HOW TO LIMIT THE ENVIRONMENTAL IMPACT

Mar Capeans

EDMS 2735914

OUTLINE

Environmental protection at CERN

Reporting

Targets

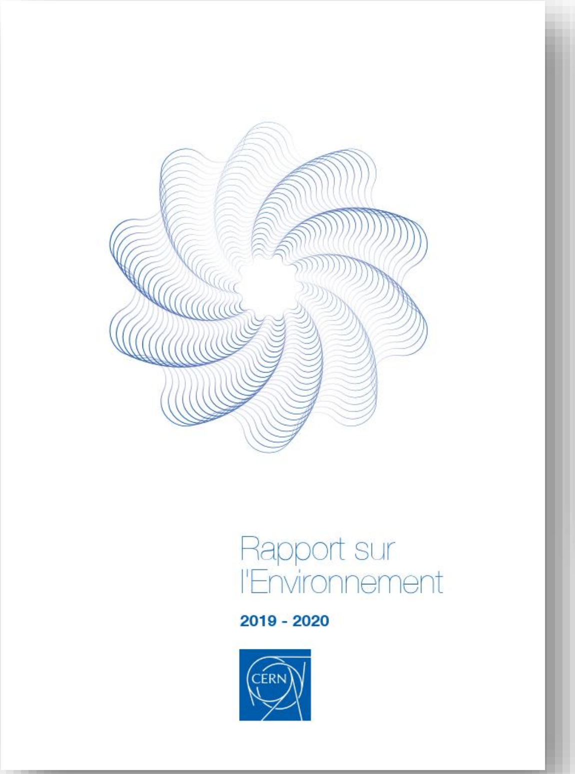
Actions

Site development

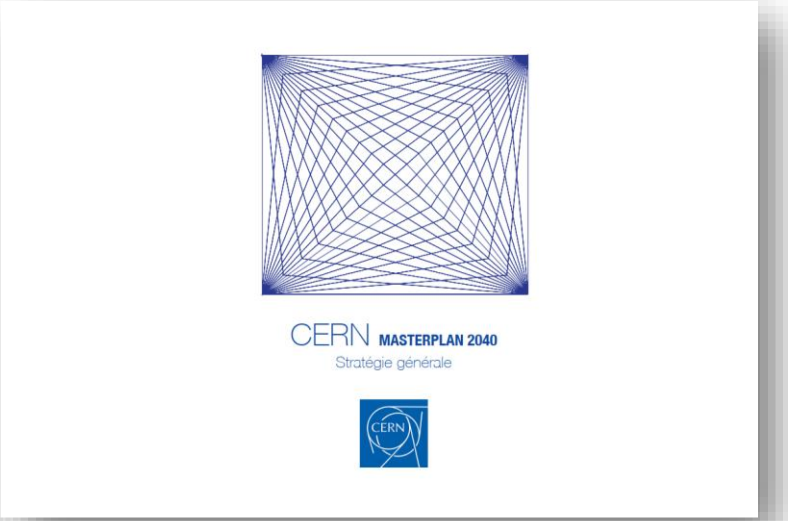
Future

Outlook

CERN Environmental Reports



CERN Masterplan 2040



ACKNOWLEDGEMENTS

B. Delille and S. Kleiner, CERN Health, Safety and Environmental Unit, **E. Cennini**, CERN Industry, Procurement and Knowledge Transfer, **N. Bellegarde and S. Claudet**, CERN Accelerator & Technology Sector, **FCC team, CLIC team**, CERN **Site and Civil Engineering Department team**

KEY FIGURES

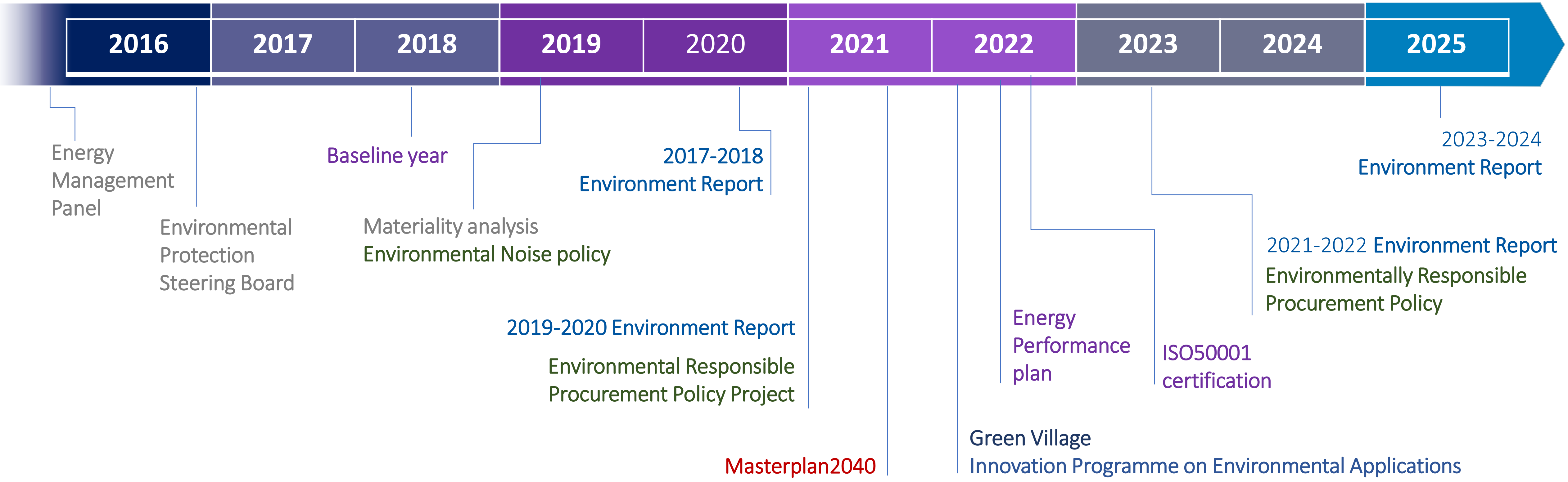
- 590 ha (220 fenced)
- 2 main sites and 15 satellite sites
- 670 buildings from 10 m^2 to 20.000 m^2
- 65% built before the 70’s
- 70 km tunnels and 80 caverns
- 30 km roads
- 1000 km technical galleries and trenches

- 9000 persons/daily
- 490 hostel rooms
- 8500 working places
- 4300 parking places in Meyrin, 1400 in Prévessin
- 25000 daily movements to- and inter-sites
- Public transport links in CH, not in FR

STRATEGY

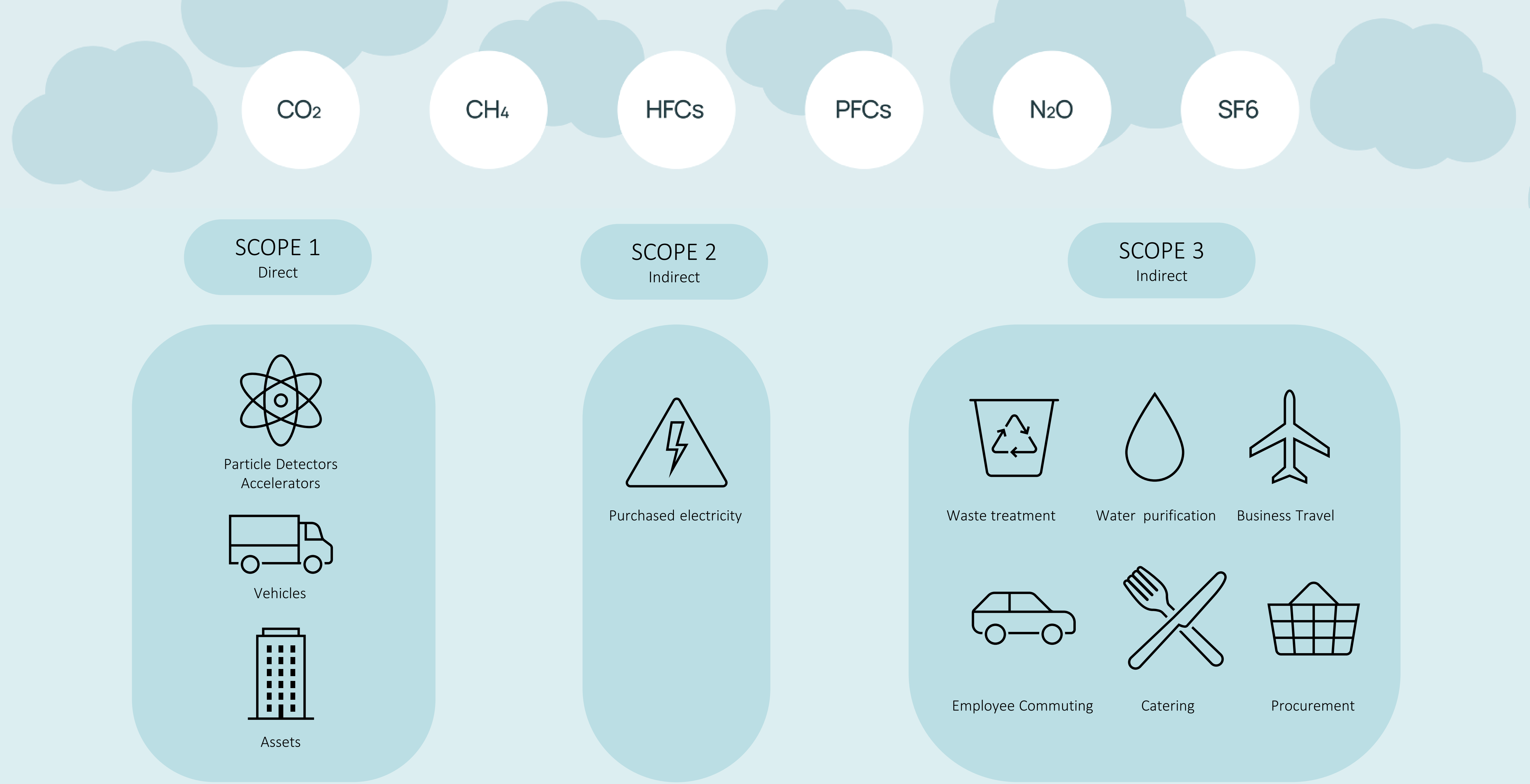
- Involving the entire organization
  - Environment included in CERN's main objectives for 21-25
  - Strong strategic direction from the DG, endorsed by Council and supported by enthusiastic efforts throughout the organization
  - Increasing accountability and governance
- Generating transparent and reliable reporting
  - Materiality assessment and stakeholder review
  - Reporting on GHG emissions since 2019, Global Reporting Guidelines (GRI)
- Acting
  - Setting targets
  - Global strategy with objectives and measures that take up the framework objectives and translate them into operational prioritized measures

STRATEGIC ACTIONS



MATERIALITY

Significance for external stakeholders / Significance for CERN	MEDIUM	HIGH
HIGH	Natural resources and biodiversity Water consumption	Energy consumption Greenhouse gas emissions Mobility Ionising radiation Radioactive waste Effluent quality Prevention of environmental accidents Hazardous substances
MEDIUM	Environmental impact of procurement Legionella treatment Material consumption Non-ionising radiation Sewer system Soil protection	Noise Conventional waste



CO_2
CH_4
HFCs
PFCs
N_2O
SF6
SCOPE 1
Direct
Particle Detectors
Accelerators
Vehicles
Assets
SCOPE 2
Indirect
Purchased electricity
SCOPE 3
Indirect
Waste treatment
Water purification
Business Travel
Employee Commuting
Catering
Procurement

AT A GLANCE CERN AND THE ENVIRONMENT 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)*.

TARGETS 2025

GHG Emissions

Reduction by 28%

Energy Consumption

Limit raise by 5%

Water Consumption

Limit raise by 5%

ENGAGEMENTS

Waste

Increase recycling rate

Noise

Restrict

Commuting

Constant

Biodiversity

Protect

GHG EMISSIONS

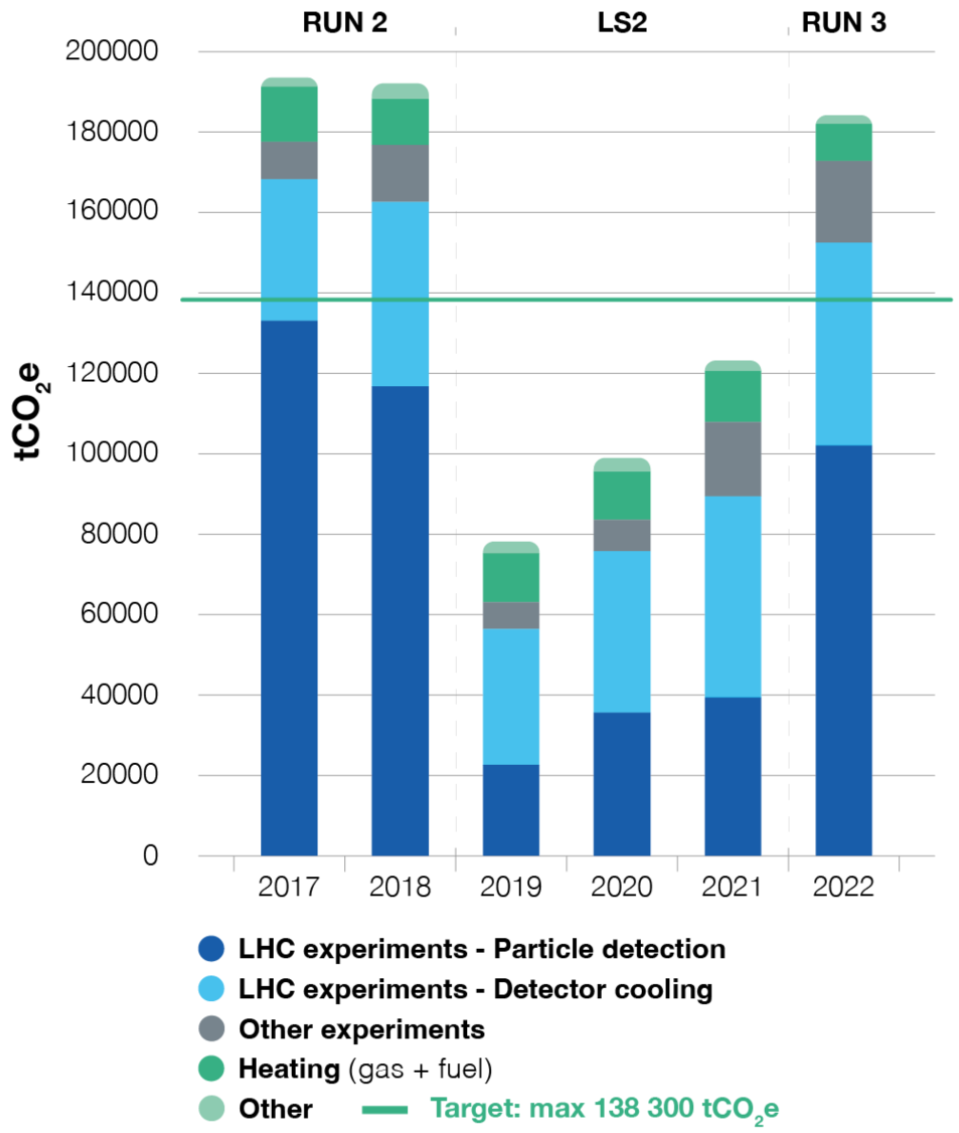
Detector cooling

Systems using F-gases will be stopped by end of Run3 and replaced by CO_2 cooling for Run4

With forecasted reduction ~40’000 tCO_2e/year

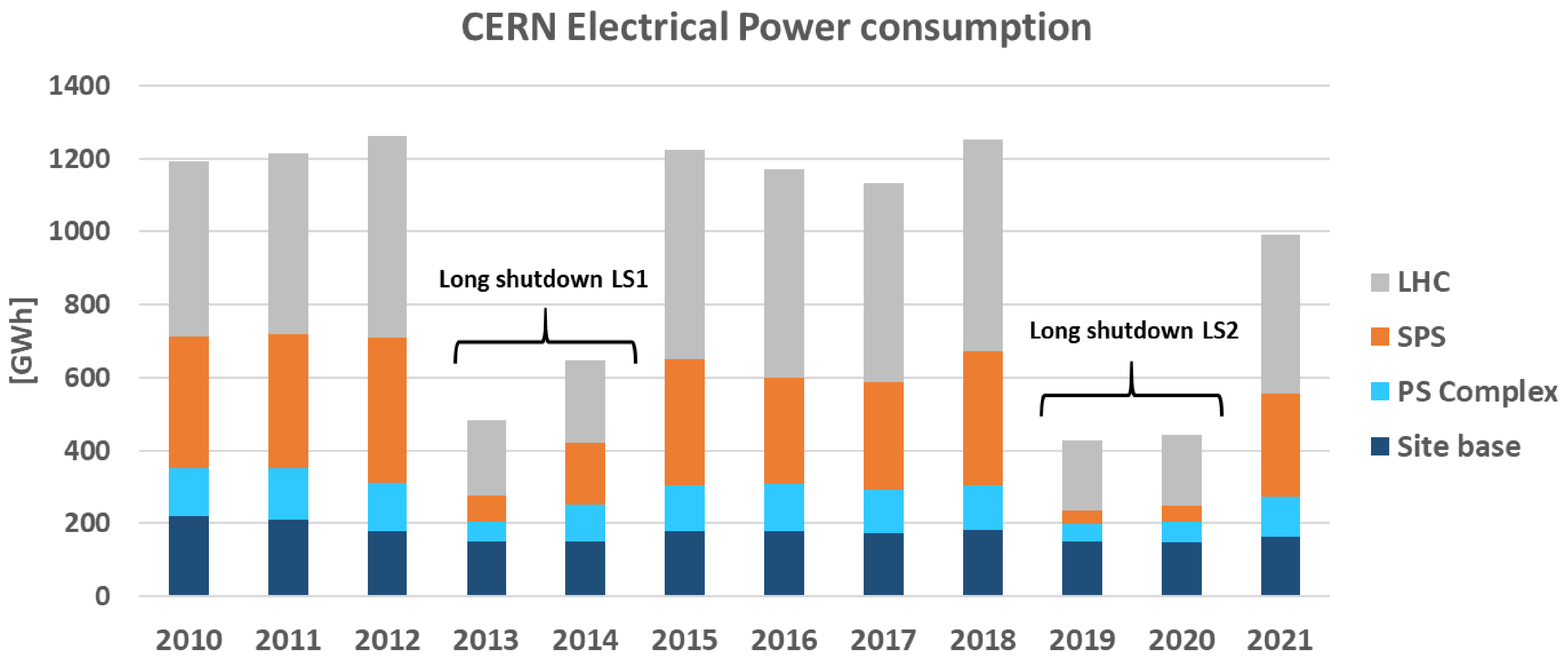
Particle detection (gases)

Reduction target ~13’000 tCO_2e/year



CERN SCOPE 1 EMISSIONS FOR 2017–2022 BY CATEGORY. “Other” includes air conditioning, electrical insulation, emergency generators and the fuel consumption of the CERN vehicle fleet.

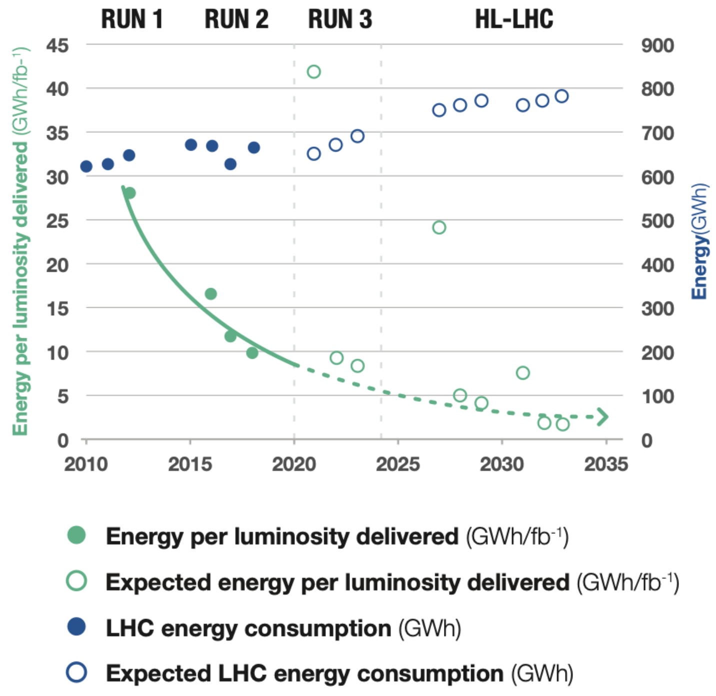
SCOPE 2: INDIRECT EMISSIONS



SCOPE 2: ACTIONS ON ENERGY CONSUMPTION

INCREASE EFFICIENCY

- Savings up to ~100 GWh/y since 2010
- LHC high availability at ~constant energy consumption

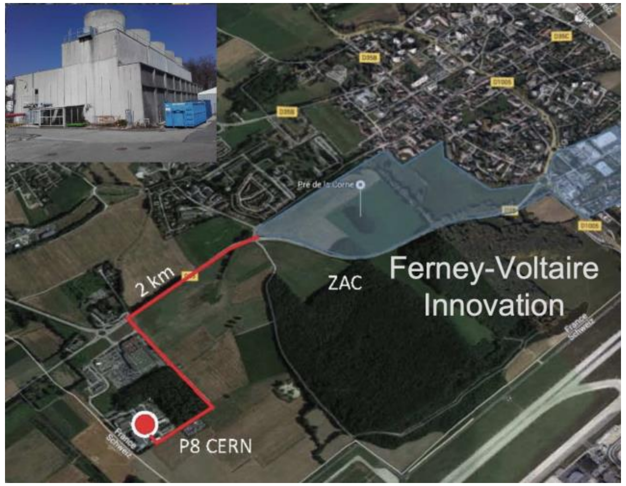


USE LESS

- Technology: PS East area power converters designed to supply the magnets on a cyclical basis, with an energy-recovery stage between each cycle resulting into 90% electricity consumption reduction: (11 to 0.6 GWh/y)
- Campus: Building Global renovations for reduction of losses (energy, water, gas, cooling), densifying occupation
- Annual Virtual Energy Bills
- Energy performance plan & ISO50001

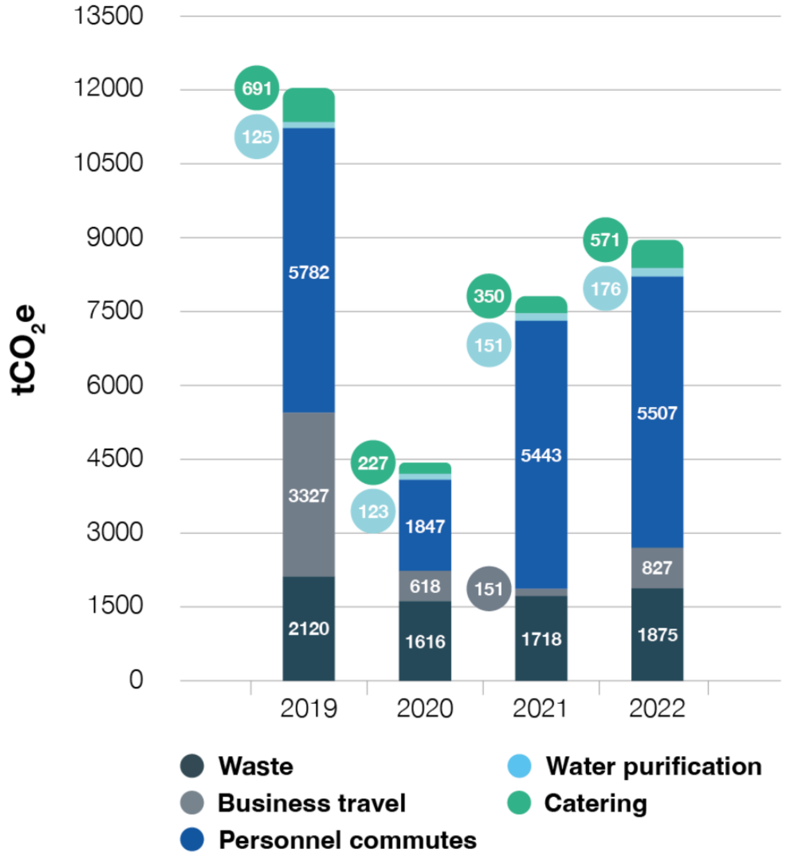
RECOVER

- Hot water from LHC cooling system (P8, 2 x 5 MW heat exchangers) to heat up a residential area (*20 GWh/y at peak*).

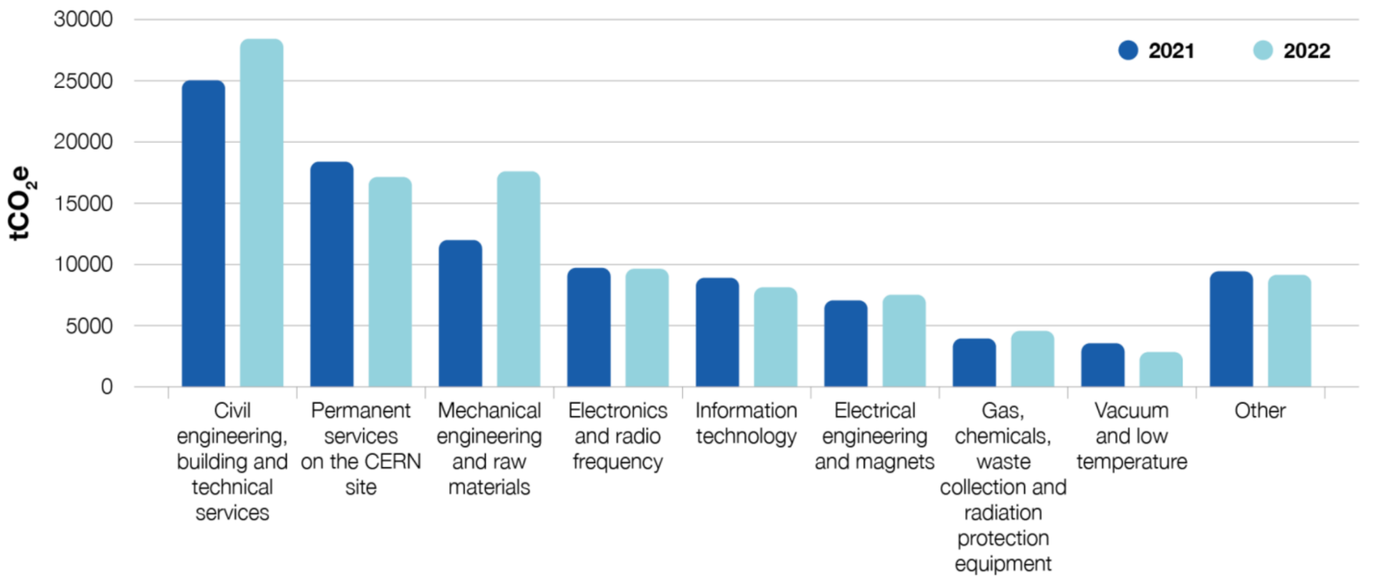


- PCC to heat Prevessin CERN site (3-4 MW)
- LHC Cooling towers at P1 to heat Meyrin CERN site (5-10 MW)

SCOPE 3: INDIRECT EMISSIONS



CERN'S SCOPE 3 EMISSIONS 2019–2022 (EXCLUDING PROCUREMENT). "Waste" includes the waste that is sent through the different elimination pathways, as well as the water that is sent to wastewater treatment plants. For emissions related to business travel and personnel commutes, only personnel on CERN's payroll are included. The calculation methodology is aligned with the GHG protocol; the emission factors were retrieved from the Ecoinvent database, and the impact method used was IPCC 2021 GWP100 V1.01. All data from previous reporting years have been recalculated for this report. Emissions arising from procurement are not included and are reported separately.



EMISSIONS BY PROCUREMENT FAMILY 2021–2022. "Other" includes: office supplies, furniture, transport, handling and vehicles; centralised expenses and codes for internal use; particle and photon detectors; health, safety and environment; optics and photonics.

SCOPE 3: ACTIONS

CERN Environmental Responsible Procurement Policy Project (2021)

Courtesy E. Cennini

Challenge the need!

As user/owner?
Functional approach
KPIs e.g. % recycled
Buy/Partner/Make

WHY BUYING

HOW DO WE BUY

Fair competition
Payment deadline

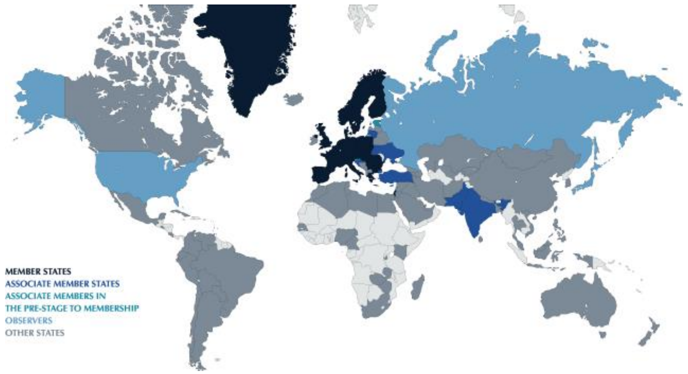
Reasoned negotiation
Suppliers’ performance
Respect of commitments

SUSTAINABLE PROCUREMENT

WHAT DO WE BUY

Polluting materials?
Carbon footprint?
Social impact?

Eco-design/Life Cycle Analysis
Resource optimization (water/energy)
Total Cost of Ownership (TCO)



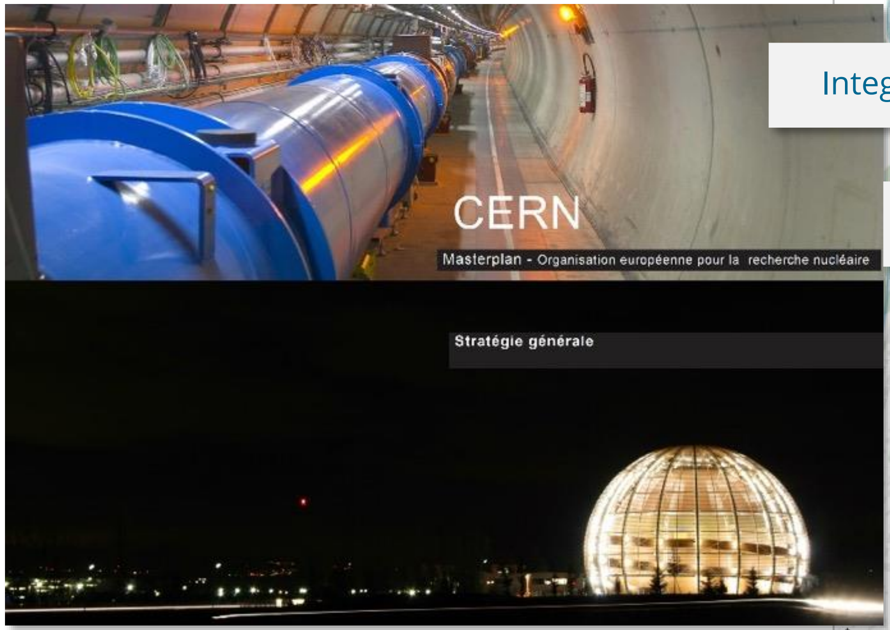
WHO WE BUY FROM

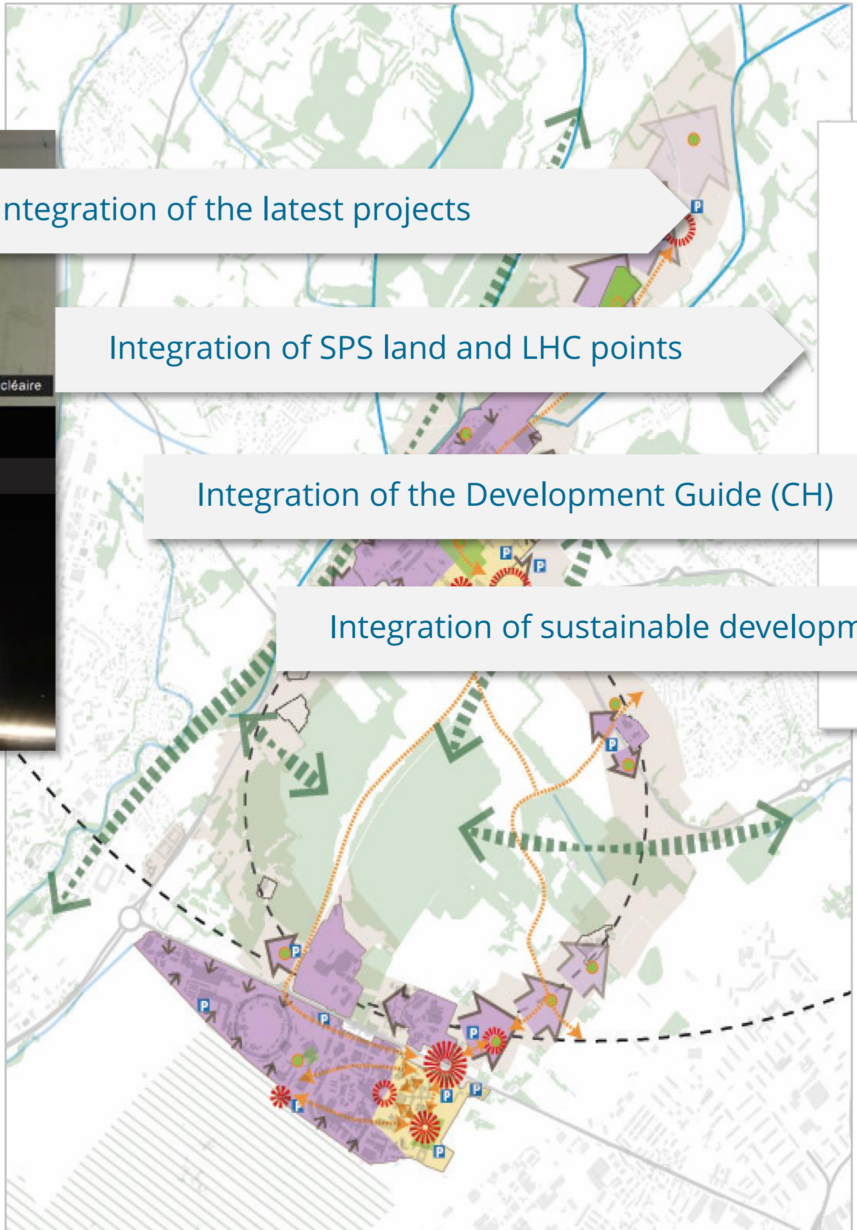
Countries/people exposed
Duty of vigilance/Compliance

(Very) Poorly balanced Countries
Labels/Certification
Local purchase/Diversity

ISO 20400

CERN MASTERPLAN2040





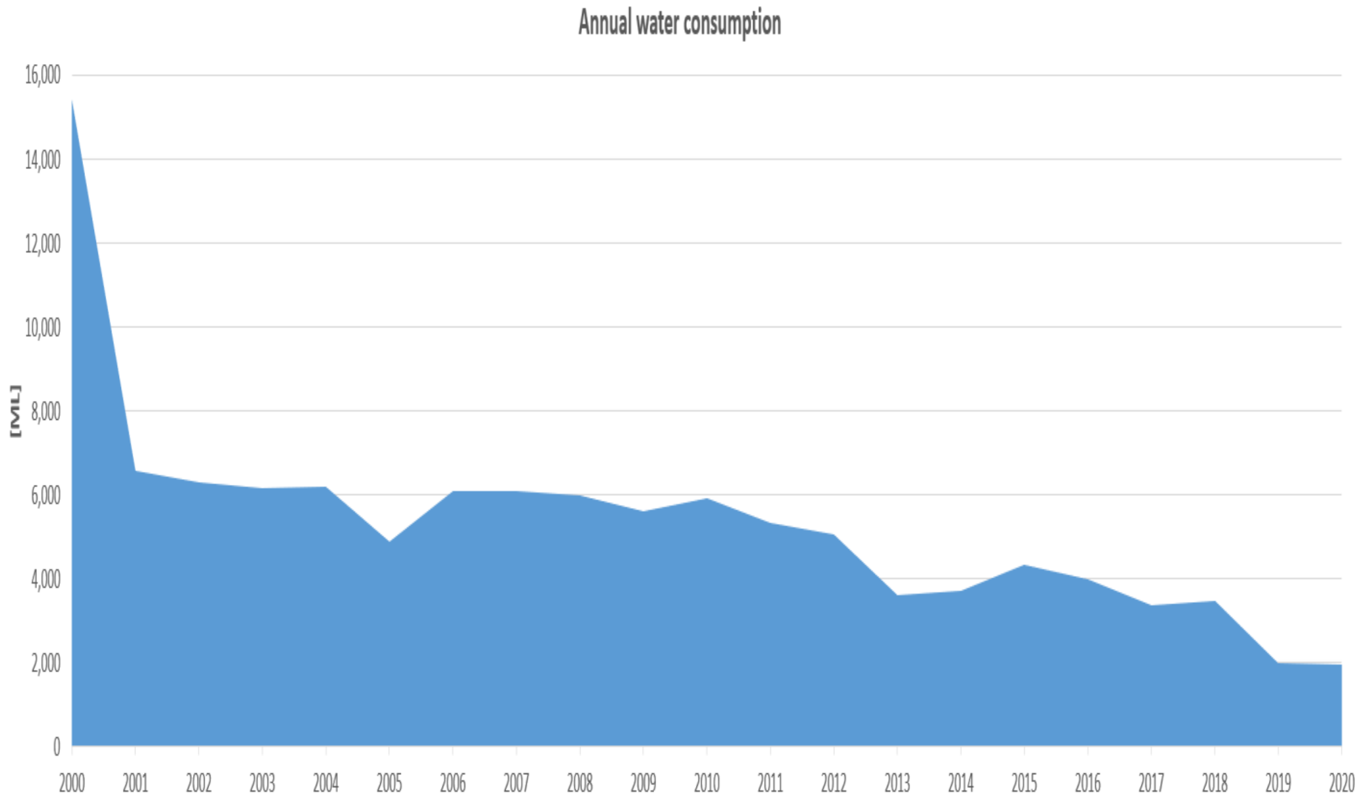
- Integration of the latest projects
- Integration of SPS land and LHC points
- Integration of the Development Guide (CH)
- Integration of sustainable development

MASTERPLAN2040

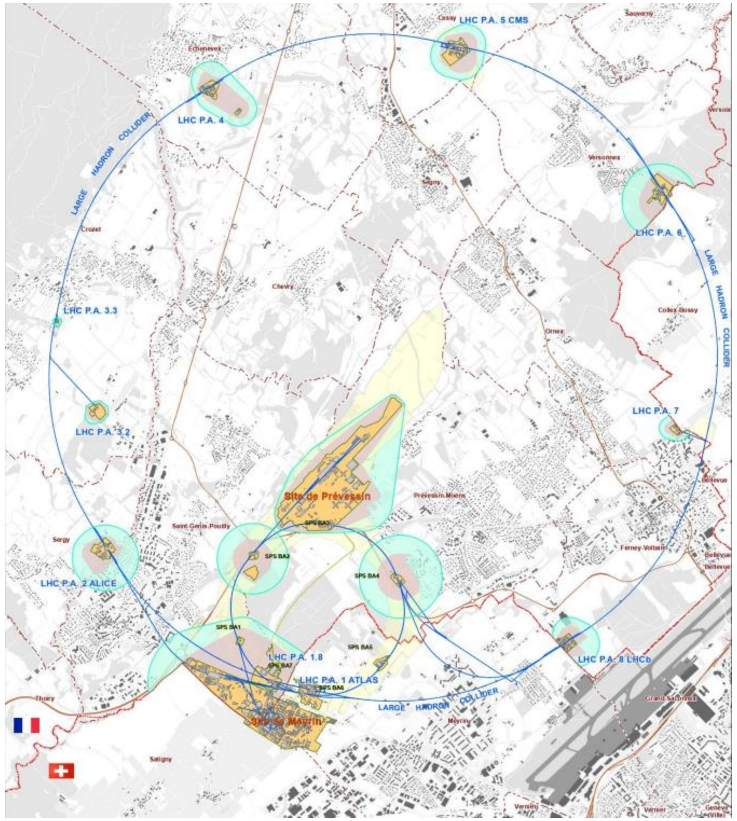
Framework objectives and measures

MASTERPLAN 2040: Environment

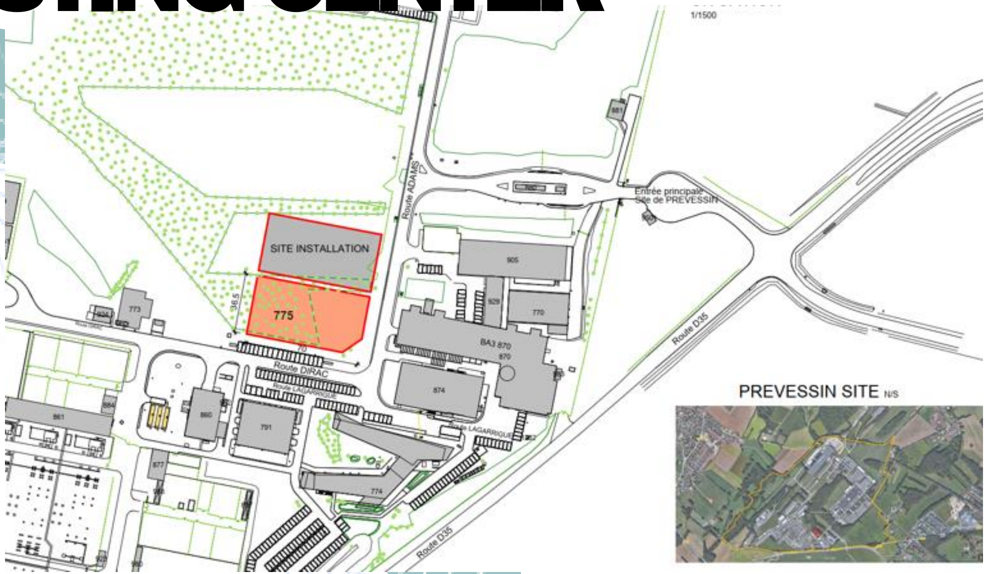
WATER



NOISE



PREVESSIN COMPUTING CENTER



Initial capacity of 4 MW available for IT equipment with stepwise future increases to 12 MW.

To meet CERN's environmental goals the project incorporates the following considerations :

- Designed to be energy efficient with a target PUE (Power Usage Efficiency) of 1.10 (1.15 contractual)
- Optimised water consumption via a recirculation system lowering consumption in hot periods
- All cleared vegetation will be reconsolidated
- The acoustic study used for design of the building follows CERN commitments
- A heat recovery system is foreseen for up to 25% of power produced to be recovered
- Green terrace on the roof

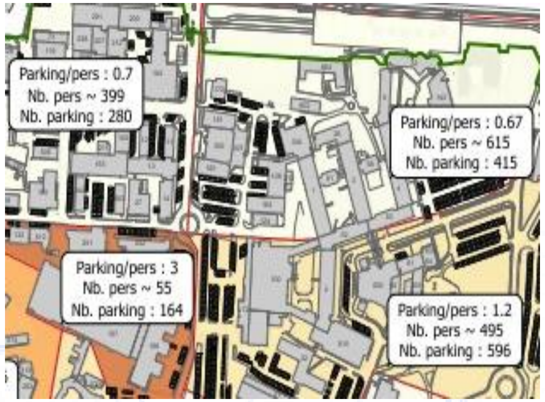
MOBILITY

STRATEGIC PRINCIPLES

- Focus on people needs
- Integrate transport modes
- Adaptable to the future needs of the organization
- Sustainable and eco-responsible
- Communicate, cooperate with local actors, and involve the community

ROADMAP

- Data driven
- Targets
- KPIs



ACTIONS

- Eliminate abandoned vehicles (2021)
- 10 km Cycle paths (2020)
- +40% Bike parkings (2022)
- 2 E-charging stations (2022)
- 80 E-bikes (2021)
- Increased car-sharing (2022)
- Optimization of the car fleet (2023)
- Modal points at < 5min walk
- Mobility Report (2022 and yearly)

TECHNOLOGY & ENVIRONMENT

INNOVATION PROGRAMME ON ENVIROMENTAL APPLICATIONS

FROM CERN TO SOCIETY

CIPEA: Developing advanced technologies linked to environment and sustainability

E.g. solar thermal panels derived from vacuum technology; CO_2 cooling technology; superconductive power transmission lines and current leads

GREEN VILLAGE

FROM SOCIETY TO CERN TO SOCIETY

- Enabling **rapid access to CERN campus as a test site** for technologies linked to environment and sustainability
- Accelerating the commercialization of ideas, technologies and prototypes
- Involving Young Innovators (new ideas for unforeseen applications)

- Challenges: waste management, mobility, energy efficiency for tertiary activities on campus, space management, IoT, Zero-waste, urban analytics, …

FUTURE STUDIES & ENVIRONMENT

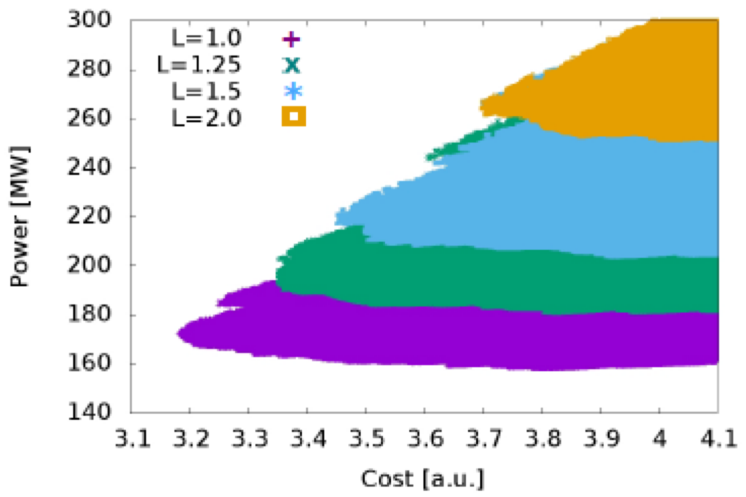
FCC

- Integration of an "Eco-design" from the first conceptual design phase onwards, balancing Scientific excellence, Territorial compatibility, Implementation and operation
- The environmental evaluation process follows **"Avoid-Reduce-Compensate"**; includes geology, urbanism, society health and safety, technical development and risks…
- Iterative co-development with the Host State partners on high-priority topics such as:
  - Consumption of resources: land, soil, water
  - Limitation of impacts, e.g. re-use of excavated materials, reduction of surface footprints, energy efficient designs, reduction of traffic and nuisances during construction
  - Creation of added value, e.g. supply of waste heat, sharing of technical infrastructures (e.g. electricity, telecommunications, water supply and treatment)

CLIC

Approaches to increase sustainability:

- Overall system design
  - Compact (short) accelerator -> high gradient
  - Energy efficient -> low losses
  - Effective -> small beam sizes
- Subsystem and component design, e.g.
  - High-efficiency klystrons, permanent magnets
  - Heat-recovery in tunnel linings
- Sustainable operation concepts
  - Recycle energy (heat recovery)
  - Adapt to regenerative power availability, Exploit energy buffering potential



SUMMARIZED AMBITIONS

Reduce direct emissions by 28%
ENERGY: limiting rises in electricity consumption to 5%
WATER: increase in water consumption below 5%

Control water effluents (CH)
Closed/loop and recycling of cooling water from Cooling towers

2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030

Reduce professional travel

100% Inventory of CERN areas of biological interests

Reduce car fleet
Potential reduction ~ 500 tCO2e/y

Control water effluents (FR)

40’000 m² new Green Space
40’000 m² Renovated buildings

Sustainable heating plants
Heat recovery from data centre in Prévessin and cooling towers at LHC PA1
Potential reduction ~1’900 tCO_2e/y and ~6’000tCO_2e/y

CO2-based detector cooling
Potential reduction ~40’000 tCO_2e

Particle detection (gases)
Reduction target ~13’000 tCO_2e

OUTLOOK

- CERN's strategy **with respect to environment and sustainability is based on three lines of action:**
  - Reduce the laboratory's impact on the environment with comprehensive CO_2 footprint evaluation and commitment to decrease it,
  - Reduce energy consumption and increase energy recovery,
  - Develop technologies that can help society to preserve the planet.

- **Actions to reduce environmental impact** require long planning, often long-lead execution and RoI; ambition and long-term planning with short-term actions are crucial. A selection of programs for improving existing infrastructures is a way to put into practice the good intentions, and to acquire expertise.

- Scientific/research organizations are often 'special' but their environment and sustainability challenges are similar; knowledge exchange on carbon accountings and sharing experiences on reduction actions is important.

- Future large-scale science projects will need to carefully address energy management and sustainability, e.g. energy efficiency, energy recovery and carbon accounting; at all levels, from design decisions through construction to operation and decommissioning plans.