC to heat up a residential area in neighbouring Ferney-Voltaire (see In focus). CERN is continuing to explore heat recovery from its other sites, notably Point 1 in Meyrin, where heat could be recovered from cooling towers to provide central heating on the Meyrin site. In 2020, CERN awarded a contract for the design, construction, operation and maintenance of a new data centre, whose heat might be recovered to heat the Prévessin site.

IN FOCUS

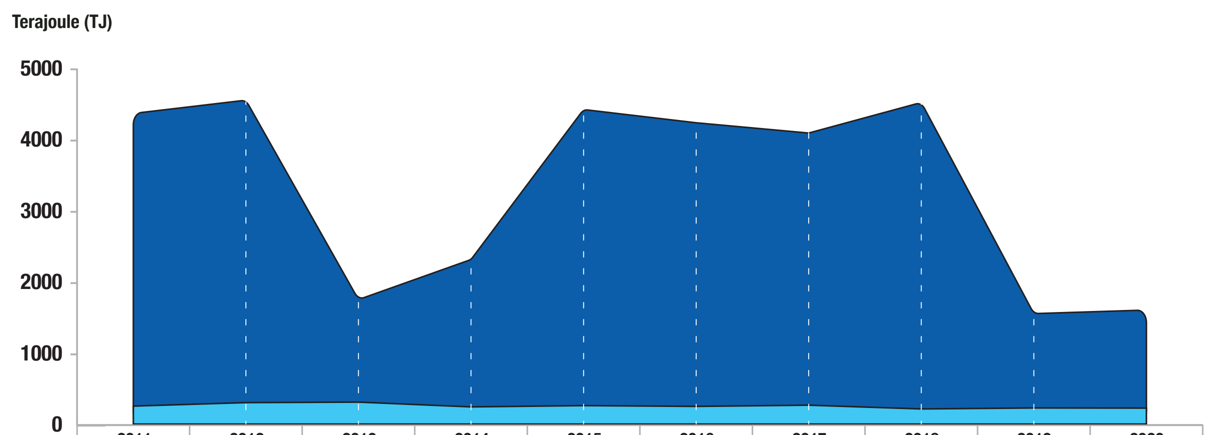
Paul Pepinster, project leader in CERN's Cooling and Ventilation group and technical coordinator of the Heat Recovery project.

— What is the Heat Recovery project?

PP: Hot water from the LHC cooling system will be diverted and used to heat up a new residential area in the town of Ferney-Voltaire. Thanks to this heat, the housing will be heated at lower cost and with reduced CO_2 emissions. The quantity of heat delivered will be progressive over 8-10 years, reaching 20 GWh/year.

— When will it be finished?

PP: We have finished the construction of the heat recovery circuit up to the perimeter of CERN's site at Point 8 of the LHC ring. To avoid disturbances to the accelerator, this work was completed during the second long shutdown. The local community is now preparing to lay 2 kilometres of pipes, while the accelerator is in operation. A plan to test the functionality of the system is scheduled for the end of 2022.



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Electricity	4350	4536	1738	2300	4405	4219	4075	4504	1541	1591
Gas (heating)	252	301	308	241	259	248	235	212	226	224
Diesel (heating and generators)	0	10.1	2.3	0.4	1.8	1.9	16.5	5.3	1.6	1.3
Renewable energy	0	0	0	0.1	0	0.1	0.1	0.1	0.1	0.2
Petrol (transportation)	18	18	20	20	26	16	13	15	18	12

CERN'S ENERGY CONSUMPTION 2011-2020. *This does not include the energy consumed at the Wigner Data centre in Hungary (2011-2019).*

EMISSIONS

CERN's greenhouse gas emissions have been estimated in accordance with the internationally recognised methodology of the Greenhouse Gas Protocol and are categorised into three groups or "scopes". Scope 1 refers to the direct emissions resulting from an organisation's facilities and vehicles, while scope 2 refers to indirect emissions related to the generation of electricity, steam, heating or cooling purchased for an organisation's own use. Scope 3 refers to all other indirect emissions occurring upstream and downstream of an organisation's activities, such as business travel, personnel commutes and catering.

DIRECT EMISSIONS - SCOPE 1

CERN's direct greenhouse gas emissions (scope 1) are mostly related to the use of various fluorinated gases (F-gases) for particle detection and detector cooling in the large LHC experiments. This includes SF_6, HFCs and PFCs for particle detection, HFCs and PFCs for detector cooling and HFCs for air conditioning systems. SF_6 is also used for electrical insulation in power supply systems. In 2019 and 2020, the total amount of scope 1 greenhouse gas emissions was 78 169 and 98 997 tonnes of CO_2 equivalent (tCO_2e) respectively. This is less than half of the amount emitted over the period 2017-2018, since CERN's accelerator complex was in its second long shutdown (LS2). However, it is not zero due the fact that detector cooling is maintained during long shutdowns to avoid accelerated ageing of the particle detection systems.

Optimisation strategies

CERN's greenhouse gas mitigation efforts focus on reducing F-gas emissions, since this is the main contributor. The Organization's objective is to reduce its scope 1 emissions by 28% by the end of 2024 (baseline year: 2018). To optimise the use of gases in the detectors, CERN has developed an R&D strategy based on four pillars: gas recuperation, abatement, optimisation of current technologies, and replacing gases with more environmentally friendly ones.

During Run 2 of the LHC, CERN tested a prototype for an HFC-134a recuperation plant on a real detector. The results from the prototype so far show a recuperation efficiency of close to 85%. An updated prototype is being designed and is planned to be installed in two detectors in 2022.

The detectors installed in the LHC experiments are equipped with F-gas recirculation systems to reduce the consumption of gas. They have an average recirculation efficiency of 90%, due to gas purity requirements. The main contributors to CERN's F-gas emissions are small leaks in the detectors as a result of their necessarily light construction. During LS2, the experiments launched a leak repair campaign. Not all planned repairs could be executed because of the COVID-19 pandemic, but the campaign remains a priority.

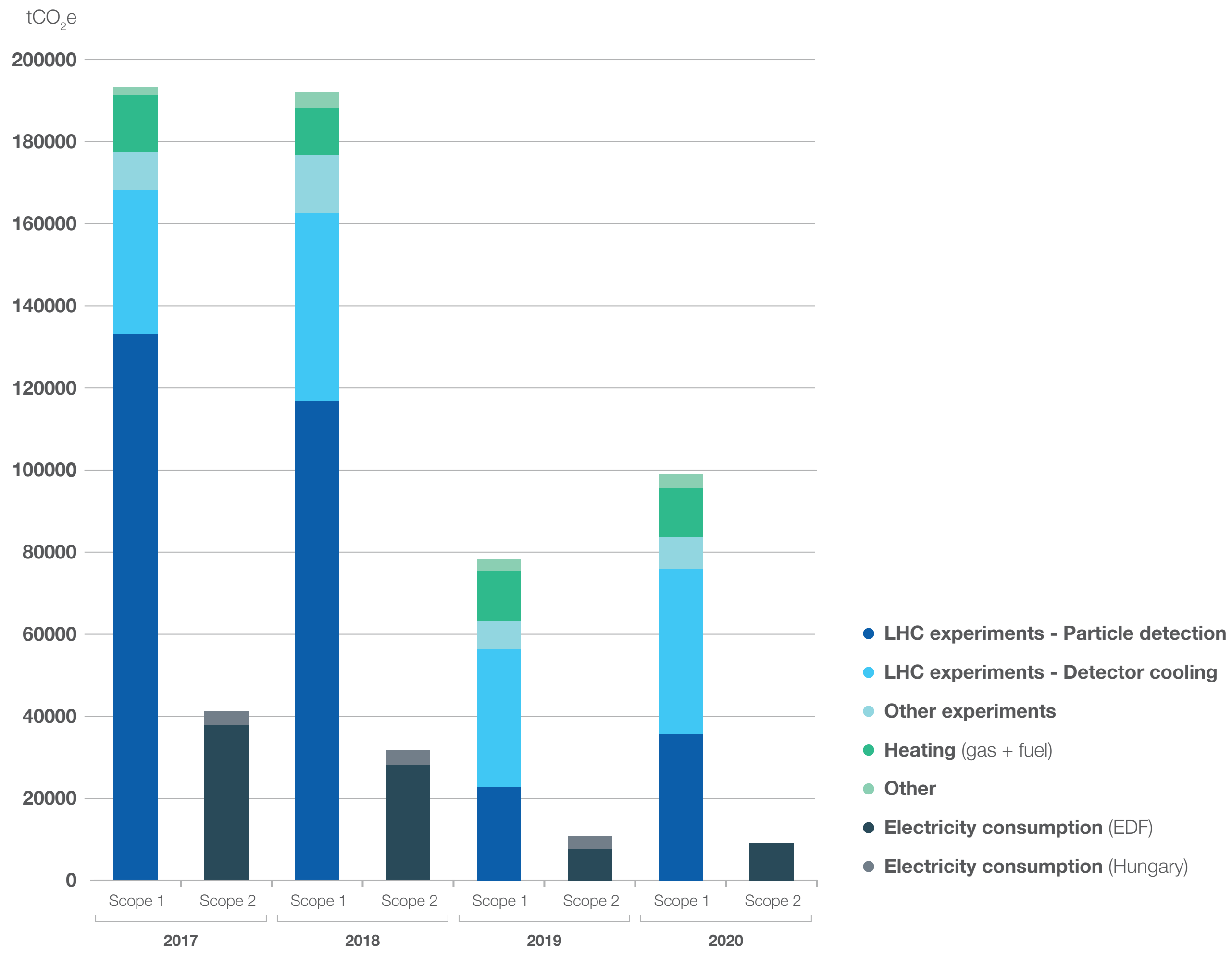
LS2 also marked the first steps towards replacing F-gases with CO_2 in detector cooling systems. CO_2 has a substantially lower global warming potential than F-gases, and it is also efficient in very small pipes, which are essential to some detector systems in the LHC.

In 2020, CERN launched a working group on managing F-gases, with representatives from the departments concerned and the large LHC experiments. The group looked at issues such as the implementation of a centralised F-gas procurement policy, leak detection, replacement alternatives, training courses for personnel handling F-gases, and improving traceability and reporting.

ENERGY INDIRECT EMISSIONS - SCOPE 2

The total amount of scope 2 greenhouse gas emissions due to CERN's electricity consumption was 10 672 and 9247 tCO_2e in 2019 and 2020 respectively. The indirect energy emissions in 2019 also include 3075 tCO_2e from the electricity consumed by a CERN-operated data centre at the Wigner Centre in Hungary. As of 2020, CERN no longer operates this computing facility. The calculations are based on average energy generation emission factors for the local energy grids in the respective countries.

EDF, CERN's principal electricity supplier, uses low-carbon power, mainly nuclear, which keeps the energy-related emissions relatively low. During LS2, electricity consumption was about 64% lower than that of operational years, which had a knock-on effect on energy-related emissions.



CERN SCOPE 1 AND SCOPE 2 EMISSIONS FOR 2017-2020 BY CATEGORY.

Other includes air conditioning, electrical insulation, emergency generators and CERN vehicle fleet fuel consumption. Emission factors for electricity: EDF Bilan des émissions de GES 2002-2020 for EDF and Bilan Carbone® V8 for Hungary.

GROUP	GASES	tCO_2e 2019	tCO_2e 2020
PFC	CF_4, C_2F_6, C_3F_8, C_4F_{10}, C_6F_{14}	43277	45678
HFC	CHF_3 (HFC-23), $C_2H_2F_4$ (HFC-134a), HFC-404a, HFC-407c, HFC-410a, HFC R-422D, HFC-507	17540	34899
Other F-gases	SF_6, NOVEC, R1234ze	3840	5377
CO_2	CO_2	13512	13046
TOTAL SCOPE 1		78169	98997

BREAKDOWN OF SCOPE 1 EMISSIONS BY GAS TYPE 2019 AND 2020.

Global warming potential (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.

OTHER INDIRECT EMISSIONS - SCOPE 3

In 2020, CERN initiated an evaluation of its scope 3 emissions for the first time. The estimate presented here covers the years 2019 and 2020. The Organization assessed emissions from business travel, personnel commutes, catering, waste treatment and water purification, applying a process-based approach. CERN applied the Ecoinvent emission factors and used the 2013 global-warming-potential values of the Intergovernmental Panel on Climate Change (IPCC).

CERN's procurement is expected to constitute the largest part of the Organization's scope 3 emissions. It is also the hardest to quantify because of the diversity of products, suppliers and origins of purchases arising from the nature of CERN's work and a procurement policy that strives to balance return to all of CERN's Member and Associate Member States. A procedure for evaluating scope 3 emissions due to procurement, along with a project to assess how to green CERN's procurement, are in preparation. These will be covered in a future report.

Waste treatment and water purification

The scope 3 emissions related to water purification amounted to 133 and 129 tCO_2e in 2019 and 2020 respectively. The indirect emissions arising from waste treatment are linked to the elimination pathways, and in 2019 and 2020 came to 2061 tCO_2e and 1750 tCO_2e respectively. A reduction in these emissions is attributable to water management (p. 28) and waste management (p. 24).

Business travel

Emissions arising from business travel amounted to 3330 tCO_2e and 619 tCO_2e in 2019 and 2020 respectively. Most of the emissions result from air travel, mainly from long-distance flights.

In this report, only travel made by CERN's employees and associated members of the personnel on CERN's payroll was considered, as travel by CERN users was beyond the topic boundaries (p. 11). Furthermore, user travel is usually paid for and managed by the users' host institutions, and CERN has only limited control and oversight in the matter. Due to the large size of CERN's user community, it is likely that travel-related emissions for users are several times higher than those for personnel on CERN's payroll.

In 2020, CERN introduced an updated procedure for business travel that favours environmentally friendly travel modes in an effort to minimise the impact of professional travel.

Personnel commutes

Emissions related to personnel commutes came to 5836 tCO_2e and 1868 tCO_2e in 2019 and 2020 respectively. In 2020, commutes could not be accurately measured as CERN adapted to the pandemic, and the figure is based on a rough estimate derived from the number of meals served in CERN's restaurants. As with business travel, emissions resulting from commuting were calculated for personnel on CERN's payroll (about 4000 people). In addition, about 12,000 users regularly visit CERN for variable periods of time (this number fell considerably during the pandemic).Their emissions are not included in the calculations.

Around 77% of all CERN personnel commute to work from France, most using individual motorised vehicles due in part to a lack of public transport. CERN's goal for 2025 is to keep individual motorised vehicle commuting constant, despite a growing scientific community. Overall, walking and cycling constitute 17% of all commutes.

CERN has a fleet of 750 bicycles available free of charge to its personnel, making it the largest such fleet among companies and organisations in Switzerland. The Laboratory also has a rental car fleet and a shuttle service for inter- and intra-site mobility. In 2020, CERN approved several measures to promote the environment-friendly mobility of its members, such as increasing the frequency of the shuttles and improving bicycle routes.

Catering

CERN has several restaurants, cafeterias and vending machines on its sites, all run by external companies. The main provider is NOVAE, which operates three restaurants, seven cafeterias and the majority of the vending machines present on site. On average, NOVAE provides around 3500 meals per day. The emissions related to food and beverages are derived from the food products purchased by NOVAE before preparation and serving, while the energy used in the kitchens on site for refrigeration and food preparation is included in CERN's scope 2 data. CERN's catering-related emissions were 738 tCO_2e and 243 tCO_2e in 2019 and 2020 respectively. Red meat and dairy products account for more than half of these emissions.

NOVAE has been actively working to reduce its environmental footprint over the years. Around 70% of the fresh produce purchased by NOVAE comes from less than 200 kilometres away. A phase-out of single-use plastics in the restaurants is ongoing but has been slowed down due to the COVID-19 pandemic.

IN FOCUS

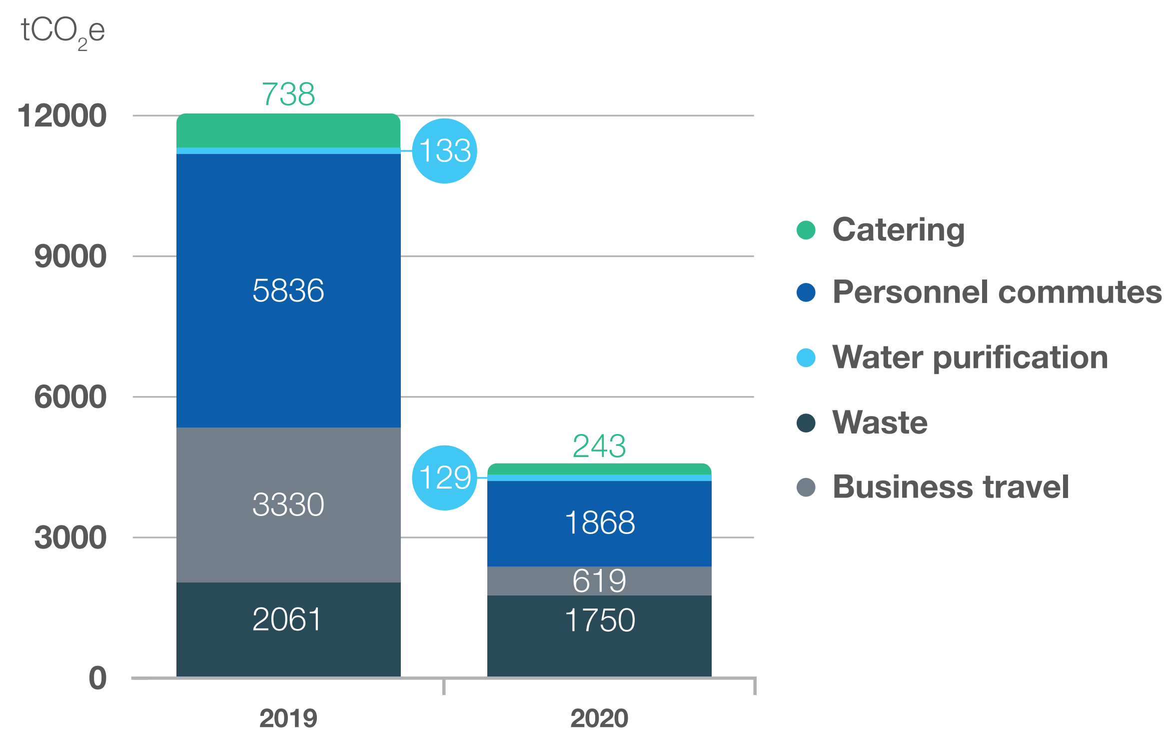
Charlotte Ioan is responsible for procurement and nutrition at NOVAE, CERN's restaurant supplier.

— What is NOVAE's approach to sustainability when it comes to sourcing?

CI: In 2009, we adopted a new sourcing strategy that focuses on quality, ethics and local producers. We also created a network for responsible and local sourcing together with our agricultural partners. We are regularly out in the fields, talking directly to our partners. Thanks to this approach, we can build long-term relationships with our agricultural partners and develop our supply chains. Today, we are proud to say that we have 95 direct partners, 75% of which are Swiss. Our purchasing model is based on a responsible and sustainable virtuous ecosystem combining culinary quality with sustainability. Since 2020, we have held the Ecovadis silver certification as well as ISO certification in quality, environment and occupational health and safety (ISO 9001, 14001 and 45001).

— What is in the future for NOVAE?

CI: Proximity is the core value of Novae, so we will continue to focus on local high-quality products together with our agricultural partners. We will continue to work on reducing plastics, food waste and our carbon footprint. For the time being, 92% of our meat comes from Switzerland, while the remainder comes from France. We are now working further with vegetables and fruit and, in addition, we are focusing on ultra-local or regional products in general.



CERN'S SCOPE 3 EMISSIONS 2019-2020.

"Waste" includes the waste sent through different elimination pathways as well as water sent to wastewater treatment plants. For business travel and personnel commutes, only personnel on CERN's payroll are included and the 2020 value for personnel commutes is a rough estimate. Emissions arising from procurement are not included.

IONISING RADIATION

At CERN, ionising radiation is produced by the collision of particle beams with matter. CERN's unique facilities require innovative approaches to minimising the exposure of workers, the public and the environment, making CERN one of the recognised leaders in this field.

RADIATION – A NATURAL PHENOMENON

Radiation is all around us. It comes from the Earth and from space. It is present in our food, and we receive doses of it in medical examinations such as X-rays and when we travel by air. Industrial and research facilities can also generate ionising radiation.

The European Council sets the annual dose limit for public exposure from artificial sources, with the exception of exposure for medical reasons, at 1 millisievert (mSv). CERN is well within its commitment to limit its contribution to less than a third of this value: no more than 0.3 mSv per year. The actual dose due to the Organization's activities received by any member of the public living in the immediate vicinity of CERN is below 0.02 mSv in a typical year when all the Laboratory's facilities are operational. This is much lower than the dose received from natural sources and medical examinations, as shown in the figure.

During 2019 and 2020, with CERN's beam and experimental facilities shut down for maintenance and upgrades, the actual dose was less than 0.0002 mSv per year, about 10 000 times lower than the annual dose received from cosmic rays, terrestrial radiation, radon and food.

RESPONSIBLE REPORTING

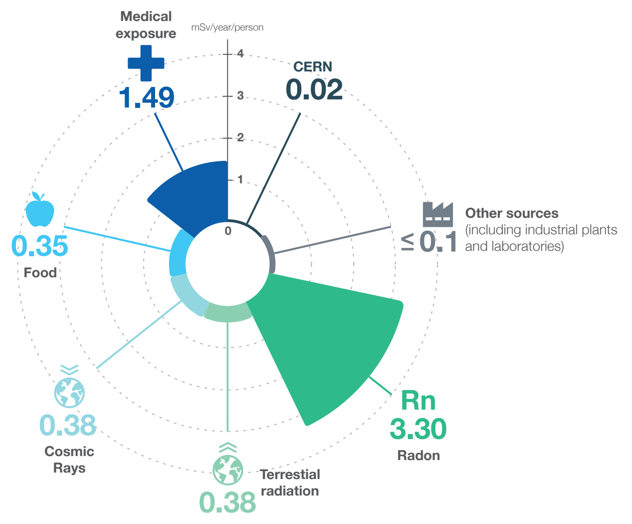
CERN follows best practice in matters of radiation protection and radiation safety, taking into account Host State legislation as well European and international standards. A tripartite agreement on radiation protection and radiation safety with the Host States provides the legal framework for the discussion of CERN-wide radiation safety and radiation protection matters in a transparent and collaborative way (p. 10). As part of this agreement, CERN reports quarterly on radioactivity measurements in the local environment to the Swiss and French authorities. The Organization always strives to apply the latest developments in applicable standards, and to adapt to evolving requests from the Host State authorities.

The methods used to evaluate doses that might be received by members of the public are based on widely recognised models and standards and consider the specific nature of CERN's facilities. The Laboratory has recently updated its methods, which are currently undergoing meticulous review by the Host State authorities as part of a homologation process.

STATE-OF-THE-ART MONITORING

CERN operates an extensive network of environmental radiation monitors and online sampling systems, which is part of the Radiation Monitoring System for the Environment and Safety (RAMSES) managed by the HSE unit. In 2020, CERN's environmental monitoring programme included 136 measuring stations comprising 649 detectors, 511 of which are dedicated to radiological monitoring. All measurement data is compiled and managed centrally by a CERN-developed software package called REMUS (Radiation and Environment Monitoring Unified Supervision). During the second long shutdown of the LHC, CERN upgraded its radiation monitoring stations for releases to air and water.

The environmental monitoring programme includes the planning of monitoring needs for the next decade so as to always ensure state-of-the-art monitoring of the evolving operation of CERN's facilities.



IONISING RADIATION. *Average doses received per person per year in Switzerland (in mSv/year/person). CERN's activities fall under the category 'other sources'. (Source: Swiss Federal Office of Public Health, 2020).*

IN FOCUS

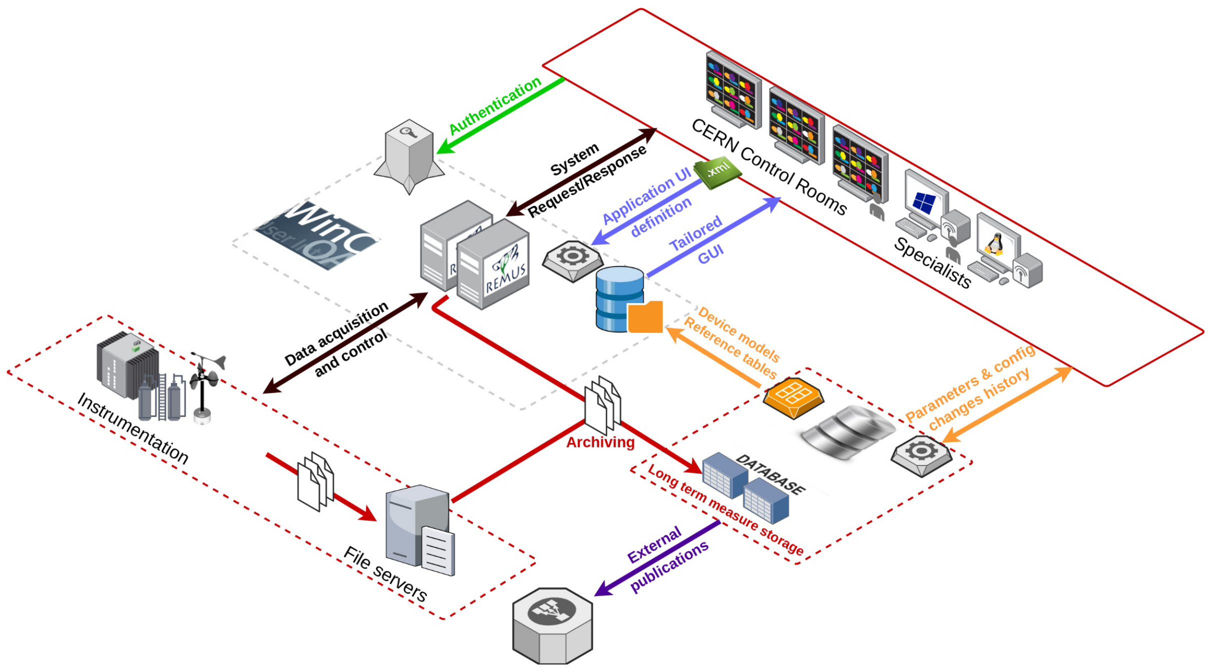
Pavol Vojtyla, a member of CERN's Radiation Protection group, is involved as an expert in the revision of a guideline from the Swiss Federal Nuclear Safety Inspectorate (ENSI).

— What is this guideline about?

PV: The ENSI guideline G14 concerns the calculation of doses due to ionising radiation in the environment that are caused by the emission of radioactive substances from nuclear installations. This directive applies to all nuclear power plants in Switzerland. A revision of the guideline started in 2019 and the project is still ongoing.

— Why was CERN involved in this revision?

PV: The guideline determines the methods to be used in radiological impact assessments of the environment. CERN has been performing similar calculations tailored to the Organization's specific conditions for more than two decades. CERN's acquired knowledge, in particular for calculating external doses due to exposure to radioactive substances in the air, has been helpful for the revision of the guideline.



THE ARCHITECTURE OF CERN'S RADIOLOGICAL AND ENVIRONMENTAL MONITORING NETWORK.

NOISE

CERN's noise footprint and its impact on the Laboratory's neighbours stem mainly from the infrastructure of its large accelerators. In 2019 and 2020, with the accelerator complex shut down, the noise source and profile were different. During this period of heavy maintenance and upgrades, noise resulted mostly from transport and worksite and civil-engineering activities.

MANAGING CERN'S NOISE FOOTPRINT

In the past, most CERN sites were in rural areas. With increasing urbanisation, housing has been constructed near to some facilities. To minimise the noise impact on the immediate neighbourhoods, the Organization has implemented noise mitigation measures, such as noise barriers and silencers to reduce noise during accelerator operation.

The majority of CERN's surface installations are in France; in 2019, the Laboratory published a noise reduction policy and implementation strategy that was agreed upon with the French authorities. This policy was established using baseline measurements carried out in 2018 and includes both preventive and corrective measures. CERN is committed to restricting noise at its perimeter to 70 dB(A) during the day and 60 dB(A) at night at worst, complying with French standards for industrial plants. At most CERN sites, the noise level at the perimeter at night is close to or below 45 dB(A). An update of the policy is under way to better calculate the impact of multiple projects on the same site.

Action has been taken, in particular, to reduce noise from cryogenic equipment, which is vital for cooling the Large Hadron Collider (LHC) and can generate noise in the neighbourhoods closest to the LHC sites. To reduce this disturbance, two large noise silencers were installed on the cryogenic exhaust at Point 2 in France prior to the start of the cool-down operation. A noise campaign to evaluate the silencers' efficiency was carried out, showing that the exhaust noise was well below the ambient noise of other CERN equipment.

NOISE MEASUREMENTS

Every year, CERN carries out noise measurement campaigns at the perimeter of its sites. Measurements are carried out during daytime, night-time and weekends at around 200 locations, and the results are then compared to the 2018 baseline. During the period covered by this report, 2019 and 2020, occasional non-conformities were identified due to maintenance and consolidation activities, which were then corrected.

CERN is also evaluating the possibility of integrating an online monitoring system that carries out real-time measurements, allowing rapid intervention if needed.

IN FOCUS

Jordan Minier is an acoustic expert who started working at CERN in 2020 to ensure implementation of the noise policy.

– What is CERN's approach to controlling the noise of its projects?

JM: In addition to carrying out routine noise measurements to evaluate the impact of existing installations, CERN has developed a strong noise-assessment process for each new project or new piece of equipment.

During the design phase of new projects, we use 3D modelling to predict their noise impact. The 3D modelling uses input from CERN's existing buildings, sensitive receptors and noise source information. This allows us to predict noise levels at the sites' perimeters and at each sensitive receptor location. Noise characterisation and 3D modelling are also used for implementing noise mitigation measures for existing buildings. All of the calculations are made in accordance with ISO 9613.

Based on the 3D modelling results, CERN develops mitigation measures and design changes to ensure that the noise remains below the limit set in the noise reduction policy.

Noise measurements being taken at Point 1.

BIODIVERSITY

CERN has three wetlands, 136 hectares of woodland and 258 hectares of cultivated fields and meadows under its stewardship. Since 2009, CERN has held the Swiss Nature & Economie *Foundation's label of quality in recognition of its efforts to protect biodiversity.*

PRESERVING THE LANDSCAPE

CERN uses low-intensity maintenance of its land to foster biodiversity preservation, keeping watering to a minimum and eliminating fertilisers and chemicals as much as possible. Woodlands in the *Pays de Gex*, France, are an important local resource. Those on CERN land are jointly managed by CERN and the French National Forests Office (ONF).

In 2020, CERN discovered a new orchid species, the Autumn Lady's-tresses, on its site, bringing the total to 16 species. The Organization has the largest variety of orchids to be found anywhere in the Geneva basin. The International Union for Conservation of Nature (IUCN) Red List has categorised one, the green-winged orchid, as near threatened. Eleven of the species are on the Swiss national conservation list, as shown in the graphic.

PLANNING FOR THE FUTURE

Managing the impact of CERN's activities on the environment and landscape of the neighbouring region is of pivotal importance to the Organization. In 2015, CERN created a 15-year masterplan, a strategic framework to support the Laboratory's site development. The plan includes short-, medium- and long-term goals centred on four themes: urban planning, mobility, environment, and landscape. A revision of the current masterplan is in progress. It adopts biodiversity-positive principles and standards in the planning and implementation of CERN's facilities, both new builds and renovation projects. Measures are being developed not only to preserve CERN's natural heritage, but also to strengthen biodiversity on the land under CERN's management.

In 2020, the CERN Environmental Protection Steering Board (CEPS) launched a working group on biodiversity to identify actions to be implemented with four key objectives: conserving and protecting natural spaces in the CERN domain; developing biodiversity in fenced and unfenced areas; establishing measures for biodiversity for new development projects on CERN sites; and defining indicators to monitor biodiversity at CERN.

CERN has co-signed a charter initiated by WWF Geneva for the revitalisation of the *Nant d'Avril* watercourse. In addition to improving water quality, the project will boost biodiversity in the entire watershed. It includes building natural riverbanks to promote re-colonisation by certain target species (p. 29).

ENDANGERED
Early spider-orchid

VULNERABLE
Green-winged orchid*
Monkey orchid
Bee orchid
Bee orchid var. botteronii
Autumn lady's tresses

LEAST CONCERN
Lesser butterfly-orchid
White helleborine
Narrow-leaved helleborine
Common spotted orchid
Common twayblade

NEAR THREATENED
Pyramidal orchid
Lizard orchid
Man orchid
Military orchid
Giant orchid

*In the international IUCN Red List, this species is categorised as Near Threatened

ORCHID SPECIES PRESENT ON CERN SITES. *Categorised by the Swiss Red List on vascular plants (2016).* ***The photo shows the newly-found autumn lady's tresses on the CERN site in 2019.***

IN FOCUS

Mathieu Fontaine, head of Green Spaces and Biodiversity Service at CERN.

– What is your vision for CERN's green spaces in the future?

MF: There are many ideas and dreams about improving biodiversity on the CERN sites. For example, planting new trees, and creating a procedure to compensate for each felled tree on both the French and Swiss parts of the Organization's sites. CERN is a pioneer in physics and technology, and we would like CERN to set an example for responsible land management in the region, using the same principles to manage the fenced and unfenced areas, which include woodland and land leased to local farmers. It is also my mandate, and a pleasure, to communicate with and educate my CERN colleagues and our neighbours about CERN's biodiversity protection efforts.

WASTE

CERN's scientific activities generate the majority of the Laboratory's waste. A smaller quantity is produced by other operations.

TYPES OF CONVENTIONAL WASTE

The Organization's conventional, non-hazardous waste consists of industrial waste, electrical and electronic equipment (which is subject to monitoring according to the Swiss regulation OMod), aluminium and other metals, glass and PET, paper and cardboard, biodegradable waste, coffee capsules and household waste.

CERN's hazardous waste consists of chemicals and their containers, batteries, printer cartridges, lightbulbs and any type of equipment and materials contaminated by hazardous substances. In 2020, the latter included personal protective equipment, such as facemasks, used to protect against COVID-19 transmission.

Data on end-of-life equipment picked up by or sent back to the supplier is not included in this report. Data on waste generated by contractors is also not included, as they managed the waste disposal themselves. As part of an improvement announced in the 2017-2018 report, a small fraction (8%) of the non-hazardous waste generated and eliminated by contractors active on the CERN sites has been integrated into the 2020 data. CERN strives to continuously increase the traceability of waste disposed of by contractors.

MANAGING CONVENTIONAL WASTE

CERN has a centralised waste management system that oversees all conventional waste collection and transportation. This is designed to ensure that waste is managed safely and appropriately, in ways that present no unacceptable risk to people or the environment. The system also includes an inventory of the waste leaving CERN in order to ensure the traceability of waste pathways. In 2019 and 2020, CERN generated and disposed of a total of 5985 and 4704 tonnes of conventional waste.

CERN works with authorised third-party service providers to manage the disposal of conventional waste other than metals. Metal and electronic waste is sorted and sold for recycling. Hazardous waste is temporarily stored in a buffer zone where it is collected weekly.

More than 70% of the Organization's waste is non-hazardous. In an effort to boost the recycling rate of non-hazardous waste, CERN initiated a pilot sorting-bin project in several buildings in 2019. Instead of individual waste bins in every office, sorting stations for paper, PET and household waste were installed. The same year, CERN also started to replace single-use plastics with reusables in its restaurants in an effort to reduce plastic waste as much as possible. The effects of these projects have been hard to measure due to the COVID-19 pandemic and the consequent reduction of CERN personnel on site as part of the health measures implemented at the Laboratory.

In 2020, the recycling rate was 59%, compared to 56% in 2018 and 57% in 2019. This was mainly achieved thanks to more thorough sorting of household waste introduced by CERN's service provider in 2020 in response to objectives set by the recycling policy of the Canton of Geneva. It should be noted, however, that the effects of the pandemic also had an impact on the waste produced and disposed of by CERN.

The CERN Environmental Protection Steering Board launched a working group for waste management in 2020 that identified and proposed action plans to be implemented in future years. The group looked at different waste issues such as traceability, reduction objectives, waste recovery rates and consolidation of storage areas.

TYPES OF RADIOACTIVE WASTE

CERN's scientific activities produce radioactive waste with low-level activity, generated by the interaction between particle beams and equipment present inside CERN's accelerator complex. Equipment that is activated by this process is managed as radioactive waste at the end of its life cycle.

Radioactive waste consists, for example, of metal components, cables and ventilation filters, as well as waste from maintenance and upgrade work, such as gloves and overalls.

MANAGING RADIOACTIVE WASTE

Radioactive waste management has always been a high priority for CERN. It is handled in the framework of the tripartite agreement with the Host State authorities on radiation protection and radiation safety (p. 10).

The Organization minimises radioactive waste in the design, operation and decommissioning of accelerators, experiments and other equipment by avoiding or recycling and re-using activated material. Activated shielding components are a prominent example of re-use. For instance, 3255 tonnes of steel structures, cast iron and concrete blocks were re-used and thus diverted from disposal in 2019. In 2020, the figure was 1060 tonnes.

CERN's specialised radiation protection team categorises radioactive waste and treats it in a dedicated facility where it is dismantled, sorted, compressed and packaged according to radioactive waste treatment and elimination criteria. It is disposed of through agreed pathways in France and Switzerland, and the Laboratory regularly reports on radioactive waste matters to the Host State authorities. Before being eliminated, radioactive waste is temporarily stored in a dedicated secure storage area.

CERN strives to reduce radioactive waste as much as possible by making consistent use of the possibility for free-release in Switzerland. After demonstration that waste no longer qualifies as radioactive according to the Swiss ordinance for radiation protection (ORaP), such waste is treated as traceable conventional waste.

In 2019 and 2020, CERN generated 641 and 202 tonnes and disposed of 1472 and 358 tonnes of radioactive waste respectively. During this period, with CERN's accelerator complex in its second long shutdown (LS2), accelerator and experiment equipment coming to the end of its life was dismantled. This is why more radioactive waste was generated during LS2 than during periods of accelerator and experiment operation.

IN FOCUS

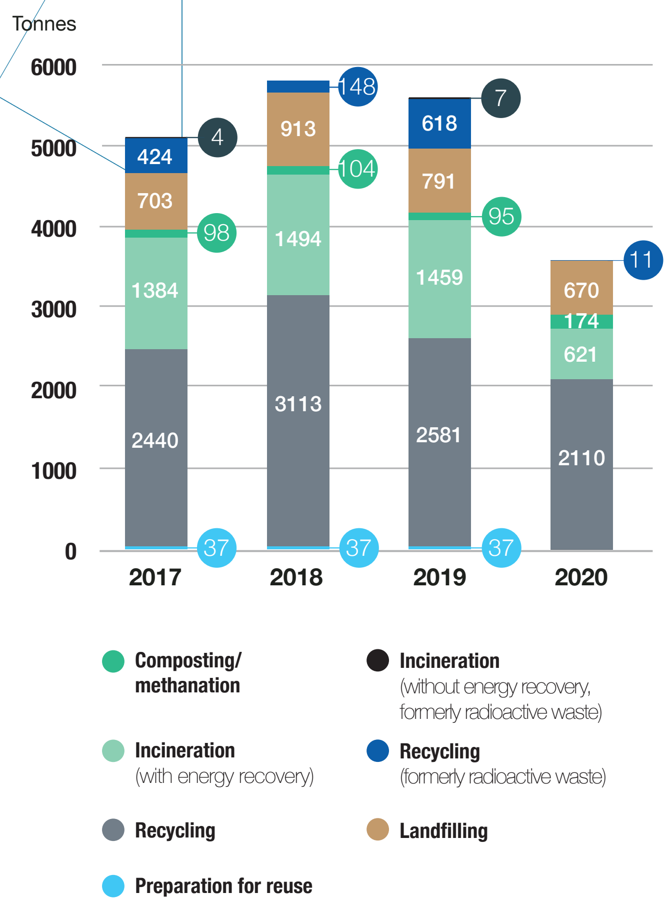
David Widegren, leader of the Information Management group in the Engineering department.

– In short, what is TREC?

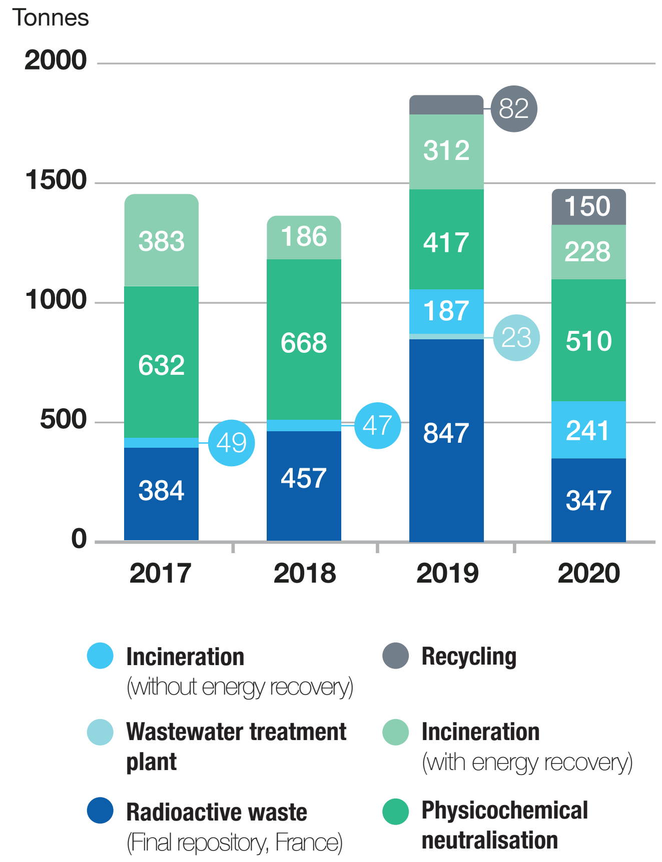
DW: TREC, which stands for Traceability of Radioactive Equipment at CERN, is an IT application primarily used to trace and manage potentially radioactive equipment at the Laboratory. As it is based on our central asset-management platform, it avoids duplicating data in multiple information systems and helps us treat radioactive traceability as an integral part of our physical assets' lifecycles.

– What does the future hold for this system?

DW: The application has evolved from mainly being a traceability tool to also becoming an application with integrated workflows. Additionally, TREC has evolved to cover other related processes linked to safety and the environment. For example, we are planning an extension of the application to also support and formalise water release processes.



NON-HAZARDOUS WASTE BY ELIMINATION PATHWAY 2017-2020.
This data does not include the excavated material from the civil engineering works in preparation for the High-Luminosity LHC.



HAZARDOUS WASTE BY ELIMINATION PATHWAY 2017-2020.

WATER AND EFFLUENTS

Water is essential for the cooling systems of CERN's scientific facilities, and responsible water management is of utmost importance to the Laboratory.

WATER WITHDRAWAL AND CONSUMPTION

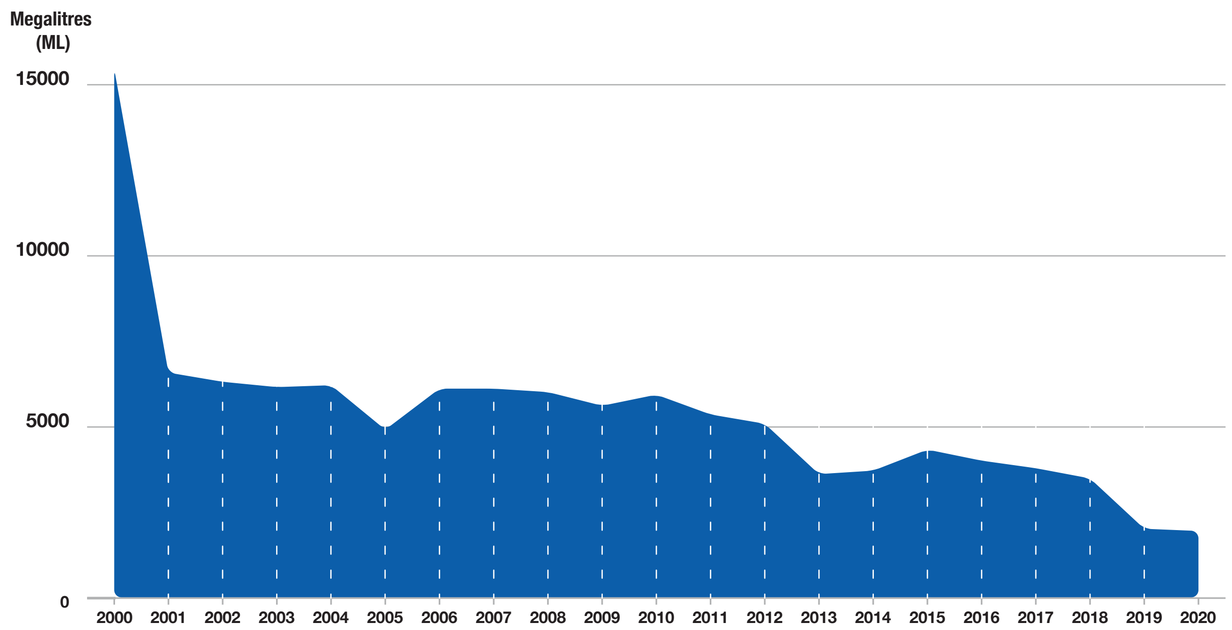
CERN's industrial activities account for around 75% of the Organization's water consumption during accelerator shutdown years. The remaining 25% is used for sanitation purposes.

In 2019 and 2020, CERN consumed 2006 and 1941 megalitres (ML) of water respectively. Water is mostly used to supply the various cooling systems and for sanitation purposes. With the Large Hadron Collider (LHC) in its second long shutdown (LS2), about 47% less water was needed than in operational years. As of 2021 and with the restart of physics, water consumption for cooling research facilities will gradually increase. CERN decreased its water consumption radically from 15 000 ML in 2000 to 3477 ML in 2018, principally by changing its cooling tower water circuits from open circuits to semi-open or closed ones.

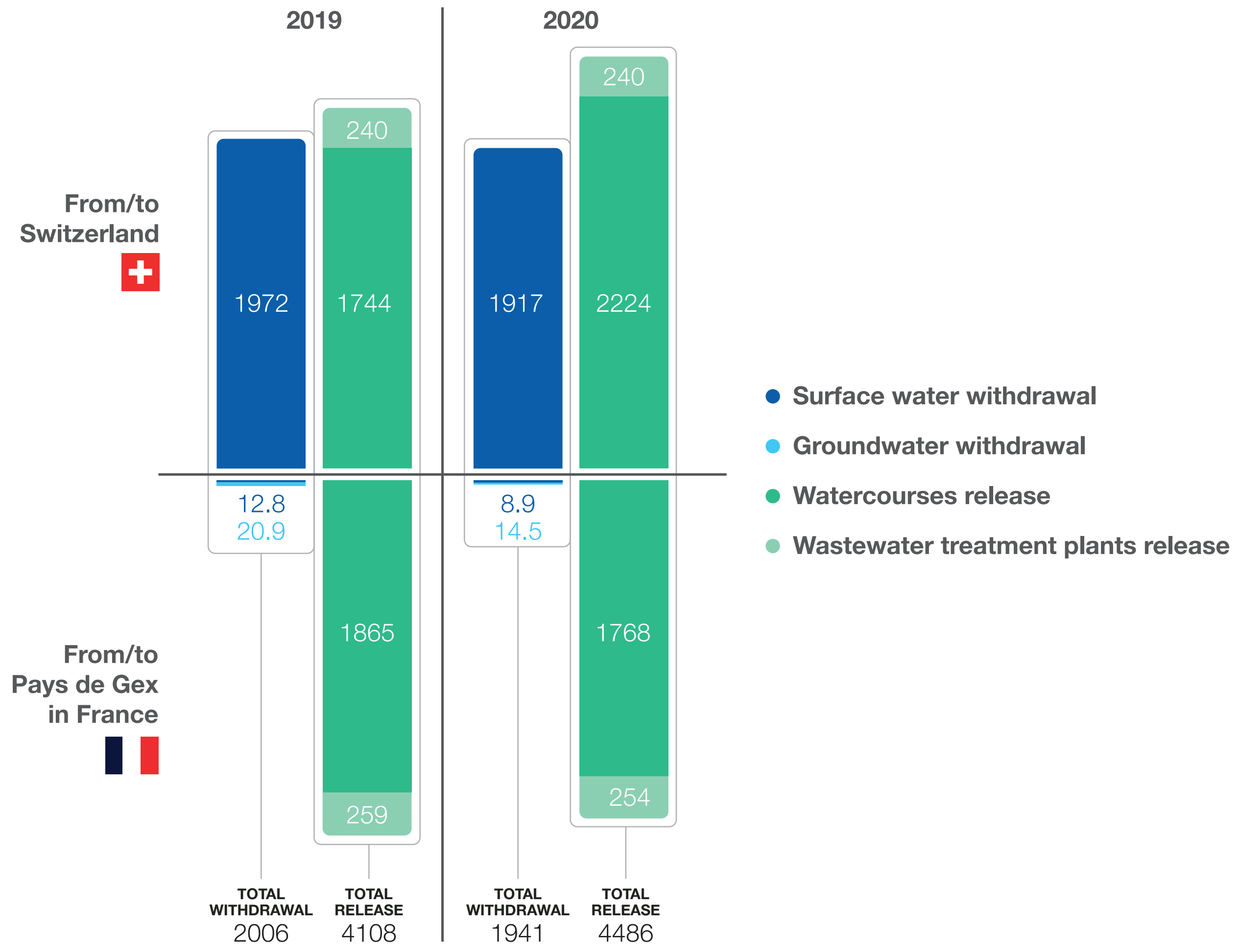
All water supplied to CERN is of drinking quality. It is either used as is, or demineralised. The *Services Industriels de Genève* supply most of CERN's water, which comes from Lake Geneva. About 1% comes from the *Pays de Gex* in France, which is a water stressed area. It consists mainly of groundwater and is provided by the *Régie des Eaux Gessiennes*.

WATER RELEASES

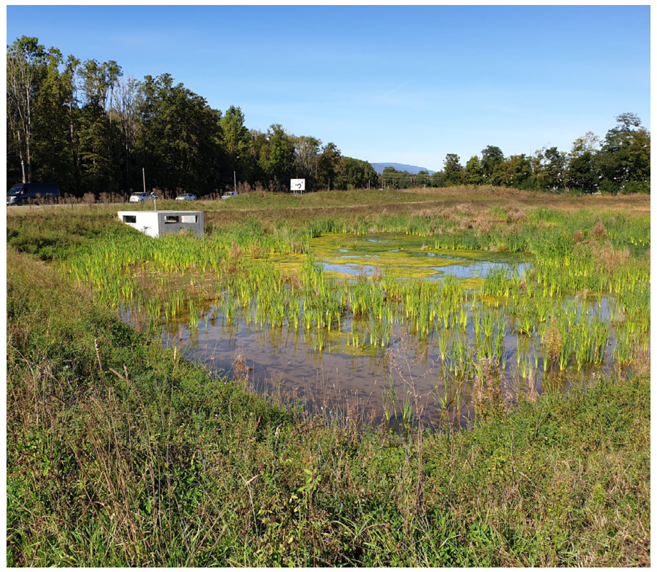
CERN's cooling towers evaporate a fraction of the water used for cooling the accelerators. Part of it is released as effluent water. The latter contains residuals of treatments used to prevent scaling, corrosion and bacteria, including Legionella. As some receiving watercourses are small and sensitive to the quality and quantity of effluents, CERN is implementing a programme aimed at improving the quality of its effluents. This is the case for the *Nant d'Avril* and the *Lion*, a tributary of the *Allondon*, as well as the *Allondon* itself, which receives around 80% of all water released into watercourses. The improvement programme is due to be completed during the next long shutdown. Sanitation water is released to local public wastewater treatment plants. The Laboratory also releases infiltration water, which is pumped from underground tunnel areas, along with run-off rainwater, into neighbouring watercourses. This explains why water releases are higher than the water withdrawal figures provided by the suppliers. These quantities vary from year to year and according to the different sites around the LHC ring.



CERN'S WATER CONSUMPTION 2000 - 2020.



TOTAL WATER WITHDRAWAL AND RELEASE 2019-2020.



Retention basin that receives rainwater from the CERN Prévessin site, allowing the regulation of run-off into the Lion and the retention of accidental pollution.

IN FOCUS

Michael Poehler, project manager for CERN's new retention basin.

— What has CERN done to safeguard the local watercourse, the Lion?

MP: Following discussions between CERN and local French and Swiss authorities, in the framework of the tripartite committee for the environment, a hydraulic study of the operating conditions of the Laboratory's rainwater networks and the related surface run-offs from the Prévessin site was carried out. This study highlighted the need for two retention basins to prevent potential accidental pollution.

In 2020, CERN built a retention basin at point BA2 of the SPS accelerator. The basin has a volume of approximately 6000 m^3 and handles about 60% of the rainwater from the Prévessin and BA2 sites. The basin will ensure a lower temperature of the water released into the Lion watercourse, provide decantation of water releases containing suspended solids and ensure the retention of any accidental releases of potential pollutants.

WATER MANAGEMENT

CERN is committed to keeping the increase in its water consumption to below 5% up to the end of 2024 (baseline year: 2018), despite a growing demand for the water cooling of upgraded facilities. Longer-term objectives will be set in future reports. The Organization is also committed to optimising qualitative and quantitative aspects of its water releases and to full compliance with the technical requirements laid down in the Host State regulations. The Organization has a long-term programme to further reduce the concentration of chemicals in the effluents it releases to watercourses.

CERN regularly samples the neighbouring watercourses to evaluate its impact and reports on its monitoring programme to the Host State authorities on a quarterly basis. Intervention plans exist as part of CERN's emergency preparedness in the event of an incident. The Laboratory has procedures to mitigate the consequences and to alert the relevant Host State authorities and emergency services. Regular exchanges with the local Host State authorities on water protection issues are held in the framework of the tripartite committee for the environment. This committee bases its discussions and recommendations on the results of the monitoring programme, which was recently reinforced. No event detrimental to the environment that would have led to a fine or non-monetary sanction occurred during the period covered by this report (p. 30).

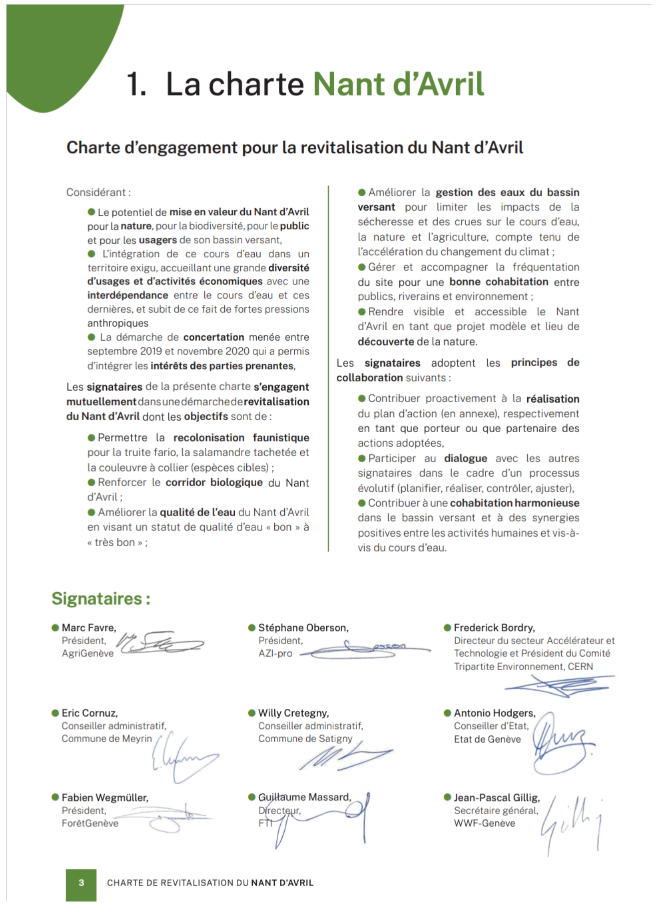
During the period covered by this report, the Laboratory created a new station for demineralised water on the Meyrin site. This improves evaporation, limits the consumption and reduces the need for chemicals in cooling towers. Additionally, the piping was replaced to distribute water more efficiently.

WATER MEASUREMENTS IN THE ALLONDON.

Revitalisation of the *Nant d'Avril*

In 2020, CERN co-signed a charter initiated by WWF Geneva for the revitalisation of the *Nant d'Avril*, the second largest tributary of the *Rhône* in the Geneva basin. The project will run until 2033 and brings together the key stakeholders of the *Nant d'Avril* basin. It aims to improve water quality and biodiversity throughout the waterway. CERN carried out detailed studies to integrate retention basins on the Meyrin site for effluents reaching the *Nant d'Avril*.

CERN has set objectives regarding the quality of effluents released to the *Nant d'Avril* in the context of the regional plan on the evacuation of water (*Plan Régional d'Evacuation des Eaux*, PREE), developed by the Canton of Geneva. LS2 provided the opportunity to make significant progress on these objectives. In particular, the Laboratory upgraded its main cooling towers on the Meyrin site. The aim was to replace old systems and increase capacity, as well as limit water consumption and the impact of water releases. The new cooling towers are made of stainless steel to avoid copper and other potentially problematic materials with regard to Legionella. Upgrades of the remaining cooling towers will be carried out before the end of the next long shutdown.



1. La charte Nant d'Avril

Charte d'engagement pour la revitalisation du Nant d'Avril

Considérant :

- Le potentiel de **mise en valeur du Nant d'Avril** pour la **nature**, pour la biodiversité, pour le **public** et pour les **usagers** de son bassin versant,
- L'intégration de ce cours d'eau dans un territoire exigu, accueillant une grande **diversité d'usages et d'activités économiques** avec une **interdépendance** entre le cours d'eau et ces dernières, et subit de ce fait de fortes pressions anthropiques
- La démarche de **concertation** menée entre septembre 2019 et novembre 2020 qui a permis d'intégrer les **intérêts des parties prenantes**,

Les **signataires** de la présente charte **s'engagent mutuellement** dans une démarche de **revitalisation du Nant d'Avril** dont les **objectifs** sont de :

- Permettre la **recolonisation faunistique** pour la truite fario, la salamandre tachetée et la couleuvre à collier (espèces cibles) ;
- Renforcer le **corridor biologique** du Nant d'Avril ;
- Améliorer la **qualité de l'eau** du Nant d'Avril en visant un statut de qualité d'eau « bon » à « très bon » ;
- Améliorer la **gestion des eaux du bassin versant** pour limiter les impacts de la sécheresse et des crues sur le cours d'eau, la nature et l'agriculture, compte tenu de l'accélération du changement du climat ;
- Gérer et accompagner la fréquentation du site pour une **bonne cohabitation** entre publics, riverains et environnement ;
- Rendre visible et accessible le Nant d'Avril en tant que projet modèle et lieu de **découverte** de la nature.

Les **signataires** adoptent les **principes de collaboration** suivants :

- Contribuer proactivement à la **réalisation** du plan d'action (en annexe), respectivement en tant que porteur ou que partenaire des actions adoptées,
- Participer au **dialogue** avec les autres signataires dans le cadre d'un processus évolutif (planifier, réaliser, contrôler, ajuster),
- Contribuer à une **cohabitation harmonieuse** dans le bassin versant et à des synergies positives entre les activités humaines et vis-à-vis du cours d'eau.

Signataires :

- **Marc Favre,** Président, AgriGenève
- **Stéphane Oberson,** Président, AZI-pro
- **Frederick Bordry,** Directeur du secteur Accélérateur et Technologie et Président du Comité Tripartite Environnement, CERN
- **Eric Cornuz,** Conseiller administratif, Commune de Meyrin
- **Willy Cretegny,** Conseiller administratif, Commune de Satigny
- **Antonio Hodgers,** Conseiller d'Etat, Etat de Genève
- **Fabien Wegmüller,** Président, ForêtGenève
- **Guillaume Massard,** Directeur, FTI
- **Jean-Pascal Gillig,** Secrétaire général, WWF-Genève

3 CHARTE DE REVITALISATION DU NANT D'AVRIL

ENVIRONMENTAL COMPLIANCE

CERN enjoys privileges and immunities that come with its status as an intergovernmental organisation. These mean that CERN develops and implements its own internal rules. When it comes to environmental protection, CERN strives to keep the environmental impact of its existing and planned activities as low as possible and in compliance with its Host States' legal frameworks. The Occupational Health and Safety and Environmental Protection (HSE) unit carries out an environmental monitoring programme that includes both radiological and physicochemical parameters.

PREVENTING RADIOLOGICAL ENVIRONMENTAL ACCIDENTS

CERN has robust radiation safety and radiation protection rules in place (p. 20). As a result, no environmental radiological accident caused by CERN has ever been recorded.

PREVENTING CONVENTIONAL ENVIRONMENTAL ACCIDENTS

The CERN Environmental Protection Steering Board (CEPS) is, among other entities, responsible for following up on all environmental events, near misses and remedial actions, as well as putting in place adequate measures for preventing environmental accidents.

During the period covered by this report, CERN had no conventional pollution event that would have led to a fine or non-monetary sanction. In 2020, the newly constructed retention basin near CERN's Prévessin site proved to be effective, as it detected and averted a minor accidental hydrocarbon pollution event that would have affected the nearby *Lion* watercourse.

MANAGEMENT OF HAZARDOUS SUBSTANCES

CERN has put in place a regulatory framework governing the use of hazardous substances that could cause soil and water pollution. Specific environmental measures have been taken according to the relevant Swiss and French regulations. The Working Group on the Prevention of Pollution by Liquid Chemical Agents (PoLiChem), which finished its mandate at the end of 2018, recommended CERN-wide actions monitored by CEPS to reduce pollution risks. CERN has already funded and implemented some of the proposed mitigation actions, such as dismantling obsolete equipment, constructing the aforementioned retention basin near Prévessin (p. 27) and replacing an old fuel tank.

In 2020, CERN dismantled the old fuel tank identified as a high-risk case by PoLiChem, which was replaced with a state-of-the-art diesel generator. The project included decontaminating the tank, managing the waste, setting up a temporary tank permitting continuous activity, and designing a new loading and unloading area as well as a sewer network to protect the aquatic environment.

WATER MONITORING STATION *with a hydrocarbon detection system at CERN's Meyrin site.*

IN FOCUS

Sabrina Schadegg works in CERN's Environment Group and was involved in developing the CERN Chemical Register for Environment, Health and Safety, CERES.

— What is CERES?

SS: CERES is a new web tool for chemical safety that the Organization launched in 2020. It gives an overview of all liquid, solid and gaseous chemicals present on CERN's sites. The database includes safety information, the precise location of the chemicals and data on chemical and environmental risk assessments and the mitigation measures in place.

— How is it useful?

SS: CERES has a map view, which is very useful for the Fire and Rescue service during emergency interventions. The map is also useful for assessing the risks within a building or an area. Within the Environmental Protection group, CERES is used to identify environmentally sensitive activities and areas on CERN's sites, and allows increased interaction across the departments to improve pollution prevention measures.

HIGH-GRADE HELIUM MANAGEMENT AT CERN

The Large Hadron Collider (LHC) is the largest cryogenic system in the world and one of the coldest places on Earth. The LHC's main magnets operate at a temperature of 1.9 K (-271.3°C), colder than the 2.7 K (-270.5°C) of outer space. The LHC's cryogenic system requires some 130 tonnes of helium to keep the magnets at 1.9 K.

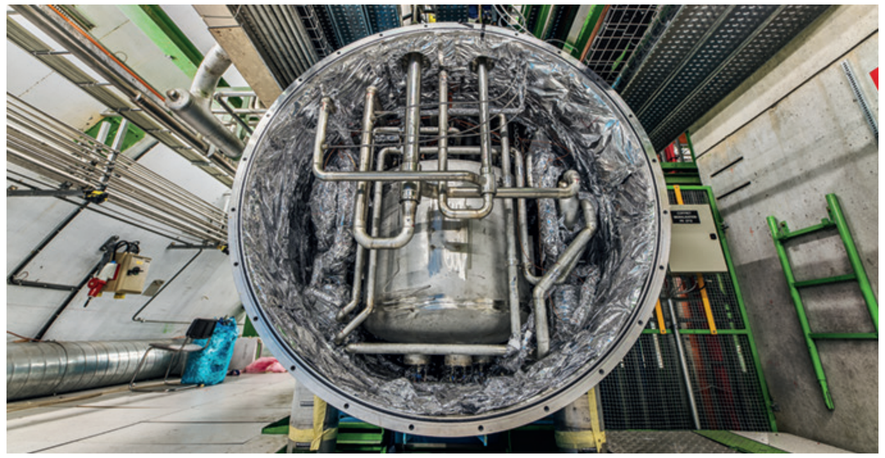
Helium is extracted as a by-product of natural gas production and is not a greenhouse gas. It is supplied to CERN, mainly in liquid state, by means of thermally insulated ISO containers from world-leading industrial gas companies operating in Europe.

The Organization's total helium inventory at the end of 2020 amounted to 175 tonnes, the majority of which is used for cooling the superconducting magnets of the LHC.

Following the LHC's initial start-up in 2008, CERN made an effort to reduce its helium needs in terms of compensation for operational losses and equipment conditioning. Annual operational losses were reduced from 30% of the LHC inventory down to 10%. This effort was initiated during Run 1 of the LHC (2008-2013) and completed and stabilised during Run 2 (2015-2019).

Reducing the need for helium when restarting the LHC after long shutdown periods has also been a priority. While the restart phase after the first long shutdown (2013-2014) consumed 21% of the LHC's helium inventory, CERN succeeded in halving helium consumption to about 11% of the inventory when restarting the LHC after the second long shutdown.

CERN initially concentrated on reducing helium losses related to the LHC, which represents 75% of the total helium inventory at CERN. After this very successful campaign, CERN has also implemented close monitoring of the helium inventory for non-LHC related applications, including test bench facilities and experiments.



CRYOGENIC INSTALLATION *at Point 4 of the LHC ring during the second long shutdown.*

KNOWLEDGE AND TECHNOLOGY FOR THE ENVIRONMENT

CERN's engineers, technicians and scientists develop novel technologies and competences that contribute to applications in fields beyond high-energy physics, helping to address global societal challenges in areas such as health and the environment.

TRANSFERRING KNOWLEDGE AND TECHNOLOGY

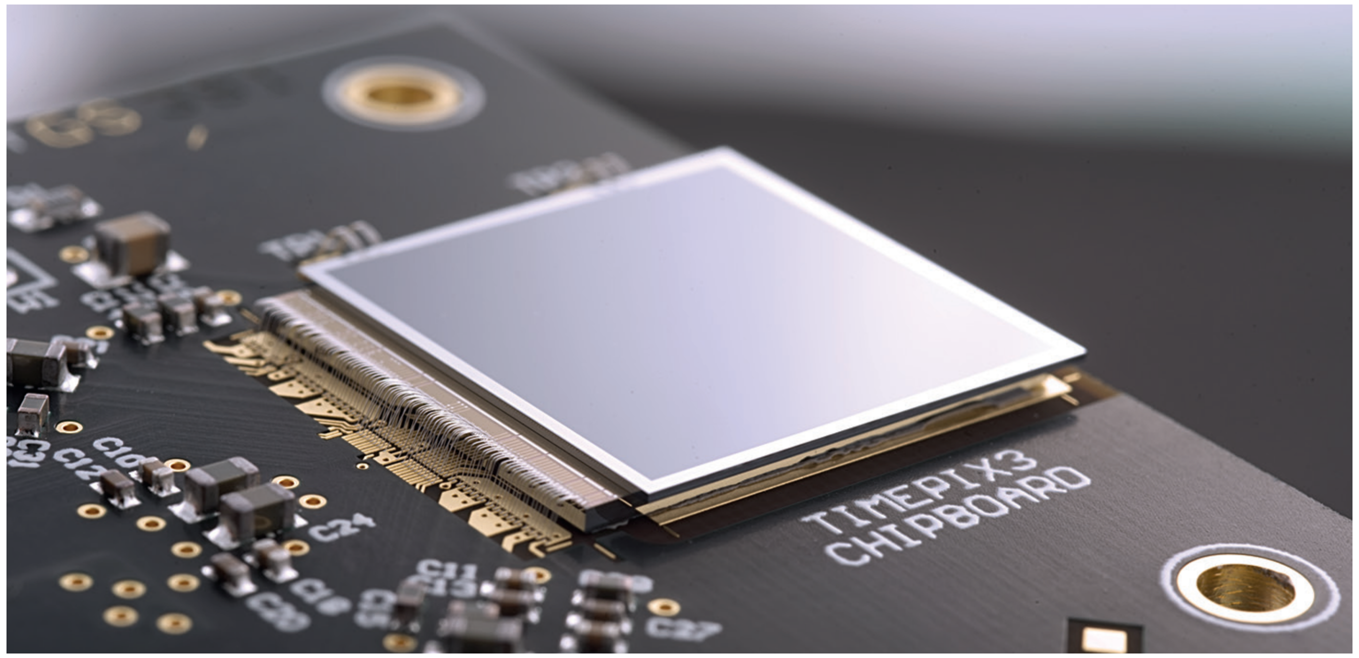
CERN's knowledge translates into impact across several domains, including medical technology, the handling of big data, and the environment. Ensuring that CERN's knowledge and technologies reach society as a whole is enshrined in the Organization's founding Convention, which states that: *"the results of its experimental and theoretical work shall be published or otherwise made generally available"*. This has fostered a long-standing tradition of freely and openly sharing scientific knowledge for the benefit of all, which is manifested today in many forms. The Organization engages in collaboration agreements with industry, supports spin-off companies, participates in projects co-funded by the European Commission and is a pioneer in open-access scientific publishing. CERN's Knowledge Transfer group engages with experts in science, technology and industry in order to create opportunities for the transfer of CERN's technology and know-how.

During the period covered by this report, the Organization signed six license agreements and one non-disclosure agreement on technologies related to the environment. In 2020, the Knowledge Transfer group hosted an innovation day focused on health, safety and the environment, which is also one of the focus areas for 2021.

Besides these agreements, CERN has other technologies with potential benefit for the environment, such as superconducting electrical transmission lines and CO_2 cooling technology. The latter is being actively investigated for applications beyond the Laboratory, such as for cooling batteries or data centres.

TIMEPIX3

Timepix3 is a multi-purpose hybrid pixel detector with multiple applications varying from X-ray imaging to particle track reconstruction. Recycling electronic waste is a key challenge in waste management. In 2020, CERN signed a licence agreement with *Technologies de France* for the use of Timepix3 in this field. The aim is to use the spectroscopic properties of Timepix3 to differentiate metals in electronic components, thus improving the recycling of electronic waste.



The Timpepix3 chip is a multi-purpose hybrid pixel detector with many applications outside CERN.

C2MON

The CERN Control and Monitoring Platform, C2MON, is a modular Java framework for fast-built, highly available, large-scale industrial monitoring and control solutions. It has been developed for CERN's demanding infrastructure-monitoring needs, and is based on more than 10 years of experience with the Technical Infrastructure Monitoring (TIM) systems at CERN. It is distributed under the open source GNU LGPLv.3 licence, a form of free software licence. The C2MON technology is currently used in several initiatives, such as PlanetWatch (see *In focus*) and SecuraXis, a new acoustics sensor system designed to detect and report emergencies like fires and explosions.

IN FOCUS

Claudio Parinello, CEO and co-founder of PlanetWatch.

— What is PlanetWatch?

*CP: PlanetWatch is a CERN spin-off company, which joined **Innogex**, the French Business Incubation Centre of CERN technologies, in 2020. We decentralise and incentivise environmental monitoring. By using a citizen-science-oriented approach with incentives, we can deploy dense, real-time air quality monitoring networks in cities in a fast and cost-effective way.*

— What role has CERN's technology played in developing PlanetWatch?

CP: We have a licence agreement for C2MON. We leverage this technology in the framework of data acquisition systems. The challenge is to acquire, validate and process data from thousands of sensors. We haven't fully leveraged its potential yet, so we look forward to further interactions with the C2MON community.

GLOSSARY

The **Autorité de sûreté nuclaire (ASN)** is the French Nuclear Authority responsible for the oversight of nuclear safety and radiation protection in order to protect people and the environment.

CERN's Energy management panel (EMP) examines CERN's energy consumption and identifies measures to improve efficiency organisation-wide and promote energy reuse.

The **CERN Environmental Protection Steering Board (CEPS**) was established in 2017. CEPS's mandate is to identify and prioritise environmental areas to be addressed, propose programmes of action, and follow-up their implementation following endorsement by the Enlarged Directorate.

The **CERN Safety Policy** is the Organization's reference document for all matters relating to health, safety and environmental protection. The policy includes the explicit goal of limiting the impact of the Organization's activities on the environment.

The **Comité Tripartite sur l'environnement (CTE)** is a tripartite committee with CERN, the environmental authorities of the Canton of Geneva (Switzerland) and the Prefectures of Ain (France), regarding non-radiological environmental aspects.

The **European Intergovernmental Research Organisation forum (EIROforum)** is a consortium uniting eight of Europe's large intergovernmental research organisations in promoting the quality and impact of European Research.

The **Global Reporting Initiative (GRI)** is an international independent organisation helping private and public bodies understand and communicate their impact through the development of a sustainability reporting framework and set of guidelines.

Global Warming Potential (GWP) is a value describing the radiative forcing impact of one unit of a given greenhouse gas, relative to one unit of CO_2 over a given period of time. The GWP values convert greenhouse gas emissions data for non-CO_2 gases into units of CO_2 equivalent.

The **High Luminosity LHC (HL-LHC)** is an upgrade of the LHC to achieve instantaneous luminosities a factor of five larger than the LHC nominal value, thereby enabling the experiments to enlarge their data sample by one order of magnitude compared with the LHC baseline programme.

The **Occupational Health and Safety and Environmental Protection unit (HSE)** is responsible for all matters regarding health and safety and environmental protection at CERN.

The **International Union for Conservation of Nature (IUCN)** is the global authority on the status of the natural world and the measures needed to safeguard it.

The **Large Hadron Collider (LHC)** is the world's largest and most powerful particle accelerator. It first started up on 10 September 2008 and consists of a 27-kilometre ring of superconducting magnets with a number of accelerating structures to boost the energy of the particles along the way.

Materiality is a term used in sustainability reporting. In this report, material topics are those reflecting the environmental impact of CERN and/or those influencing internal and external stakeholders.

The **Fondation Nature & Economie** is a Swiss foundation that promotes work, living and study environments that are close to nature, and awards a quality label to exemplary sites. CERN has been rewarded with the label since 2009 for its efforts to protect biodiversity.

The **Office fédéral de la santé publique (OFSP)** is the Swiss Federal Office for Publish Health. The authority is responsible for responsible for public health in Switzerland, including matters of radiation protection.

The **Prevention of Pollution by Liquid Chemical Agents (PoLiChem)** was a working group with the purpose to update and consolidate the inventory of the quantities and types of liquid chemical agents present on CERN sites, with risk assessments and risk severity scores.

The **Plan régional d'evacuation des eaux (PREE)** is a regional water evacuation plan in the Canton of Geneva. This report refers specifically to the PREE for the Nant d'Avril, a watercourse near CERN, and includes a plan with 14 actions to be undertaken.

Science Gateway will be an education and outreach facility next to the Globe of Science and Innovation. It will be a beacon to encourage young people to aim for careers in science, technology, engineering and mathematics, STEM.

Scope 1 is the direct greenhouse gas emissions, i.e. emissions from sources that are owned or controlled by an organisation.

Scope 2 is the energy indirect greenhouse gas emissions, i.e. emissions that result from the generation of purchased or acquired electricity, heating, cooling, and steam consumed by an organisation.

Scope 3 is the other indirect greenhouse gas emissions, i.e. emissions that occur outside of the organisation, both upstream and downstream, that are not included in the energy indirect greenhouse gases (Scope 2).

The **United Nations Sustainable Development Goals (SDGs)** address the global challenges the world is facing, including those related to poverty, inequality, climate change, environmental degradation, peace and justice.

The **Super Proton Synchrotron (SPS**) is the second-largest machine in CERN's accelerator complex and it provides beams for experiments at CERN, as well as preparing beams for the LHC.

The **tripartite agreement on radiation protection and radiation safety** is an agreement between CERN, the Swiss Federal Office for Public Health (OFSP) and the French Nuclear Authority (ASN). It has established a framework for the discussion of topics related to radiation protection, specifically protecting CERN workers and people from ionising radiation whether on-site or in the vicinity of CERN's facilities.

The **Worldwide LHC Computing Grid (WLCG)** is the data-storage and analysis infrastructure built and maintained for the entire high-energy physics community using the LHC.

GRI CONTENT INDEX

For the materiality disclosures service, the GRI service team reviewed that the GRI content index was clearly presented and that the references for disclosures 102-40 to 102-49 were aligned with the appropriate sections in the body of the report. The materiality disclosures service was performed on the English version of the report.

GRI MATERIALITY DISCLOSURES SERVICE 2021

Standards and Disclosures	Title	Pages / Informations
GRI 101:2016 FOUNDATION		
GRI 102:2016 GENERAL DISCLOSURES		
Organisational Profile		
102-1	Name of the organisation	8
102-2	Activities, brands, products and services	8,12,13, 32, 33
102-3	Location of headquarters	8
102-4	Location of operations	8
102-5	Ownership and legal form	8
102-6	Markets served	8
102-7	Scale of the organisation	8
102-8	Information on employees and other workers	This information is published in CERN's Annual Report. That for 2019 can be found at https://cds.cern.ch/recrod/2723123 on page 53, and those for 2020 can be found at https://cds.cern.ch/record/2771424 on page 57.
102-9	Supply chain	8,9
102-10	Significant changes to the organisation and its supply chain	None
102-11	Precautionary principle or approach	10, 20
102-12	External initiatives	9
102-13	Membership of associations	8
Strategy		
102-14	Statement from senior decision-maker	4, 5
Ethics and Integrity		
102-16	Values, principles, standards, and norms of behaviour	9
Governance		
102-18	Governance structure	9
Stakeholder Engagement		
102-40	List of stakeholder groups	See Environment Report 2017-2018 on page 11. https://cds.cern.ch/record/2737239
102-41	Collective bargaining agreements	The CERN Staff Association represents the entire staff body on the Tripartite Employment Conditions Forum (TREF). Besides the Staff Association, TREF is composed of representatives of the Member States and the Management. TREF examines the conditions of pay and employment at CERN and its recommendations, if adopted by the Council, apply to all staff.
102-42	Identifying and selecting stakeholders	Relevant stakeholders either influence or are affected by CERN's activities.
102-43	Approach to stakeholder engagement	11
102-44	Key topics and concerns raised	11
Reporting Practice		
102-45	Entities included in the consolidated financial statements	CERN's financial statements are presented to the Council at its June meeting. Those for 2020 can be found at http://cds.cern.ch/record/2774015 on page 21.
102-46	Defining report content and topic boundaries	11
102-47	List of material topics	11
102-48	Restatements of information	There are no restatements of information.
102-49	Changes in reporting	There are no changes in reporting.
102-50	Reporting period	This report covers the years 2019 and 2020.
102-51	Date of most recent report	9 September 2020
102-52	Reporting cycle	The reporting cycle is biennial.
102-53	Contact point for questions regarding the report	Questions regarding this report may be addressed to environment.report@cern.ch
102-54	Claims of reporting in accordance with the GRI Standards	This report has been prepared in accordance with the GRI Standards: Core option.
102-55	GRI content index	This document.
102-56	External assurance	No external assurance was sought for this report. However, Host State authorities carry out independent measurements concerning CERN's water releases, ionising radiation and noise emissions.

GRI CONTENT INDEX

Topic specific standards		Pages
GRI 300: ENVIRONMENTAL		
GRI 302: 2016	**ENERGY**	
GRI 103: 2016 103-1/ 103-2/ 103-3	Management approach	14, 15
302-1	Energy consumption within the organisation	14, 15
302-2	Energy consumption outside of the organisation	14
302-3	Energy intensity	14
GRI 303: 2018	**WATER AND EFFLUENTS**	
GRI 103: 2016 103-1/ 103-2/ 103-3	Management approach	26, 27, 28, 29
303-1	Interactions with water as a shared resource	26, 27, 29
303-2	Management of water discharge-related impacts	26, 27, 28
303-3	Water withdrawal	26
303-4	Water discharge	26, 27
303-5	Water consumption	26
GRI 304: 2016	**BIODIVERSITY**	
GRI 103: 2016 103-1/ 103-2/ 103-3	Management approach	23
304-4	IUCN Red List species and national conservation list species with habitats in areas affected by operations	23
GRI 305:2016	**EMISSIONS**	
GRI 103: 2016 103-1/ 103-2/ 103-3	Management approach	16, 17, 18, 19
305-1	Direct (scope 1) GHG emissions	16, 17
305-2	Energy indirect (scope 2) GHG emissions	17
305-3	Other indirect (scope 3) GHG emissions	18, 19
GRI 306: 2020	**WASTE**	
306-1	Waste generation and significant waste-related impacts	24, 25
306-2	Management of significant waste-related impacts	24, 25
306-3	Waste generated	24, 25
306-4	Waste diverted from disposal	24, 25
306-5	Waste directed to disposal	24, 25
GRI 307: 2016	**ENVIRONMENTAL COMPLIANCE**	
GRI 103: 2016 103-1/ 103-2/ 103-3	Management approach	30
307-1	Non-compliance with environmental laws and regulations	30
CERN-SPECIFIC		
	HAZARDOUS SUBSTANCES	
GRI 103: 2016 103-1/ 103-2/ 103-3	Management approach	30, 31
	HELIUM	
GRI 103: 2016 103-1/ 103-2/ 103-3	Management approach	31
	IONISING RADIATION	
GRI 103: 2016 103-1/ 103-2/ 103-3	Management approach	20
	NOISE	
GRI 103: 2016 103-1/ 103-2/ 103-3	Management approach	22
	RADIOACTIVE WASTE	
GRI 103: 2016 103-1/ 103-2/ 103-3	Management approach	24, 25

CERN
1211 Geneva 23, Switzerland
http://home.cern

Images: CERN

Editorial and Design Production:

Report by the CERN Occupational Health and Safety and Environmental Protection unit and the CERN Education, Communications and Outreach group. This report was compiled in consultation with the Sofies consultancy.

Translation and Proofreading:

CERN Translation, Minutes and Council Support group, and Griselda Jung.

ISBN 978-92-9083-610-0 (printed version)

ISBN 978-92-9083-611-7 (electronic version)

DOI: 10.25325/CERN-Environment-2021-002
https://doi.org/10.25325/CERN-Environment-2021-002