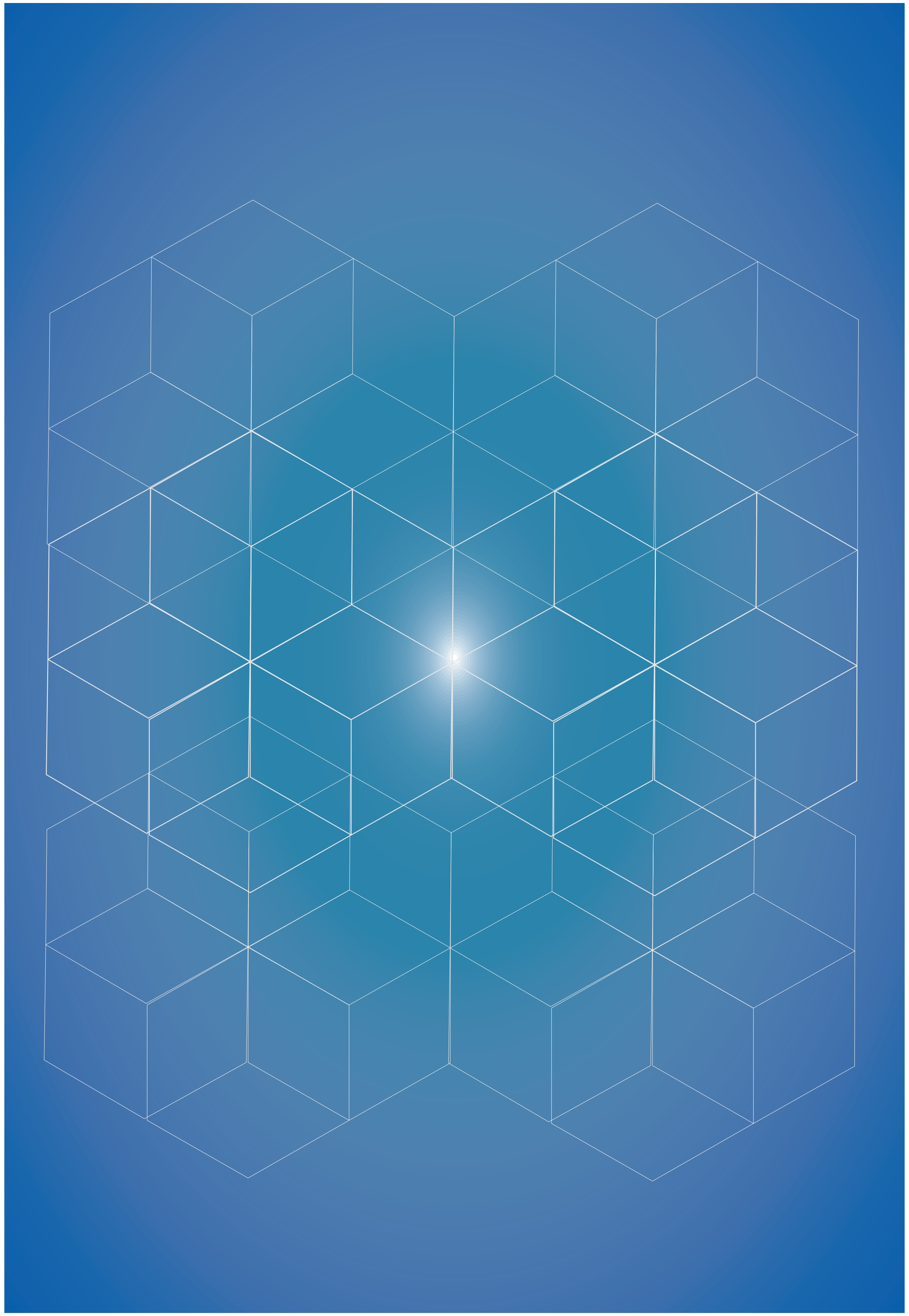
# Environment Report

**2017 - 2018**



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*Photos, clockwise from top left: the Globe of Science and Innovation; the LHC accelerator; ALICE, a heavy-ion detector at the LHC; a Pyramidal orchid at CERN.*

# FOREWORD

## A ROLE MODEL FOR ENVIRONMENTALLY RESPONSIBLE RESEARCH

Among the 626 hectares of forests, meadows, agricultural and recreational land under CERN's stewardship are 211 hectares devoted to fundamental research. This makes CERN an integral part of its environment: a responsibility we take very seriously, both within the spaces we manage and beyond.

Over recent years, CERN has become a byword for excellence in research, and has also established itself as a model for technological developments, training and education, and scientific collaboration across borders. Today, more than ever, science's flag-bearers need to demonstrate their relevance, their engagement, and their integration into society as a whole. That's why it is my pleasure to introduce CERN's first environment report.

At CERN, we strive for excellence in everything we do, from our core mission of designing, building and operating a unique collection of particle accelerators and detectors, to deploying modern policies in areas ranging from human resources to the protection of the environment. CERN takes environmental considerations into account when designing new programmes, and as environmental awareness has risen over recent decades, we have also become increasingly pro-active in identifying societal applications of the technologies we develop, some with potential for environmental protection. The vast superconducting installations needed for the LHC, for example, are a proving ground for technologies that may in the future improve the efficiency of electricity distribution networks. Over recent years, substantial financial and human resources have been invested to minimise the impact of our facilities on the environment and foster technological developments for environmental applications.

In this report, we set out a range of environmental indicators identified as being the most significant at CERN through careful consultation with internal and external stakeholders, along with their current status, and ambitious but realistic goals for each of them. It is our vision for CERN to be a role model for environmentally responsible research. This report is important in that respect, not only in terms of open and transparent reporting, but also as a tool to help us to achieve those goals.
***Fabiola Gianotti, Director-General***

## EFFECTIVE STRUCTURES FOR ENVIRONMENTAL MANAGEMENT

CERN's particle accelerators and detectors bring great benefit to society in the form of knowledge and innovation, training and international collaboration. They are also big consumers of energy, and they generate an environmental footprint in various ways. This is an inescapable fact, and one that CERN has always taken into consideration when designing new facilities. For example, in the 1990s when our current flagship facility, the Large Hadron Collider, LHC, was being designed, ozone destruction was a major environmental concern. The gas mixtures necessary for the effective operation of the LHC's particle detectors were therefore designed to be ozone-friendly. Two decades on, environmental priorities have evolved, and so must we. It is in this context that CERN has established a range of bodies to manage its environmental footprint.

The CERN Environmental Protection Steering board, CEPS, and the Energy Management Panel, EMP, are foremost among these. CEPS has a mandate to study and prioritise environmental actions, and, following management approval, to implement concrete measures for improvement. The EMP examines CERN's energy use and identifies areas where consumption can be reduced. Together, they make a significant contribution to ensuring that CERN is a good custodian of the environment. Much of this report stems from their work.

Beyond the walls of the Laboratory, we also enjoy strong links with the regulatory bodies of our two Host States, and have established tripartite agreements with them in the areas of radiation protection and the environment. CERN was also a founding partner in a series of workshops on Energy for Sustainable Science, which seek to establish a culture of energy and environmental awareness across the research infrastructure community.
***Frédérick Bordry, Director for Accelerators and Technology***

## A STRONG ENVIRONMENTAL POLICY

The Occupational Health, Safety and Environmental Protection Unit, HSE, is the CERN body responsible for monitoring and advising on best practices for minimising CERN's environmental footprint. In addition, it is responsible for radiation protection, occupational health surveillance of its workers, and the Fire and Rescue Service. Crucially, it is the keeper of CERN's Safety Policy, the Organization's reference document for all matters relating to health, safety and environmental protection. HSE chairs the CERN Environmental Protection Steering board, CEPS.

The Safety Policy includes the explicit goal of limiting the impact of the Organization's activities on the environment, stipulates collaboration with Host State authorities in matters of environmental protection, and assigns responsibility for the implementation of the Policy to the Director-General, assisted by the HSE Unit. It highlights the commitment of the CERN management, and provides a robust framework for environmental protection at CERN.
***Doris Forkel-Wirth, Head of the Occupational Health, Safety and Environmental Protection Unit***

## CERN AND THE SUSTAINABLE DEVELOPMENT GOALS

As an intergovernmental organisation founded under the auspices of UNESCO, CERN has always enjoyed a close relationship with the United Nations. It's therefore no surprise that CERN is fully-signed up to the UN's sustainable development agenda, and in particular the current set of Sustainable Development Goals, SDGs.

Over the years, the multilateral approach to sustainable development has tangibly improved the lives of literally billions of people, and the SDGs have equally lofty ambitions. There are 169 targets in total, divided across 17 goals ranging from eliminating poverty and hunger to promoting peace and justice through strong institutions.

CERN contributes to several of the 17 SDGs. Techniques derived from CERN technology make important contributions to health and well-being: goal number three. We play a valuable role in providing education and inspiration for careers in the fields of science, technology, engineering and mathematics (STEM): goal number four. We foster innovation, goal nine, across a range of disciplines, including areas that can contribute to environmental protection. Goal 16 promotes peaceful and inclusive societies, which is not only in our DNA, but also in our governing convention. Goal 17 aims to revitalise the global partnership for sustainable development. CERN is a model for global cooperation in science, inspiring and providing practical guidance in international collaboration.
***Charlotte Warakaulle, Director for International Relations***

# CERN AND THE ENVIRONMENT

AT A GLANCE

IN 2018

## About CERN

**>17 900 people**

CERN employs around **3600** people and some **12 500** scientists from around the world use the Laboratory's facilities. The remainder is largely made up of associates and students *(page 8).*

## Energy

**1251 GWh**

CERN consumed **1251 GWh** of electricity and **64.4 GWh** of fossil fuel. The Laboratory commits to limiting rises in electricity consumption to **5%** up to the end of **2024**, while delivering significantly **increased performance** of its facilities *(page 12).*

## Emissions

**223 800 $tCO_2e$**

CERN's direct greenhouse gas emissions were **192 100 tonnes of $CO_2$ equivalent,** $tCO_2e$. Indirect emissions arising from electricity consumption were **31 700 $tCO_2e$.** CERN's immediate target is to reduce direct emissions by **28%** by the end of **2024** *(page 14).*

## Ionising Radiation

**< 0.02 mSv**

People living in the vicinity of CERN received an effective dose of between 0.7 and 0.8 milliSieverts, mSv, from natural sources. CERN's activities added under **0.02 mSv** to this, less than **3%** of the naturally occurring background *(page 16).*

## Waste

**56% recycled**

CERN eliminated **5808 tonnes** of non-hazardous waste, of which **56%** was recycled, and **1358 tonnes** of hazardous waste. CERN's objective is to increase the current recycling rate *(page 18)*

## Noise

**70 dB(A)**

CERN has invested resources to keep noise at its perimeters below **70 dB(A)** during the day and **60 dB(A)** at night. This corresponds to the level of conversational speech *(page 17).*

## Environmental Compliance

**146 monitoring stations**

CERN has a state-of-the-art environmental monitoring system consisting of **146 monitoring stations.** The Organization reports **quarterly** on environmental issues to Host State authorities. **No serious** environmental **incidents** were recorded **in 2018** *(page 23).*

## Biodiversity

**15 species of orchids**

There are **15 species** of orchids growing on CERN's sites. CERN land includes **258 hectares** of cultivated fields and meadows, **136 hectares** of forest and three wetlands *(page 22).*

## Water and Effluents

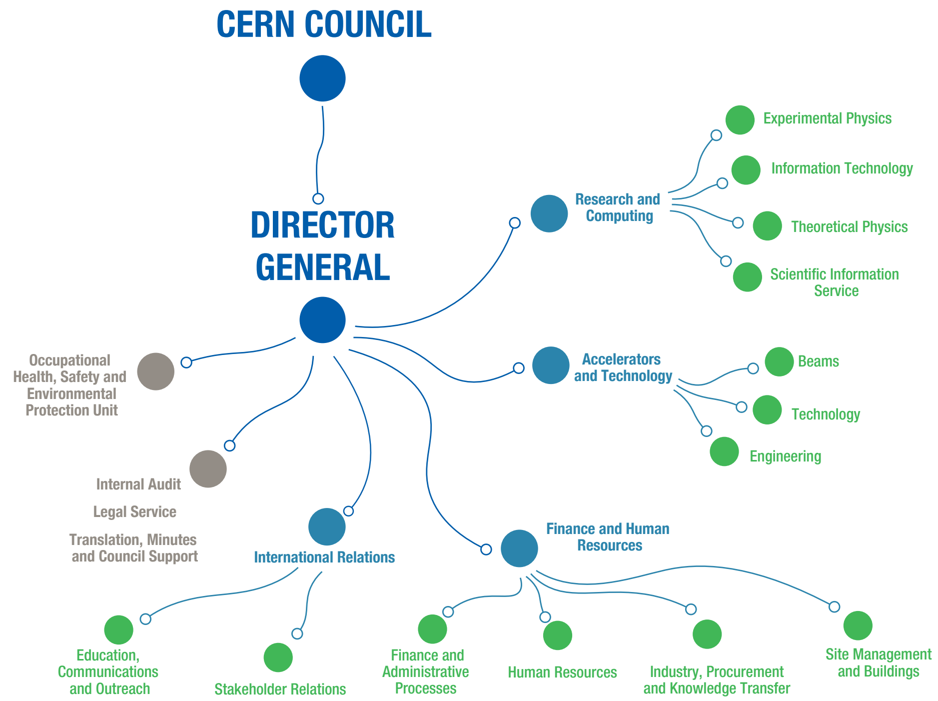
**3477 megalitres**

CERN drew **3477 megalitres** of water, mostly from Lake Geneva. The Laboratory commits to keeping its increase in water consumption **below 5%** up to the end of **2024**, despite a growing demand for water cooling of upgraded facilities *(page 20).*

## Knowledge Transfer

**18 domains**

CERN's 18 technology domains have several environmental applications including reducing air and water pollution, environmental monitoring, and more efficient energy distribution using superconducting technology *(page 24).*




# ABOUT CERN

## ORGANISATIONAL PROFILE

**Studying the elementary particles**

CERN, the European Organization for Nuclear Research, is the world's leading laboratory for particle physics. Its mission is fundamental physics – exploring the fundamental constituents of matter and what the universe is made of. The main tool for research is the Organization's unique network of particle accelerators, which collide beams of particles or direct them to fixed-target experiments. Giant 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. It also brings together eight Associate Member States and six Observers. It has become a prime example of international collaboration, uniting people from all over the world to push 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 smaller sites around the 27-kilometre ring of the Large Hadron Collider, LHC, situated in both countries. These are host to unprecedented experiments resulting from worldwide collaborations between nations, universities, and scientists.

Over 17 900 people from around the world work together on CERN-based projects, constantly advancing the limits of knowledge. Around 3600 of them are employed by CERN. They take part in the design, construction, and operation of the research infrastructures. CERN staff also contribute to the construction and operation of the experiments, as well as to the analysis of the data gathered for a vast community of users comprising over 12 500 scientists of 110 nationalities from institutes in more than 70 countries. Other personnel consists of associates, fellows, students, and contractors.

**The frontiers of technology**

CERN inspires visionary thinking. Since the beginning, it has been a trailblazer for technologies relating to accelerators, detectors and computing. As a laboratory with a long-term research plan, it continuously develops innovative technologies that benefit industry and society as a whole. CERN's research contributes to medical and biomedical technologies, aerospace applications, safety, the environment, the handling of big data, cultural heritage, and emerging technologies.

**Taking part in scientific associations**

CERN is represented in several scientific associations including:

- **ECFA**, the European Committee for Future Accelerators
- **ICFA**, the International Committee for Future Accelerators
- **EIROforum**, the European Intergovernmental Research Organisation forum

CERN engages with many other scientific partners and multilateral entities around the world, for example having Observer Status at the United Nations.

## SUPPLY CHAIN

With a long-run average annual spend of 500 MCHF, CERN has identified procurement as potentially materially important for the Organization's environmental stewardship and subject to future discussion. CERN's status as an intergovernmental organisation shapes its procurement rules and processes. These currently involve competitive tendering and the adjudication of contracts to the lowest compliant bidder, or in some cases, the bidder offering best value for money. CERN procurement seeks to achieve balanced industrial returns for all CERN Member States. In 2018, 12% of CERN's spending was on utilities, 25% on services including temporary labour, and 63% on supplies. In any given year, CERN carries out around 850 competitive tenders and places over 60 000 purchase orders or contracts.

## ETHICS AND INTEGRITY

CERN is committed to fostering a harmonious, diverse and inclusive workplace, and has a number of tools in place to support this. Underpinning these tools are the CERN Staff Rules and Regulations, which spell out the roles and responsibilities of the Organization and its personnel. CERN also has a Diversity & Inclusion office and a full-time Ombudsperson. The CERN Code of Conduct was launched on 1 July 2010. It is the key tool in promoting and upholding standards of ethical behaviour and integrity at CERN.

The CERN Code of Conduct is a guide to help all those at CERN understand how to conduct themselves, treat others and expect to be treated. It is built upon five core values: Integrity, Commitment, Professionalism, Creativity and Diversity. Together, they serve to promote excellence and respect across the Organization. As well as having internal tools to ensure inclusiveness in the Organization, CERN also subscribes to a number of external initiatives. These include, but are not limited to, *International Gender Champions, the EU Charter of Researchers and Code of Conduct for the Recruitment of Researchers,* and the Geneva-based *Le respect, ça change la vie.*

## CERN AND THE SDGS

The science and work carried out at CERN have an impact across many of the United Nations Sustainable Development Goals, SDGs. Five goals have been identified as particularly relevant for the Laboratory, namely Good health and well-being (3), Quality education (4), Industry, innovation and infrastructure (9), Peace justice and strong institutions (16), and Partnerships for the goals (17), and efforts are undertaken to ensure that the Organization contributes actively towards their implementation.

## GOVERNANCE

**The Council**

The CERN Council is the highest authority of the Organization and decides on CERN's activities in scientific, technical and administrative matters as well as admission of new Member and Associate Member States. 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.

**Director-General**

Appointed by the Council, usually for five years, the Director-General manages CERN, assisted by a Directorate composed of members proposed by the Director-General and endorsed by the Council. The Director-General reports directly to the Council.

# MANAGEMENT APPROACH

## A STRATEGY FOR THE ENVIRONMENT

CERN strives to be a role model for environmentally responsible research. Limiting the environmental impact of the Organization's activities is a priority for CERN's management, making environmental protection integral to all management processes. The environment is a central ingredient of the CERN Safety Policy, which sets out policy in matters of health, safety and environmental protection. The Occupational Health & Safety and Environmental Protection Unit, HSE, CERN's centre of competence in environmental matters, is a driving force behind the Safety Policy, working with all CERN Departments. CERN applies the precautionary principle in all aspects of environmental management. First introduced in the Rio Declaration on Environment and Development, the principle specifies that 'lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation'. Many technologies developed at CERN have potential applications in environmental management. It is an integral part of CERN's management approach to ensure that these are made available to society as a whole.

In 2016, CERN's Directorate strengthened its commitment to the environment through the adoption of an Environmental Protection Strategy, which identified top priority environmental domains. In 2017, this was followed by the establishment of CEPS, the CERN Environmental Protection Steering board. CEPS is constituted of representatives from CERN Departments, designated by the Department Leaders, and is Chaired by a member of the HSE Unit. 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, which is composed of the Organization's Directors and Department Leaders. The Director-General allocates the resources managed by CEPS.

CERN works closely with its Host States in matters of environmental protection. As an Organization 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.

CERN signed a memorandum of cooperation in 2007 for non-radiological environmental aspects with the environmental authorities of the Canton of Geneva, Switzerland, and the Sub-Prefectures of Gex and Nantua, France. This established a tripartite committee for the environment, CTE from its French acronym, which holds two plenary meetings a year, as well as regular technical meetings.

In 2010, a tripartite agreement between CERN, the Swiss Federal Office for Public Health, OFSP, and the French Nuclear Authority, ASN, regarding matters of radiation protection and radiation safety at CERN replaced the previously existing bilateral arrangements. This 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. It paved the way for regular trilateral technical meetings, as well as annual high-level plenary meetings chaired by CERN's Director for Accelerators and Technology. The Organization reports formally to the OFSP and ASN individually in matters of radiation protection. The HSE Unit has authority in matters of radiation protection at CERN, and is a recognised leader in the field.

While CEPS has a global mandate for environmental protection, a separate body was established in 2011 for the particular case of energy management. The Chair of the CERN Energy Management Panel, EMP, is an ex-officio member of CEPS. The EMP examines CERN's energy consumption and identifies measures to improve efficiency organisation-wide and promote energy reuse. It was established following the first workshop on Energy for Sustainable Science, set-up by CERN and other European research organisations to share strategies for energy management. These workshops are held every two years.

Important CERN-developed environmental management tools include a Radiation and Environment Monitoring Unified Supervision system, REMUS, and the CERN Geographical Information System, GIS. REMUS provides round-the-clock online supervision of CERN radiological and conventional environmental field instrumentation 365 days per year. GIS provides a visual geographical directory of all installations relevant to the environment, such as monitoring stations and CERN water networks.

Training plays an important role in CERN's approach to environmental custodianship. The HSE Unit runs a training centre on the Laboratory's Prévessin campus, at which courses on all aspects of health, safety and environmental protection are delivered. In addition, the Laboratory develops and maintains a series of e-learning modules covering environmental issues.

| CHAPTER | MATERIAL TOPIC | REFERENCE |
|---|---|---|
| Energy | Energy consumption | GRI 302 |
| Emissions | Greenhouse gas emissions<br>Mobility | GRI 305<br>CERN-specific |
| Ionising Radiation | Ionising radiation | CERN-specific |
| Noise | Noise | CERN-specific |
| Waste | Radioactive waste<br>Non-radioactive waste | CERN-specific<br>GRI 306 |
| Water and Effluents | Water consumption<br>Effluent quality | GRI 303<br>GRI 303 |
| Biodiversity | Natural resources & Biodiversity | GRI 304 |
| Environmental Compliance | Prevention of environmental accidents<br>Hazardous substances | GRI 307<br>CERN-specific |

**GLOBAL REPORTING INITIATIVE, GRI, DISCLOSURES AND CERN-SPECIFIC TOPICS BY CHAPTER.**

## MATERIALITY

This report focuses on issues identified as being of material importance to the Organization and to concerned groups. It is based on an analysis of internal and external stakeholder dialogues. The result is a set of topics and disclosures covered in this report that are drawn from the Global Reporting Initiative, GRI, 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 focus group meetings with internal stakeholders chosen to reflect the diversity of viewpoints within the Organization. Based on insights from these dialogues, external stakeholders were identified and interviewed (GRI 102-43). The internal stakeholders are (GRI 102-40):

- Heads of CERN Departments;
- Administrative, finance and procurement officers;
- Personnel responsible for aspects of external relations;
- Representatives of the user community and Staff Association;
- CERN Directors;
- CERN Council president and delegates (Member State representatives);
- Personnel with responsibility for environmental aspects.

The external stakeholder groups are as follows (GRI 102-40):

- Host State participants in meetings held under the tripartite agreement on radiation protection and radiation safety;
- Host State participants in meetings held under the tripartite committee for the environment;
- The Mayors of some local communities with a strong CERN presence;
- Energy suppliers;
- Representatives of Host-State media;
- Sustainability consultants.

These interviews established the relative importance of topics to external stakeholders (GRI 102-44). The overall result is shown in the materiality table above (GRI 102-47). High significance topics with respect to stakeholder relevance and impact on sustainable development are the main focus in this report (GRI 102-46). Soil protection, the sewer system, legionella treatment, the environmental impact of procurement, material consumption, and non-ionising radiation arose as topics through the materiality process, though with lower significance to all stakeholders. These topics are not comprehensively covered in this report, but have been identified for future consideration.

**A note on topic boundaries**

CERN's position as an intergovernmental organisation, coupled with its function as a user facility, has required choices to be made in defining topic boundaries for this report. The data presented here refer exclusively to the impact of CERN's facilities in the Geneva region, plus that arising from the operation of computing facilities in Budapest (GRI 102-45).

As a user facility, CERN hosts people and equipment from universities and institutes around the world. The participation of these people in CERN programmes and the production of research equipment under the responsibility of collaborating institutes are not considered here.

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

# ENERGY

CERN’s unique complex of particle accelerators is responsible for most of CERN’s energy consumption. As powerful research instruments, these machines support a global community of scientists, and CERN takes every effort to run them in the most energy-efficient way possible. CERN’s peak power demand, with the full accelerator chain running, is around 180 megawatts, which is about half the capacity of the nearby Génissiat hydroelectric power plant in France.

CERN procures its electricity mainly from France, whose production capacity is 87.9% carbon-free (2017 figures). CERN uses about 4300 TJ (1.2 TWh) of electricity in years when the accelerators are running. This corresponds to about 2% of the electricity consumed by Switzerland, where CERN is headquartered, or 0.03% of consumption in Europe. Energy procurement represents around 5% of CERN’s budget. In years when the accelerators are not running, consumption is between 30% and 50% lower. Electricity is the major source of energy used at CERN, constituting around 95% of CERN’s energy in a typical year. The Organization also consumes natural gas for heating, petrol for its fleet of vehicles and diesel for emergency generators. Non-accelerator consumption accounts for 15% of the total. Fossil fuel consumption was 232 TJ (64.4 GWh) in 2018.

CERN’s main product is data produced in particle collisions and recorded by experiments. The Organization constantly strives to make its accelerators more efficient at delivering data. The LHC, for example, delivered twice as much data per unit energy in its second run compared to its first. A metric to formally quantify and illustrate this is under development and will appear in CERN's next environment report.

## DATA MANAGEMENT

Data recorded by CERN’s experiments is transformed into knowledge by scientists around the world. With proton-proton collisions in the LHC happening up to around a billion times per second, and the larger experiments consisting of some 100 million sensors, the amount of data produced is vast. The LHC experiments produce around 90 petabytes ($10^{15}$ bytes) of data per year. An additional 25 petabytes of data are produced per year by non-LHC experiments. The data are stored, processed and distributed using the World-Wide LHC Computing Grid, WLCG, a distributed structure whose top level is split between CERN and the Wigner Centre in Budapest. The data centre at CERN consumed 127.8 TJ (35.5 GWh) in 2018, while the part hosted in Budapest consumed 36.5 TJ (10.1 GWh). The WLCG currently consists of some 170 computer centres in 41 countries. Their consumption is not included in the figures presented here.

## IMPROVING ENERGY EFFICIENCY

Guided by the Energy Management Panel, EMP, CERN’s efforts to improve energy efficiency focus on the accelerators. CERN has three strategies for energy management. The first is to minimise the increase of energy consumed for new accelerator projects. In the transition from the Large Electron Positron collider, LEP, CERN’s previous flagship facility, to the LHC, this was achieved through the large-scale deployment of superconducting magnet technology. The LHC is the world’s largest superconducting installation, and a valuable test bed for the potential deployment of superconducting technology for power distribution. As the LHC gives way to the High-Luminosity LHC, with a tenfold increase in luminosity, the Organization’s immediate priority is to limit the increase in energy consumption to 5% up to the end of 2024. Longer-term objectives will be set in future reports. The second strategy is to increase energy efficiency. This includes the deployment of monitoring tools and forecasts for optimisation, avoiding waste, and increasing awareness among the CERN Departments and services that consume large amounts of energy. All new buildings at CERN are designed to be energy efficient, and when older buildings are refurbished, it is done with energy efficiency in mind. The third strategy is energy recovery. In 2018, CERN identified opportunities to use heat recovered from CERN's accelerator cooling systems to heat a new residential area in the town of Ferney-Voltaire, benefiting up to 8000 people. Studies are under way for a similar project to heat offices on CERN’s Meyrin site.

### IN FOCUS

*Serge Claudet is CERN's Energy Coordinator, and Chair of the Energy Management Panel.*

***— What is the Energy Management Panel, EMP?***

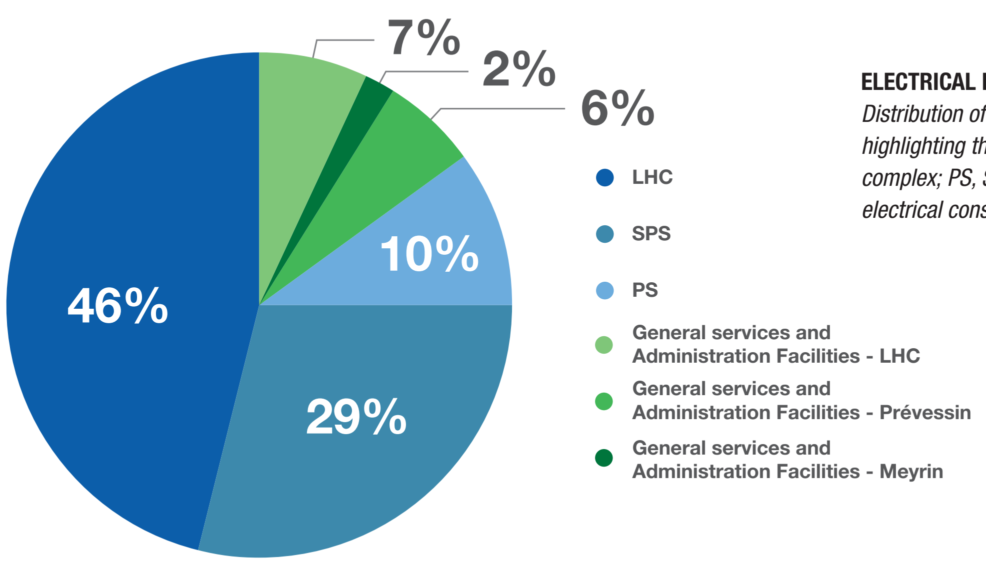
*SC:The EMP brings together people representing CERN's most energy-intensive activities. It meets 5-6 times a year to pool skills and identify measures for improving energy efficiency.*

***— What are the EMP’s objectives?***

*SC: The EMP raises awareness of energy efficiency at CERN. Each member brings proposals for rational consumption and energy-saving measures in their area. The panel accurately forecasts CERN’s consumption, which is valuable information for our electricity supplier, and results in a discount in the price to CERN. The EMP evaluates renovation projects to identify the potential for reduced energy consumption. Since 2018, although the energy bill is paid centrally, the EMP has issued virtual invoices to consumers allowing them to understand their energy use.*

***— What is the role of the Energy for Sustainable Science at Research Infrastructures workshops?***

*SC: The Energy for Sustainable Science at Research Infrastructures workshops were established in 2011 to allow research organisations to share best practice in matters of energy use. One example of a project presented by CERN is the reorganisation of the magnet power supply in the SPS accelerator, which is now equipped with a control system that activates the power of the magnets only when the particles pass. This saves 5% of the total energy consumed at CERN.*

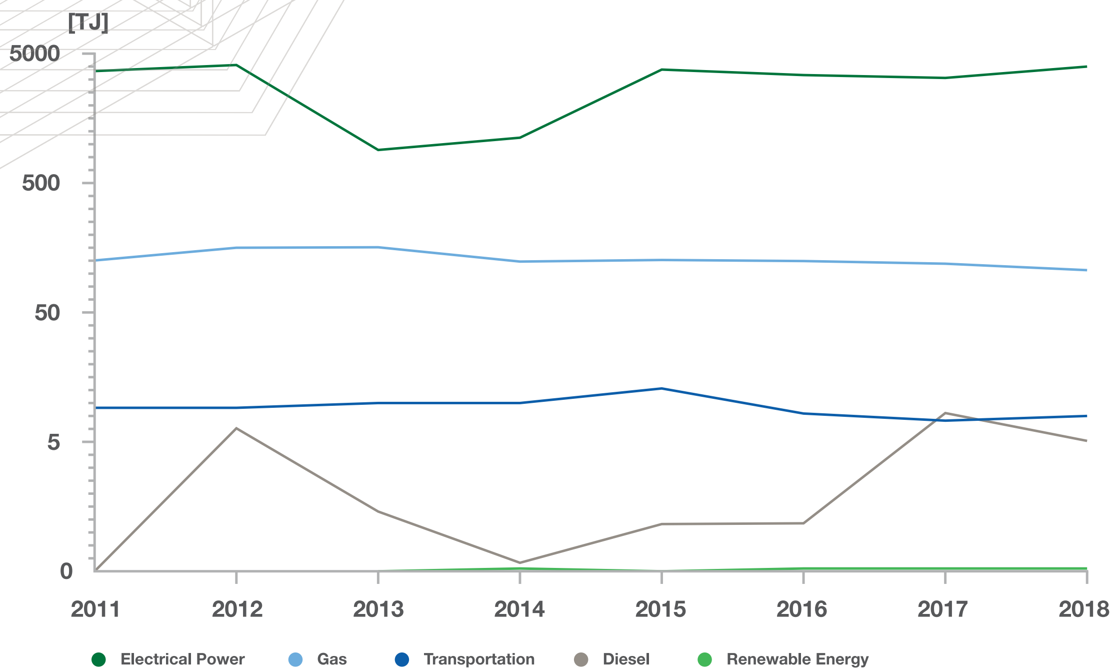



**ELECTRICAL POWER DISTRIBUTION 2018**

*Distribution of the electrical consumption at CERN highlighting the large part used by the accelerator complex; PS, SPS and LHC. In 2018, the total electrical consumption was 4504 TJ (1251 GWh).*

**ENERGY CONSUMPTION INSIDE CERN**

*CERN energy consumption 2011-2018.*



# EMISSIONS

*Greenhouse gas emissions at CERN arise from the operation of the Laboratory's research facilities. The majority of emissions come from CERN's core experiments and more than 78% are fluorinated gases. With climate change a growing concern, the Organization is committed to reducing its direct greenhouse gas emissions.*

## DIRECT EMISSIONS

CERN's total amount of scope 1 greenhouse gas emissions, those produced directly by the Organization, was 192 100 tonnes of $CO_2$ equivalent, $tCO_2e$, in 2018, 92% of which is related to the activities of the large LHC experiments. This is due to various fluorinated gases, F-gases, used for particle detection and detector cooling purposes.

CERN and its experiments use $SF_6$, 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.

Detectors installed in the LHC experiments are equipped with F-gas recirculation systems. Because of gas purity requirements, they have a 90% recirculation efficiency. The main contributors to CERN's F-gas emissions are small leaks in the detectors due to their necessarily light construction. Repairing them is an ongoing priority for the Laboratory.

## INDIRECT EMISSIONS

CERN's total amount of scope 2 greenhouse gas emissions, those due to CERN's electricity consumption, was 31 700 $tCO_2e$ in 2018. The source of the emission factors used is EDF Bilans des émissions de GES 2002-2018, which is a location-based approach. This means that the calculations are based on average energy generation emission factors for the local energy grid. The Organization's principal electricity supplier, EDF, uses low-carbon power, mainly nuclear, which keeps the emissions relatively low. The total indirect emissions also include 3489 $tCO_2e$ from the electricity consumed by a CERN-operated data centre at the Wigner Centre in Budapest. The source of the emission factors used is Bilan Carbone® V8.1 2018, which is a location-based approach. From 2020 onwards, CERN will no longer operate computing facilities in Budapest.

## MANAGING EMISSIONS AT CERN

CERN's HSE Unit reports annually on greenhouse gases emitted on Swiss territory to Swiss authorities and has done so since 2014. The Organization also reports to French authorities on request. Because of their major contribution, F-gases in LHC experiments are the main focus of CERN's greenhouse gas emissions mitigation effort. The Organization stabilised emissions between the first and second LHC runs by fixing leaks, optimising gas recirculation systems and installing F-gas recuperation systems. Run 1 was from 2009-2013, Run 2 from 2015-2018.

CERN has a formal objective to reduce its scope 1 emissions by 28% by the end of 2024. To achieve this objective, in addition to the ongoing efforts, CERN will replace F-gases in detector cooling systems with $CO_2$, which has a significantly lower global warming potential. Longer-term objectives will be set in future reports.

**AN HFC-134A RECUPERATION PLANT INSTALLED AT POINT 5 OF THE LHC.**

## IN FOCUS

*Roberto Guida, Beatrice Mandelli and Paolo Petagna work in CERN's Detector technologies group. Guida is project manager for gas systems, in which Mandelli also works. Petagna is project manager for detector cooling systems.*

***— How is CERN working to reduce the use of greenhouse gases in particle detection?***

*BM: The refrigerant HFC-134a, used in particle detectors in the LHC experiments, is responsible for half of CERN's scope 1 emissions. The second long shutdown of the LHC, currently ongoing, will give a unique chance to repair leaks and optimise the gas systems. R&D is ongoing to design an HFC-134a recuperation plant.*

***— How far has R&D at CERN come in terms of gas recuperation?***

*RG: During the second LHC run, CERN tested a prototype on a real detector. It had a recuperation efficiency close to 100%. Moreover, the recuperated gas was so pure that it could be recirculated and reused. Further tests still need to be performed but given the positive results, this has paved the way to designing a complete HFC-134a recuperation system for the third LHC run from 2021-2024.*

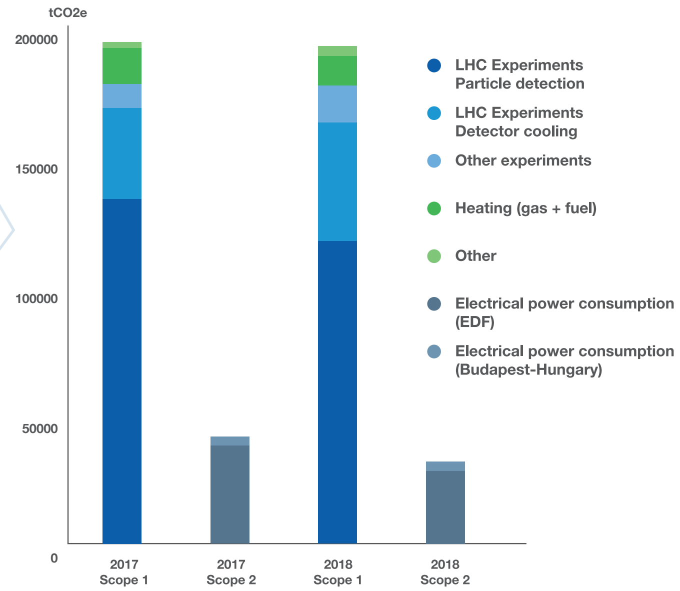
***— Is it possible to replace F-gases with greener gases in the detector cooling systems?***

*PP: The detector community has been looking for green alternatives to F-gases for many years, and we have a solution: replacing the F-gases with $CO_2$ in the cooling systems of the LHC cold silicon detectors. The global warming potential of $CO_2$ is a few thousand times lower. $CO_2$ is also extremely efficient in very small pipes, which is essential to some detector systems in the LHC. $CO_2$ is nevertheless challenging because it involves replacing most of the infrastructure. Another issue is that $CO_2$ is solid at the relatively high temperature of -53°C, which places a lower limit on the cooling temperature that can be reached.*

## MOBILITY MANAGEMENT

Given CERN's nature as an intergovernmental organisation hosting worldwide collaborations, mobility is fundamental to its mission. Scope 3 emissions include all other indirect emissions. At CERN these arise mainly from the travel of users, committee delegates and CERN employed personnel. Scope 3 emissions are recognised as an important topic to address. A future report will cover those arising from CERN staff travel, along with mitigating measures.

Around 77% of CERN personnel commute to work from France, most using individual motorised vehicles due in part to a lack of public transport. CERN's goal until 2025 is to keep individual motorised vehicle commuting constant, despite a growing scientific community. Overall, walking and cycling constitute 17% of all commutes, which is well above the Swiss national average of 6%.




**CERN SCOPE 1 AND SCOPE 2 EMISSIONS FOR 2017 AND 2018 BY CATEGORY.** *Other includes air conditioning, electrical insulation, emergency generators and CERN vehicle fleet fuel consumption.*

**BREAKDOWN OF SCOPE 1 EMISSIONS BY GAS TYPE.** *Global warming potential, GWP, based on EU Regulation 517/2014 on fluorinated greenhouse gases, while HFC-407c, HFC-410a, HFC-404a, HFC R-422D, and HFC-507 are based on the IPCC Fifth Assessment Report, 2014 (AR5).*

| GROUP | GASES | $tCO_2e$ 2017 | $tCO_2e$ 2018 |
|---|---|---|---|
| PFC | $CF_4$, $C_2F_6$, $C_3F_8$, $C_4F_{10}$, $C_6F_{14}$ | 61 984 | 69 611 |
| HFC | $CHF_3$ (HFC-23), $C_2H_2F_4$ (HFC-134a), HFC-404a, HFC-407c, HFC-410a, HFC R-422D, HFC-507 | 106 812 | 96 624 |
| | $SF_6$ | 10 192 | 13 087 |
| | $CO_2$ | 14 612 | 12 778 |
| TOTAL SCOPE 1 | | 193 600 | 192 100 |

# 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. CERN's radiation protection is in line with best practice in Europe. Keeping CERN at the forefront in this area is a priority for the Organization.*

## 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 controlled doses in medical examinations such as X-rays. Industrial and research facilities can also generate ionising radiation.

The European Council sets the annual dose limit for public exposure at 1 milliSievert, mSv. CERN commits to limit its part to no more than 0.3 mSv per year. The actual dose to any member of the public living in the immediate vicinity of CERN due to the Organization's activities is much lower: below 0.02 mSv per year. This is less than the exposure received from cosmic radiation coming from space on a flight from Geneva to New York.

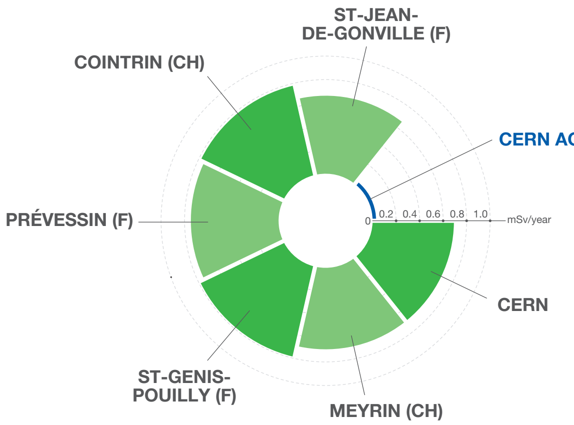
## RESPONSIBLE REPORTING

CERN adheres and contributes to internationally recognised radiation protection and safety systems. Following the precautionary principle, the Organization continuously optimises facilities and practices to minimise its radiological impact. A tripartite agreement, signed with the Host States in 2010 and steered by the HSE Unit in collaboration with CERN Departments, ensures transparency and alignment with best practice in radiation protection and safety. CERN reports quarterly on radioactivity measurements in the local environment to Swiss and French authorities.

CERN's legal framework for radiation protection sets out basic principles along with rules and procedures for protecting CERN personnel, the public and the environment. These rules adhere to the internationally-recognised As Low As Reasonably Achievable, ALARA, principle, and include job planning, training, radioactive waste management, and management of radioactive materials and sources.

## STATE-OF-THE-ART MONITORING

Ionising radiation is constantly monitored inside and outside the CERN perimeter. Every year, the Organization carries out thousands of analyses of air, ground, vegetal and water samples from the surrounding environment and employs over 100 state-of-the-art monitoring stations to ensure that emissions of ionising radiation remain below 3% of those arising from natural sources. CERN's methods, and the scope of its monitoring program, are reviewed by Host State authorities, which also carry out their own monitoring around CERN installations.




**NATURAL SOURCES OF IONISING RADIATION AT CERN AND IN NEIGHBOURING COMMUNITIES.** *The typical dose of natural sources (green) measured at several places neighbouring CERN sites compared to the dose induced by CERN activities (blue).*

### IN FOCUS

*Eric Zelnio is Deputy Head of Division at the Lyon office of the French Nuclear Safety Authority, ASN. Nicolas Stritt is Head of the Research facilities and nuclear medicine section at the Swiss Federal Office of Public Health, OFSP.*

***— How do you judge CERN's commitment to radiation protection?***

*EZ: CERN's commitment to radiation protection is seen to be significant. The production of detailed and technically substantiated reports makes it possible to document compliance with the defined limits, to evaluate the doses to reference populations, and to suggest areas for optimisation.*

***— What is the importance of the tripartite agreement?***

*NS: The tripartite agreement is important since as an international organisation, CERN is outside the normal regime of authorisations and supervision defined in national laws. The tripartite agreement provides a framework for replacing this regime. It has improved cooperation and coordination between CERN and the Host States, harmonised procedures and improved radiation protection.*

# NOISE

Managing noise produced by CERN's installations is important in order to minimise nuisance to the Organization's immediate neighbours. Consequently, the Organization has always taken measures to minimise its noise footprint and ensure conformity with Host State norms. In the past, most CERN sites were in rural areas. However, with increasing urbanisation, housing has been constructed near to some sites, requiring action to be taken.

In 2014, an extensive noise measurement campaign was undertaken to establish a baseline and determine a course of action. Readings were taken at the perimeter of CERN sites, giving priority to those with homes nearby. This allowed targeted investment to be made in noise barriers and low-noise equipment.

As a result, CERN restricts noise at its perimeter to the limits specified by French norms of 70 dB(A) during the day and 60 dB(A) at night at worst; roughly equivalent to a running shower and conversational speech respectively.

The CERN noise map is provided to local authorities so that they can plan new developments to limit noise experienced by future residents. CERN recommends no construction within a 40 dB(A) perimeter, equivalent to the sound made by a home computer. The noise map and accompanying documentation are available for consultation through local town halls.

### IN FOCUS

*José Miguel Jiménez is CERN's Executive Officer for Noise Footprint Policy and Implementation Strategy.*

***— What were the objectives of the 2018 measurement campaign?***

*JMJ: Following a long maintenance shutdown, we resumed operations in 2014 under similar circumstances to 2012 operation. Some residents of new housing developments near CERN sites noticed a change in the noise environment. We therefore produced detailed maps of our noise footprint, allowing us to quantify it, and to invest in noise reduction measures where necessary. We initially focused on sites with housing developments nearby, but in 2018 we completed the campaign for all CERN sites, allowing local authorities to plan future developments accordingly.*

***— What did the noise maps reveal?***

*JMJ: Our measurements showed that noise levels have not changed since the early 1990s, and are low by urban standards. Nevertheless, we have invested 0.7 MCHF to reduce noise in areas where people live.*

***— What is planned for the future?***

*JMJ: Minimising CERN's noise footprint for our neighbours is a priority. We measure annually to ensure we remain at or below current levels, and when restarting our facilities, which requires increased levels of activity, we monitor in real time so that if noise levels rise, we can intervene immediately. We also have an agreement with local authorities stipulating that developers must be informed about the CERN noise footprint if constructing close to the 40 dB(A) threshold, and discouraged from constructing within that zone.*



*Urbanisation has led to housing being constructed near to CERN sites such as point 2 of the LHC ring, home to the ALICE experiment.*

# WASTE

*CERN's waste management strategy is based on European, French and Swiss regulatory frameworks. It aims to ensure that waste is managed safely and appropriately, in ways that pose no unacceptable risk to people and the environment.*

## WASTE AT CERN

CERN eliminates 100% of its waste. In 2018, the total amount of conventional, non-hazardous waste eliminated was 5808 tonnes consisting of industrial waste, electrical and electronic equipment (subject to monitoring according to the Swiss regulation OMod), aluminium, glass and PET, paper and cardboard, biodegradable waste, coffee capsules and household waste. CERN had a recycling rate of 56% for non-hazardous waste. 81% of the Laboratory's total eliminated waste is non-hazardous. Radioactive waste elimination is managed through the tripartite agreement on radiation protection and radiation safety between CERN, France and Switzerland. It is overseen by the respective national authorities ASN and OFSP."

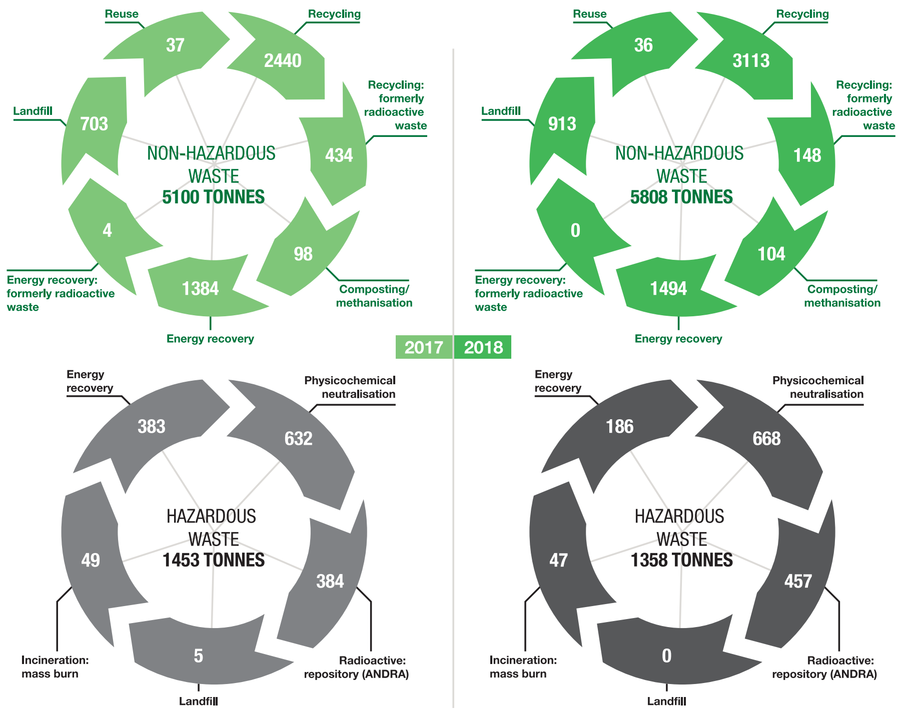
The Laboratory's hazardous waste consists of chemicals and their containers, any type of material contaminated by hazardous substances, printer cartridges and light bulbs. Radioactive waste is also categorised as hazardous. CERN has specific procedures in place for the safe storage, removal and disposal of both conventional hazardous waste and radioactive waste.

The data provided here do not include waste generated and eliminated by external contractors active on CERN's premises, or end-of-life equipment directly picked up by or sent back to the supplier. These will be included in a future report.

## RADIOACTIVE WASTE

CERN's scientific activities produce radioactive waste with low-level activity. This consists mainly of large metallic components, cables and ventilation filters, and also includes waste from operations, such as gloves, overalls and papers. These materials are collected mainly during periods of maintenance and consolidation of research facilities. The dismantling of installations can also generate activated concrete and soil from the immediate vicinity of CERN's underground infrastructures. CERN reuses activated material as far as possible, in particular as shielding.

CERN does not produce any highly radioactive waste. Most radioactive waste produced at CERN is only slightly activated, and falls into three categories: materials with extremely low activity; materials with very low activity; and materials of low to medium activity. In 2017 and 2018, CERN generated 524 and 327 tonnes of radioactive waste respectively. This is temporarily stored in a dedicated secure storage area. A specific elimination process is defined through the tripartite agreement between CERN, France and Switzerland on radiation protection and radiation safety.




**CERN'S WASTE CATEGORISED BY ELIMINATION PATHWAY.**
*Quantities of waste and information on elimination pathways for radioactive waste are based on CERN data. Data on elimination pathways for all other categories come from the companies engaged by CERN to eliminate the waste.*

## MANAGING NON-RADIOACTIVE WASTE

The Laboratory has a centralised waste management system that handles all non-radioactive waste collection and transportation for safe and appropriate disposal. Hazardous waste is sent to a temporary buffer zone and is collected weekly. Metallic and electronic waste are sorted and sold. CERN implements waste reduction projects and awareness campaigns. CERN's main objective for waste management is to increase the current recycling rate.

CERN maintains a waste inventory that lists all waste leaving CERN via the centralised management system. This helps to ensure the traceability of waste pathways.

## IN FOCUS

***Pioneering a precautionary approach to future facilities***

*Activation of material is an unavoidable issue for any facility working with high-energy particle beams. Optimising fundamental parameters, such as the chemical composition of components, is one way to reduce material activation. However, it is not a simple task. In order to reduce material activation, and thus reduce radioactive waste, CERN has developed a software package called ActiWiz. By providing a simple and intuitive way to analyse materials, ActiWiz helps decision makers choose those materials least susceptible to activation. Since the first version of ActiWiz, the code has become very versatile, allowing for detailed calculation of nuclide inventories along with associated risks and mitigation measures. ActiWiz has been adopted by several other research laboratories.*

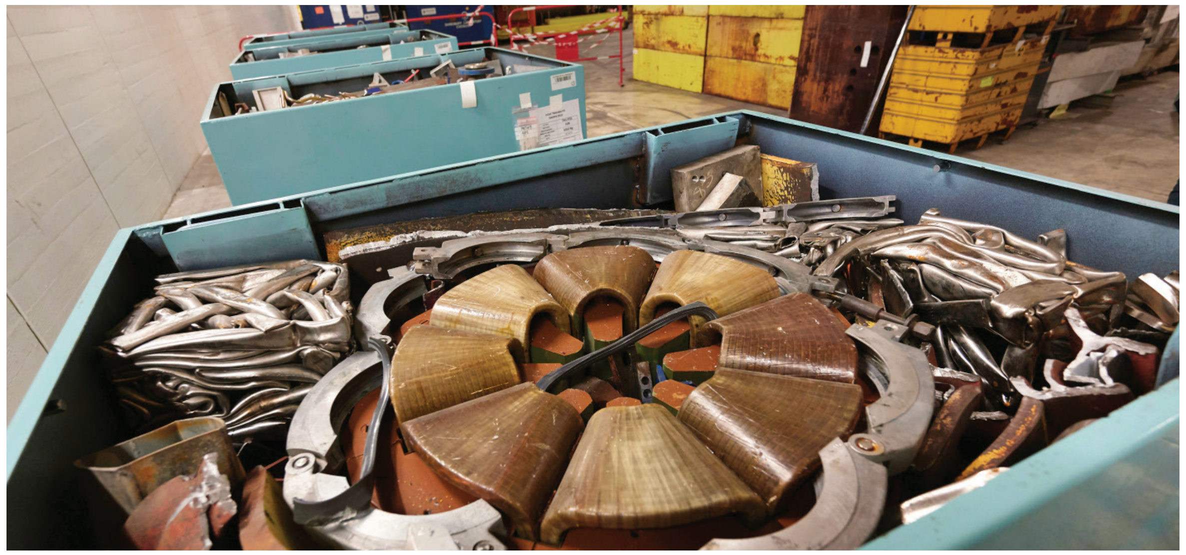
## MANAGING RADIOACTIVE WASTE

Radioactive waste management has always been a high priority for CERN. Today it is handled in the framework of the tripartite agreement on radiation protection and radiation safety. The process begins with the initial conception of a facility or experiment, and concludes with disposal of radioactive waste to the final repositories. The generation of radioactive waste is minimised by avoiding, recycling and reusing activated material.

CERN's radioactive waste management is performed by a specialised radiation protection team. The team receives waste regularly, with more being received during maintenance shutdowns. After receiving and categorising waste, the team treats it in a dedicated state-of-the-art facility where it is dismantled, sorted, reduced in volume and packaged according to elimination pathway criteria.

CERN's radioactive waste is eliminated in accordance with the tripartite agreement through existing pathways in the Host States with a view to optimising the elimination while respecting the principle of a fair share between France and Switzerland. In Switzerland, CERN uses the possibility of free-release, whereby formerly radioactive waste is released as traceable non-hazardous waste following a demonstration that it no longer qualifies as radioactive according to the Swiss ordinance for radiation protection, ORaP. CERN annually reports data on radioactive waste to the Host State authorities. In 2018, CERN produced 327 tonnes of radioactive waste and disposed of 605 tonnes, 457 of which were sent to a final repository in France (http://andra.fr). In 2017, 438 tonnes were classified as no longer radioactive and released for clearance in Switzerland. In 2018, the figure was 148 tonnes.

*Radioactive waste: sorted and compressed.*



# WATER AND EFFLUENTS

*Water is essential for the cooling systems of CERN's accelerator complex. These involve 21 cooling towers that evaporate a fraction of the water to cool the accelerators, and release another fraction as effluent water that may contain residuals of the products used to prevent scaling, corrosion, and bacteria including Legionella. CERN continuously monitors effluent quality and has procedures to mitigate the consequences in case of incident, and to alert the relevant Host State authorities. Responsible water management is of upmost importance for CERN. The Organization has a long-term programme to further reduce the concentration of chemicals in clean water releases, and commits to keeping the increase in water consumption below 5% up to the end of 2024, despite a growing demand for water cooling of upgraded facilities. Longer-term objectives will be set in future reports.*

## WATER WITHDRAWAL AND RELEASE

In 2018, CERN consumed 3477 megalitres, ML, of water. All water supplied to CERN is of drinking water quality, some of which is processed to demineralised water. The majority of the water comes from Lake Geneva and is supplied by the *Services Industriels de Genève*. Less than 1% comes from *Pays de Gex* in France, a waterstressed area. It is supplied by the *Régie des Eaux Gessiennes*, and consists mainly of groundwater.

Around 80% of CERN's water supply is dedicated to industrial activities, mostly the accelerator cooling system, and 20% is for sanitary purposes. 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.

The Organization releases rainwater, infiltration water and cooling water into local watercourses, some of which are small and sensitive to the quality of the effluents they receive. This is the case for the *Nant d'Avril* and *Lion*, a tributary of the *Allondon* and the *Allondon* itself. These watercourses are monitored by CERN and, independently, by Host State authorities. Any deviations from Host State legislation are rapidly investigated and treated. The *Nant d'Avril* receives the majority of the cooling water.

## MANAGING WATER AS A RESOURCE

CERN's approach to water management is one of constant monitoring and improvement. The first priority is to minimise water consumption. The second is to optimise qualitative and quantitative aspects of the effluents released into watercourses. CERN has committed to the regional plan for the evacuation of water (Plan Régional d'Evacuation des Eaux, PREE) for the *Nant d'Avril* developed by the Canton of Geneva. In this context, CERN's objectives by 2025 are to:

- Recycle cooling tower water to reduce and improve the quality of water released into the *Lion* and *Nant d'Avril*;
- Prevent accidental release of pollutants such as hydrocarbons in the *Lion* by implementing a retention basin at the main outlet of the Prévessin site. This will also regulate surface runoff during precipitation.

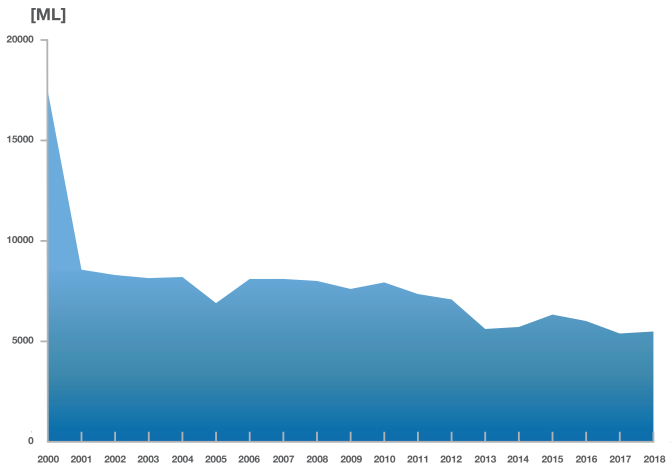
Further water retention solutions are being investigated for the Meyrin site within the scope of the PREE for the *Nant d'Avril*.

CERN has regular exchanges with local Host State authorities on water protection issues in the framework of the tripartite committee for the environment.

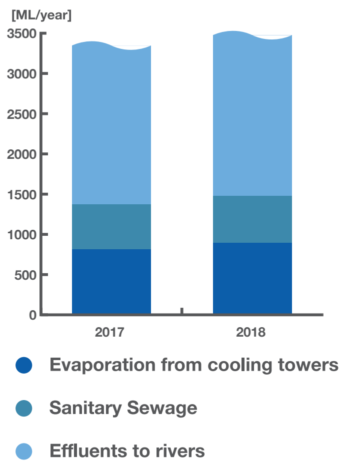
**Monitoring water released into watercourses**

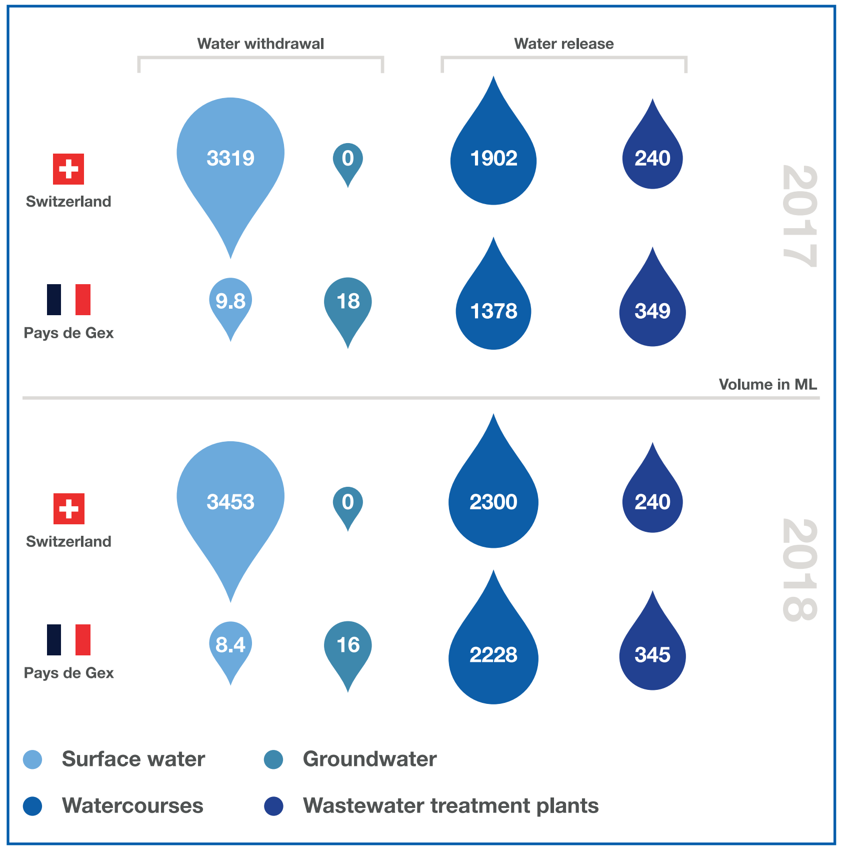
The HSE Unit runs a monitoring programme on effluent water quality and quantity and regularly samples the neighbouring watercourses to evaluate the Laboratory's environmental impact. CERN reports to the Host State authorities on a quarterly basis. Following past pollution events in the *Lion*, the monitoring programme was reinforced. No event that would have led to a fine or non-monetary sanction occured during the period covered by this report (p. 23).

**CERN'S ANNUAL WATER CONSUMPTION 2000 - 2018.** *Based on data from Services Industriels de Genève and Régie des Eaux Gessiennes.*

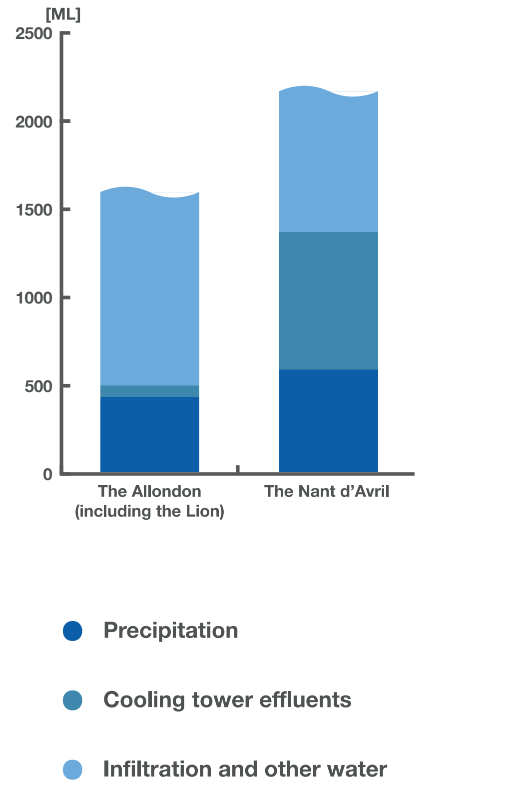



**THE DISTRIBUTION OF SUPPLIED WATER DETAILING THE RELEASE PATHWAYS.** *Data on evaporation and effluents are measured on-site. Data on sanitary sewage are measured by the Host States. This does not include the release of precipitation runoff or infiltration water.*




**TOTAL WATER WITHDRAWAL AND RELEASE 2017 - 2018.** *Withdrawal is based on data from Services Industriels de Genève and Régie des Eaux Gessiennes. Releases into watercourses are measured on-site. Data on wastewater treatment plants are measured by the Host States.*




**WATER RELEASED INTO THE MAIN WATERCOURSES 2018.** *CERN releases water into nine distinct watercourses, of which the main receivers are the Nant d'Avril and the Allondon (83% of the total water released into watercourses).*

## IN FOCUS

*Serge Deleval is manager of CERN's cooling tower project.*

***— What solutions has CERN adopted to improve the quality of water released from the cooling towers?***

*SD: The first solution involves the use of demineralised water in the cooling towers, while maintaining the releases in the site's drainage network. The lower salt concentration of demineralised water improves evaporation, and therefore decreases water consumption. The use of chemicals is also reduced, improving the quality of released effluents. CERN is deploying this solution at the Meyrin site, which has a widespread demineralised water supply network.*

*The second solution involves recycling the water in the cooling tower circuits. To decrease water consumption and effluent volume, the water is treated and fed back into the circuits. Residual effluents from the treatment process are released into the sewage network instead of watercourses. This solution was implemented at the Prévessin site at the end of 2018 to reduce the impact on the Lion. By 2025, this solution will be applied to the LHC and SPS cooling tower circuits, reducing the impact on the Nant d'Avril.*

# BIODIVERSITY

*Known for its research sites, CERN also includes 258 hectares of cultivated fields and meadows, 136 hectares of woodland and three wetlands. All this land teems with wildlife, including some rare species. CERN's environmental commitment includes preservation of all land under its management. Since 2009, CERN has held the Swiss Nature & Economie Foundation's label of quality in recognition of its efforts to protect biodiversity.*

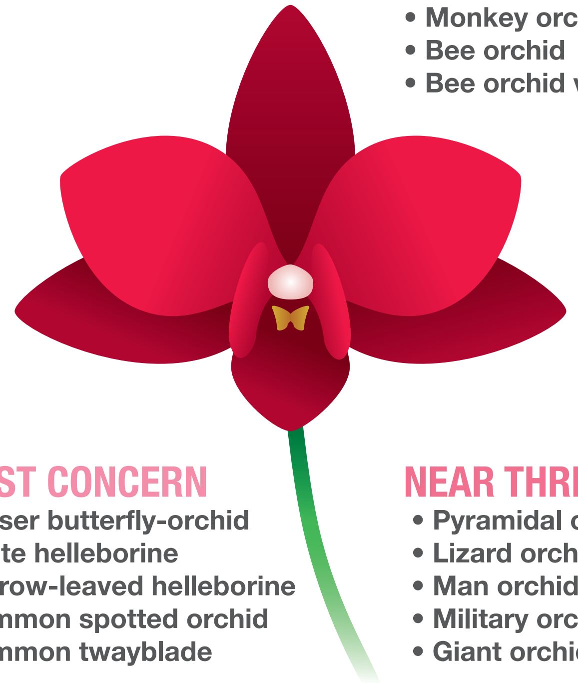
## PRESERVING THE LANDSCAPE

CERN's approach to landscape and biodiversity preservation is based on low-intensity maintenance. This means minimum watering, late mowing and reducing or eliminating fertilisers and chemicals. CERN's lowland woodlands are among the last in the *Pays de Gex*. They are an important local resource and their trees and waterways are jointly managed by CERN and the French national forests office, the ONF. New developments, such as Science Gateway, are built with conservation in mind.

**ORCHID SPECIES PRESENT ON CERN SITES**. *Categorised by the Swiss Red List on vascular plants (2016).*

**ENDANGERED**
- Early spider-orchid

**VULNERABLE**
- Green-winged orchid*
- Monkey orchid
- Bee orchid
- Bee orchid var. botteronii



**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

## PROTECTING RARE ORCHIDS

Orchids are the pride of CERN's dry grasslands with the largest variety to be found anywhere in the Geneva basin. The Organization is home to 15 species, 10 of which are on the Swiss national conservation list. In Switzerland, the early spider-orchid is endangered, while two varieties of bee orchid, the monkey orchid, and the green-winged orchid are vulnerable. The latter is also on the IUCN Red List as near threatened. Five species are categorised as near threatened in Switzerland: the pyramidal orchid, the lizard orchid, the man orchid, the military orchid and the giant orchid. Late mowing of CERN's orchid sites, identified each year by a local expert, protects these plants by allowing them to live a complete life cycle.

### IN FOCUS

*Patrick Geeraert is project manager of Science Gateway, CERN's new education, outreach and visitor centre designed by architect Renzo Piano. Construction will begin in 2020.*

***— How green is Science Gateway?***

*PG: Science Gateway is very green. The building will be heated and cooled geothermally and will generate its own solar electricity. It will also be surrounded by trees – we'll be planting at least 350 with the density of a forest to favour biodiversity.*

***— What specific measures are being taken to protect nature?***

*PG: We're working closely with conservation organisations and I'm learning a lot! For example, to encourage small animals, the forest will be too dense in places for human access. Hedgerows will be low to allow animal access, and there will be animal passages under the roads. Lighting levels will be set so as not to disturb wildlife, and we'll be using special bird-friendly glass. Science Gateway is a model for sustainable construction.*

# ENVIRONMENTAL COMPLIANCE

*The control and monitoring of the environmental impact of its activities is important to CERN. Due to its intergovernmental status, the Organization continuously collaborates with the competent authorities in both of its Host States to ensure that its environmental impact meets the requirements of their legal frameworks, and to resolve any problems encountered.*

## PREVENTING RADIOLOGICAL ENVIRONMENTAL ACCIDENTS

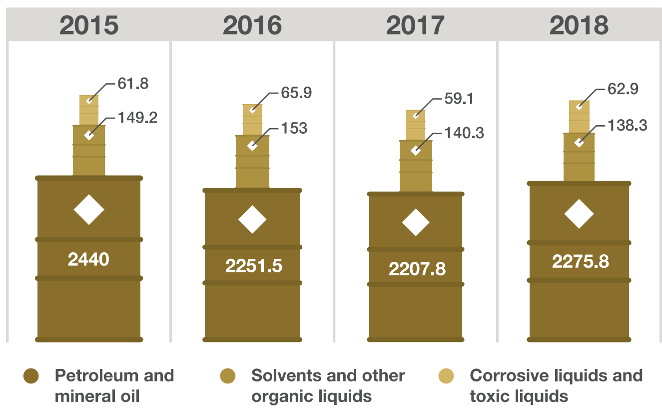
As a result of CERN's preventative approach and great expertise in radiation protection, no environmental accident related to radioactivity has ever been recorded at CERN.

## PREVENTING CONVENTIONAL ENVIRONMENTAL ACCIDENTS

CERN's HSE Unit is responsible for the environmental monitoring of chemical and other relevant parameters. The CERN Environmental Protection Steering Board, CEPS, is responsible for following up all environmental events, near misses, and remedial actions. CEPS also has responsibility for ensuring adequate measures for the prevention of environmental incidents.

During the period covered by this report, the Organization has not had any conventional pollution event that would have led to a fine or non-monetary sanction. However, there have been some water pollution events in the past. Lessons learnt from these incidents lead to improved early detection and intervention, and the establishment of an executive team for the Prevention of Pollution by Liquid Chemical Agents, PoLiChem. Moreover, communication and emergency preparedness with local authorities was reinforced. An environmental severity scale and an emergency intervention scheme were agreed upon with Host State authorities.

**TYPES AND VOLUMES OF LIQUID HAZARDOUS SUBSTANCES AT CERN.**
*Data from the PoLiChem inventory. Volume in cubic metres, m³.*




## MANAGEMENT OF HAZARDOUS SUBSTANCES

Hazardous substances with a pollution risk potential for soil and water are subject to the CERN Safety Rules on chemical agents. In addition, specific environmental measures are set according to the relevant Swiss and French regulations.

The PoLiChem executive team continuously updates the inventory of the quantities and types of liquid chemical agents present on-site and consolidates retention means following systematic risk assessments and their associated risk severity scores. During 2017 and 2018, the team reduced the number of high-risk cases by 66% through the implementation of various mitigation measures. Consolidation of the remaining cases is underway. Furthermore, replacing oil-filled transformers with dry transformers and consolidating related infrastructure was set as a priority for the Laboratory, starting in 2022.

### IN FOCUS

*Julien Régnard manages the HSE Unit's Instrumentation for Environmental Monitoring and Impact Assessment, INEMIA, project.*

***— How did INEMIA strengthen CERN's environmental monitoring?***

*JR: INEMIA strengthened, upgraded and extended CERN's network of environmental monitoring instruments. In June 2019, 69 measuring stations had been replaced and commissioned. The network has doubled since 2011 and now consists of 146 measuring stations generating more than 100 million data points per year. INEMIA will feed into future projects, and help us develop new technologies with cost reduction, increase precision and safety built in.*

# KNOWLEDGE AND TECHNOLOGY FOR THE ENVIRONMENT

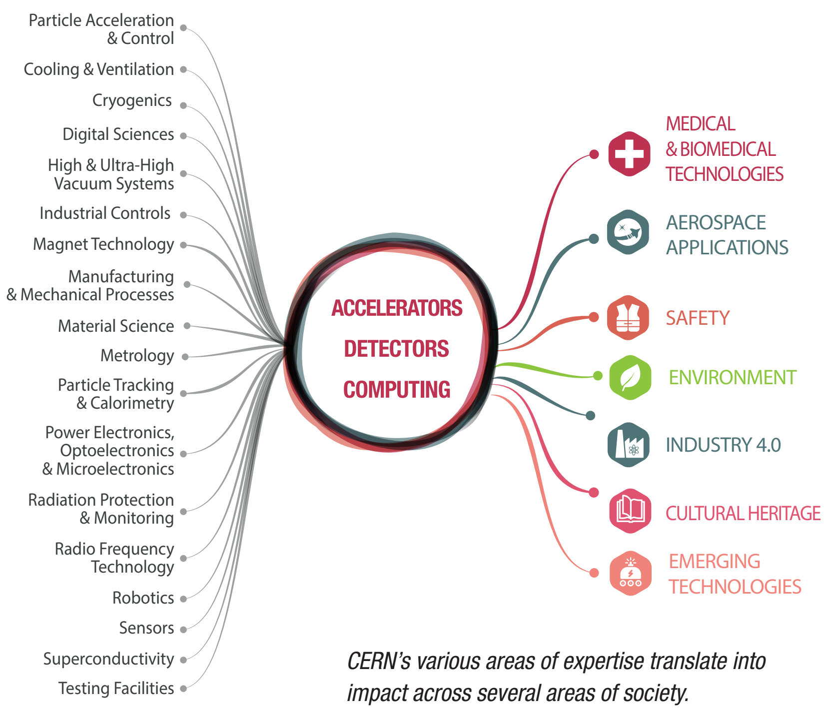
*CERN develops state-of-the-art technologies, some of which have considerable potential impact on society in many areas. To make sure these technologies reach this goal, CERN's Knowledge Transfer, KT, team has identified 18 CERN domains ranging from particle acceleration to robotics that have concrete applications in seven areas including the environment. The team actively engages with companies from start-ups to SMEs and large organisations. CERN also supports innovation through on-site activities and Business Incubation Centres. In addition to the ActiWiz software (p. 19), here are some more current projects addressing environmental issues.*

## REDUCING AIR POLLUTION FROM MARITIME TRAFFIC USING PARTICLE ACCELERATORS

Accelerator Research and Innovation for European Science and Society, ARIES, a European Commission co-funded project coordinated by CERN, is looking at ways to improve the performance, availability, and sustainability of particle accelerators. Through a competitive process, it has identified promising R&D projects for further support, one of which could contribute significantly to greening maritime transport. Maritime traffic is the backbone of global trade, but it also generates significant air pollution. One ARIES-supported project is testing a system to break down pollutants with an electron-beam accelerator before safely extracting them.

## IMPROVED WATER AND PESTICIDE MANAGEMENT WITH FIBRE OPTIC SENSORS

The Fibre Optic Sensor System for Irrigation, FOSS4I, collaboration uses particle detection technology from the CMS experiment at CERN to develop a smart water-saving solution for agriculture. FOSS4I's optimised irrigation system aims to monitor and measure temperature, humidity, concentration of pesticides, fertilisers and enzymes in the soil of cultivated fields, thus contributing to sustainable agriculture.




*CERN's various areas of expertise translate into impact across several areas of society.*

### IN FOCUS

*Silje Uhlen Maurset works with entrepreneurship development in CERN's Knowledge Transfer group, KT.*

***— What is CESP and how does it relate to a positive impact on the environment?***

*SUM: CERN's Entrepreneurship Student Programme, CESP, brings graduate students from around the globe for five-weeks of training with CERN experts and KT professionals. AquaVision is a project that has emerged from CESP. It is developing the first real-time detector for microplastics in water.*

*The detection of microplastics could help build better and more efficient water filtration solutions and raise awareness of the dangerous effects that microplastics can have on humans and the environment. CESP was instrumental in providing the student team with the range of skills needed to launch the project.*



## GRI CONTENT INDEX

For the Materiality Disclosures Service, GRI Services reviewed that the GRI content index is clearly presented and the references for Disclosures 102-40 to 102-49 align with appropriate sections in the body of the report. The service was performed on the English version of the report.

GRI Materiality Disclosures CERN Service Mar 2020

| Standards and Disclosures | Title | Pages / Informations |
|---|---|---|
| **GRI 101:2016 FOUNDATION** | | |
| **GRI 102:2016 GENERAL DISCLOSURES** | | |
| **Organizational Profile** | | |
| 102-1 | Name of the organization | 8 |
| 102-2 | Activities, brands, products, and services | 8, 24 |
| 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 organization | 8 |
| 102-8 | Information on employees and other workers | 8 |
| 102-9 | Supply chain | 8 |
| 102-10 | Significant changes to the organization and its supply chain | None |
| 102-11 | Precautionary Principle or approach | 10, 16 |
| 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 behavior | 9 |
| **Governance** | | |
| 102-18 | Governance structure | 9 |
| **Stakeholder Engagement** | | |
| 102-40 | List of stakeholder groups | 11 |
| 102-41 | Collective bargaining agreements | The CERN Staff Association represents the CERN personnel, which is an important stakeholder group to the Organization. The Association represents the entire staff body on the Tripartite Forum on Conditions of Employment (TREF). Besides the Staff Association, TREF is composed of representatives of the Member States and the Directorate. 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 2018 can be found at http://cds.cern.ch/record/2680368 on page 23. |
| 102-46 | Defining report content and topic Boundaries | 11 |
| 102-47 | List of material topics | 11 |
| 102-48 | Restatements of information | This is CERN's first GRI report. There are therefore no restatements of information. |
| 102-49 | Changes in reporting | This is CERN's first GRI report. There are therefore no changes in reporting. |
| 102-50 | Reporting period | This report covers the years 2017 and 2018. |
| 102-51 | Date of most recent report | This is CERN's first report. |
| 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, page 25 |

## GRI CONTENT INDEX

| Standards and Disclosures | Title | Pages / Informations | |
|---|---|---|---|
| 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. Regular exchanges with the Host State authorities take place within the framework of the tripartite committees for the environment and for radiation protection. | |
| **Topic-specific Standards** | | **Pages** | **Reason for omission** |
| **GRI 300: ENVIRONMENTAL** | | | |
| **GRI 302: 2016 ENERGY** | | | |
| GRI 103: 2016 103-1/ 103-2/ 103-3 | Management approach | 12 | |
| 302-1 | Energy consumption within the organization | 12, 13 | |
| 302-2 | Energy consumption outside of the organization | 12, 13 | |
| **GRI 303: 2018 WATER AND EFFLUENTS** | | | |
| GRI 103: 2016 103-1/ 103-2/ 103-3 | Management approach | 20 | |
| 303-1 | Interactions with water as a shared resource | 20, 21 | |
| 303-2 | Management of water discharge-related impacts | 20, 21 | |
| 303-3 | Water withdrawal | 20, 21 | |
| 303-4 | Water discharge | 20, 21 | |
| 303-5 | Water consumption | 20 | |
| **GRI 304: 2016 BIODIVERSITY** | | | |
| GRI 103: 2016 103-1/ 103-2/ 103-3 | Management approach | 22 | |
| 304-4 | IUCN Red List species and national conservation list species with habitats in areas affected by operations | 22 | |
| **GRI 305: 2016 EMISSIONS** | | | |
| GRI 103: 2016 103-1/ 103-2/ 103-3 | Management approach | 14 | |
| 305-1 | Direct (Scope 1) GHG emissions | 14, 15 | |
| 305-2 | Energy indirect (Scope 2) GHG emissions | 14, 15 | |
| **GRI 306: 2016 EFFLUENTS AND WASTE** | | | |
| GRI 103: 2016 103-1/ 103-2/ 103-3 | Management approach | 19 | |
| 306-2 | Waste by type and disposal method | 18 | |
| **GRI 307: 2016 ENVIRONMENTAL COMPLIANCE** | | | |
| GRI 103: 2016 103-1/ 103-2/ 103-3 | Management approach | 23 | |
| 307-1 | Non-compliance with environmental laws and regulations | 23 | |
| **CERN-SPECIFIC** | | | |
| HAZARDOUS SUBSTANCES | | | |
| GRI 103: 2016 103-1/ 103-2/ 103-3 | Management approach | 23 | |
| IONISING RADIATION | | | |
| GRI 103: 2016 103-1/ 103-2/ 103-3 | Management approach | 16 | |
| MOBILITY | | | |
| GRI 103: 2016 103-1/ 103-2/ 103-3 | Management approach | 15 | |
| NOISE | | | |
| GRI 103: 2016 103-1/ 103-2/ 103-3 | Management approach | 17 | |
| RADIOACTIVE WASTE | | | |
| GRI 103: 2016 103-1/ 103-2/ 103-3 | Management approach | 19 | |

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