Addressing the Green Innovation Challenge

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CERN

OUTLINE

Environmental protection at CERN

Reporting

Targets

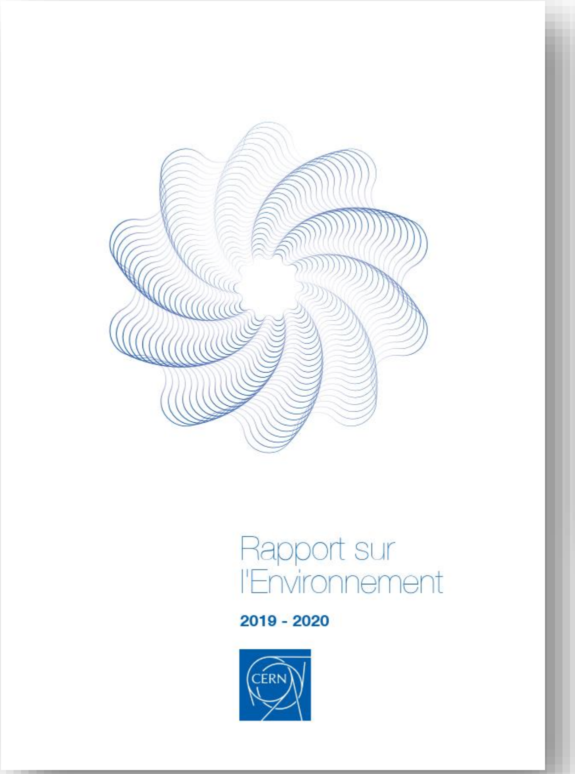
Actions

Site development

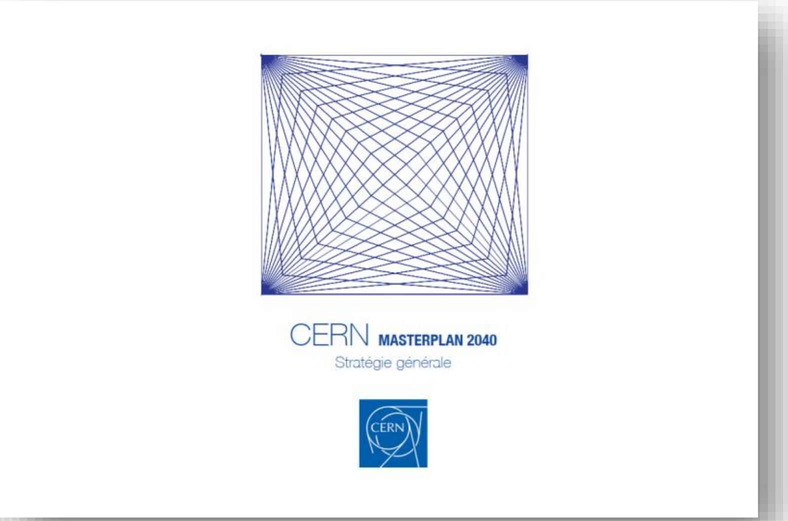
Future

Outlook

CERN Environmental Reports



CERN Masterplan 2040



ACKNOWLEDGEMENTS

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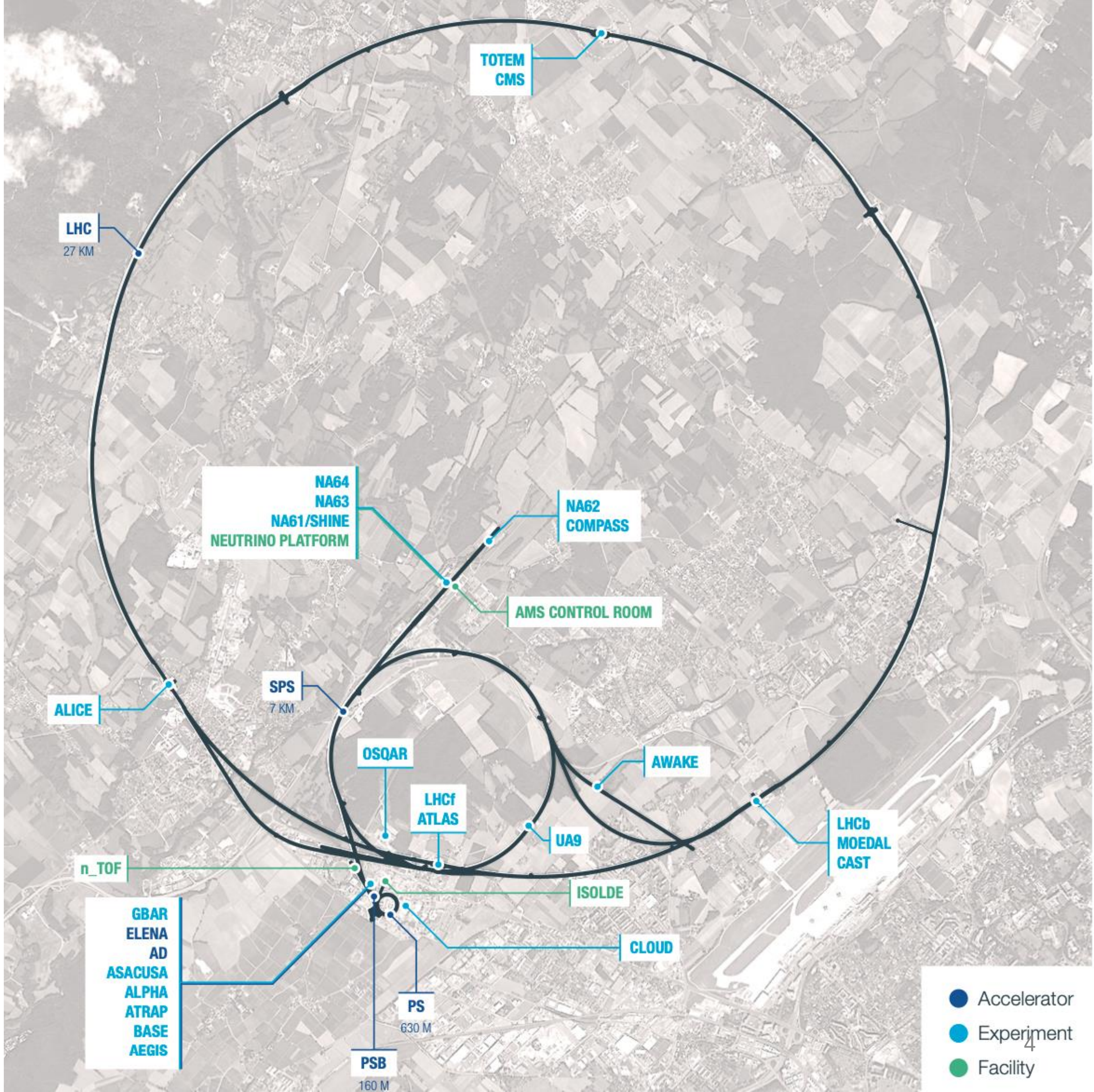
CERN

- 23 Member States
- 3600 employees
- 12'500 scientists (110 nationalities) using the Laboratory's facilities
- 35 Non-Member States with Co-operation agreements with CERN
- 1200 MCHF annual budget



KEY FIGURES

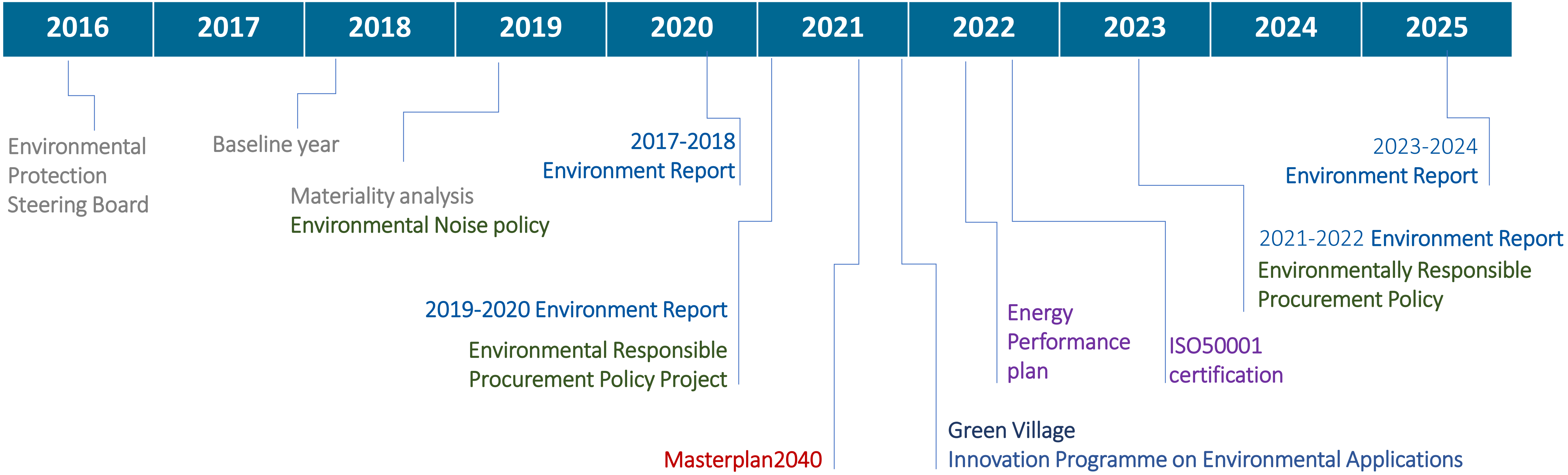
- 590 ha (220 fenced)
- 2 main sites and 15 satellite sites
- 670 buildings from 10 m^2 to 20.000 m^2
- 65% built before the 70’s
- 70 km tunnels and 80 caverns
- 30 km roads
- 1000 km technical galleries and trenches

- 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

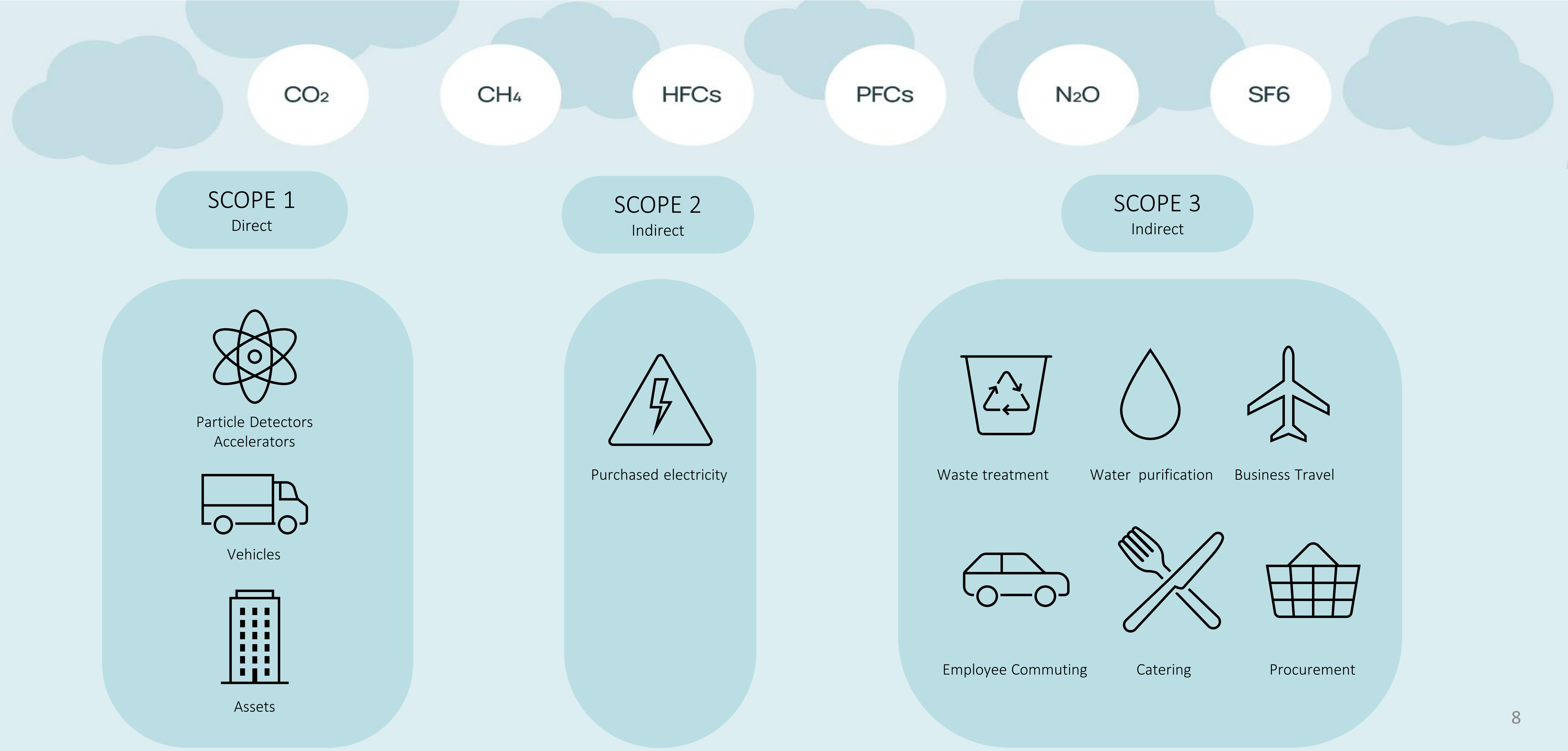
STRATEGY

- ## 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



MEASURING


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

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)*

AT A GLANCE CERN AND THE ENVIRONMENT IN 2018

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

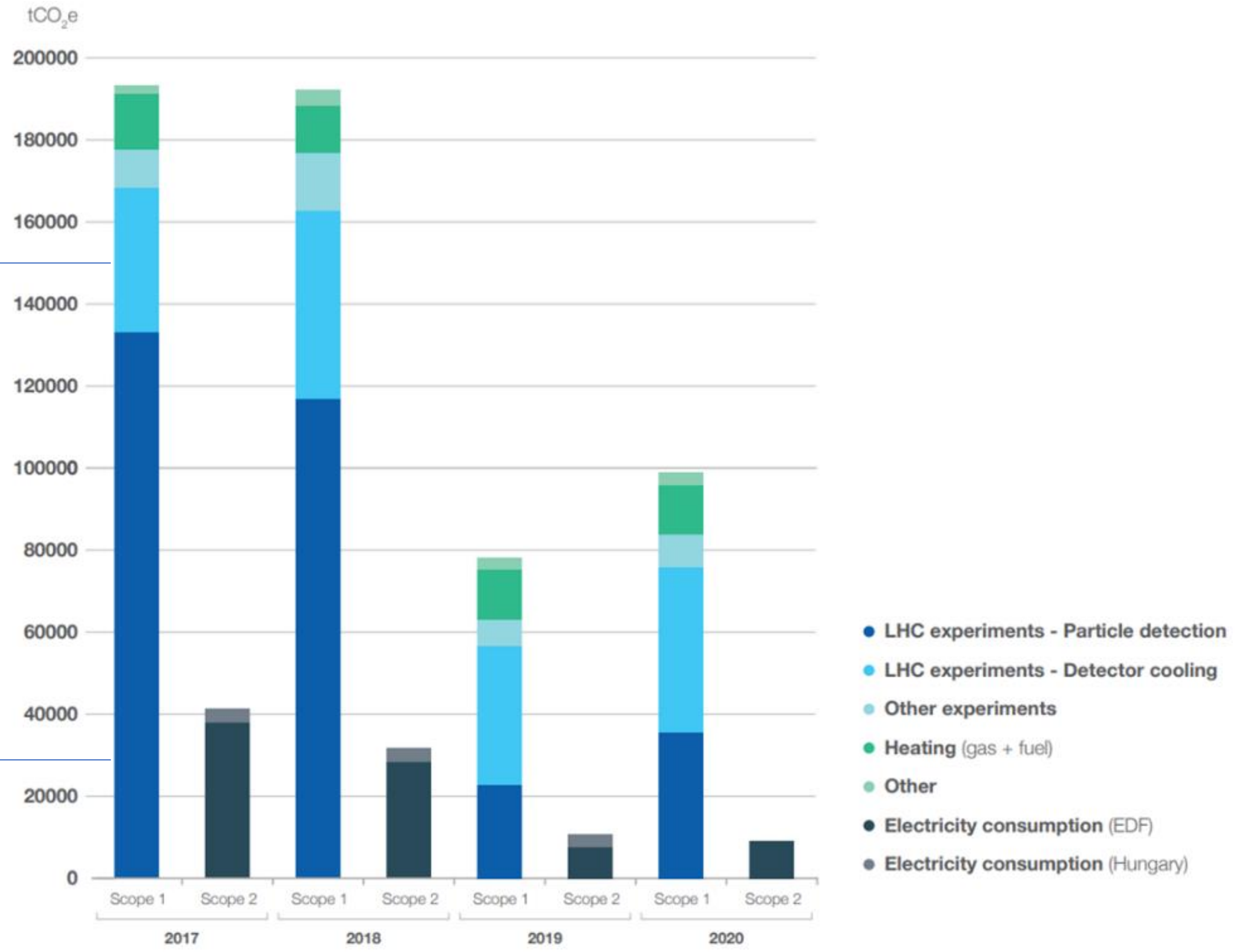
Detector cooling

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

Forecasted reduction ~40’000 tCO_2e/year

Particle detection (gases)

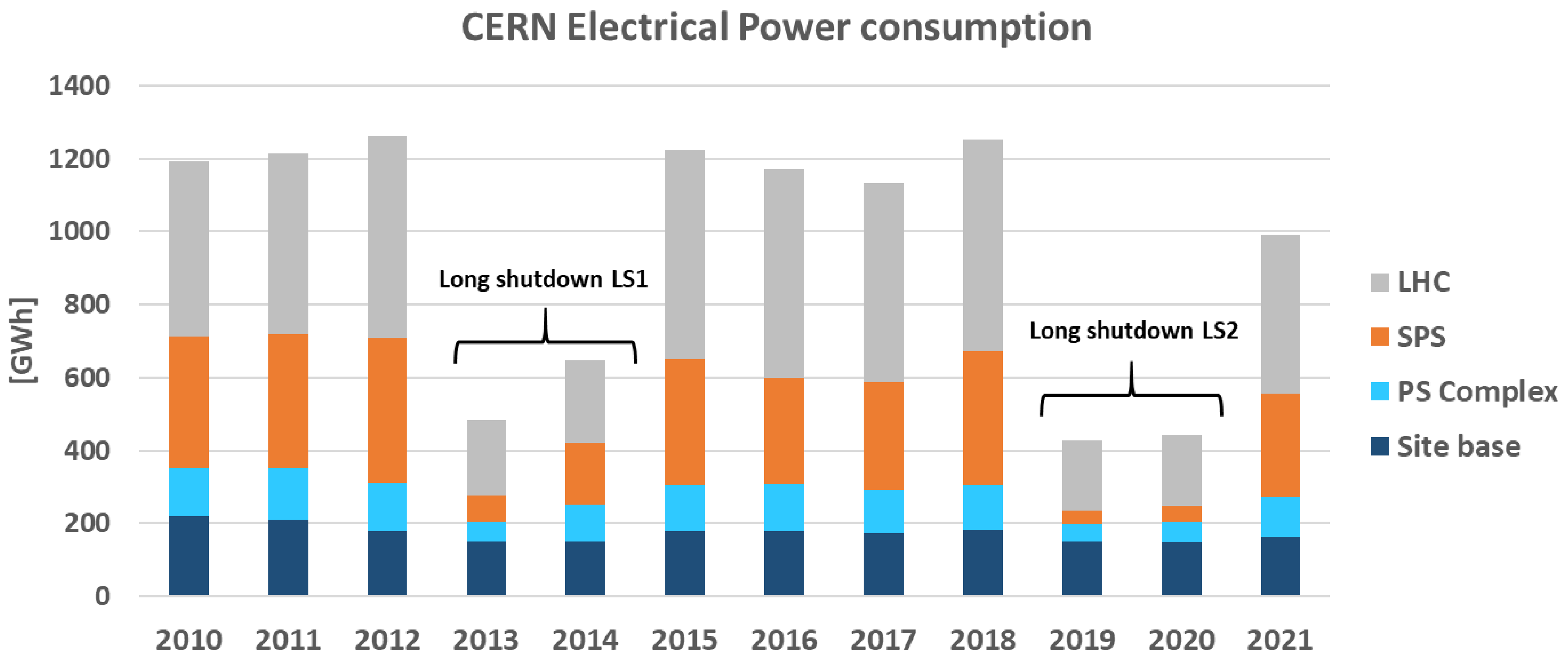
Reduction target ~13’000 tCO_2e/year



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

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

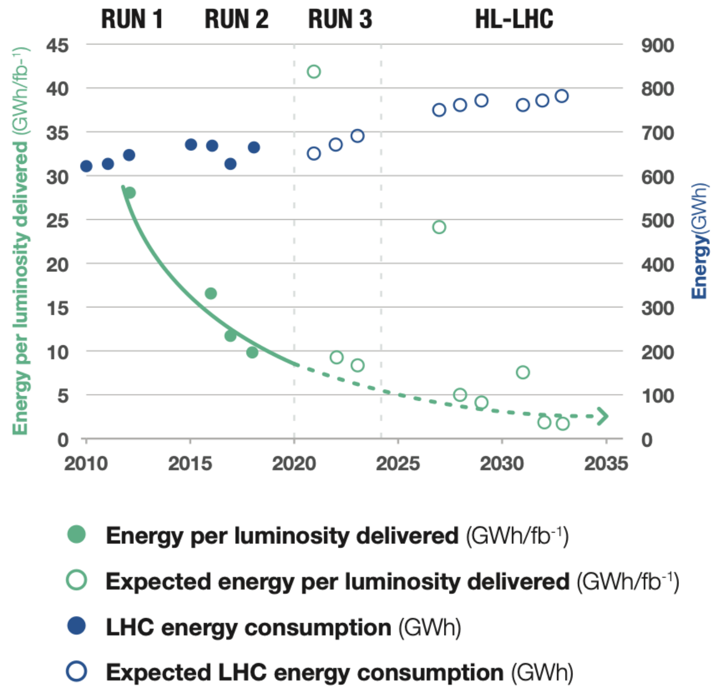
SCOPE 2: INDIRECT EMISSIONS



SCOPE 2: ACTIONS ON ENERGY CONSUMPTION

INCREASE EFFICIENCY

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

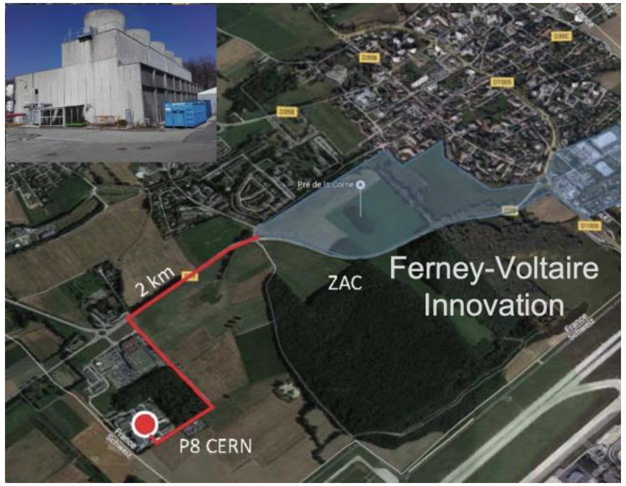


USE LESS

- 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

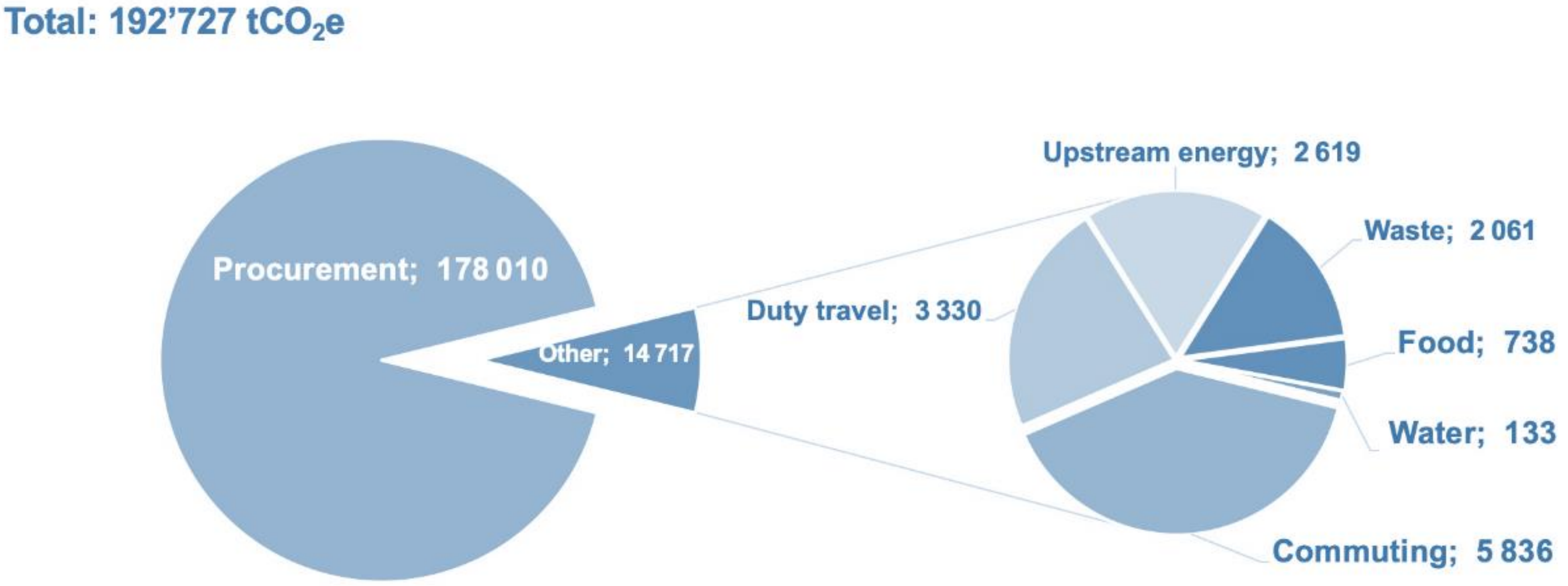
RECOVER

- 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



SCOPE 3: ACTIONS

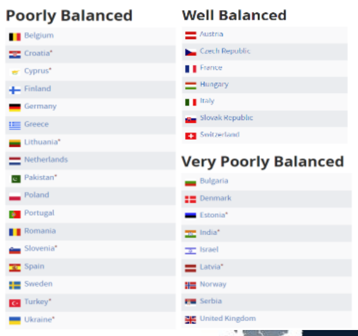
CERN Environmental Responsible Procurement Policy Project (2021)

Courtesy E. Cennini

Challenge the need!

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

WHY BUYING

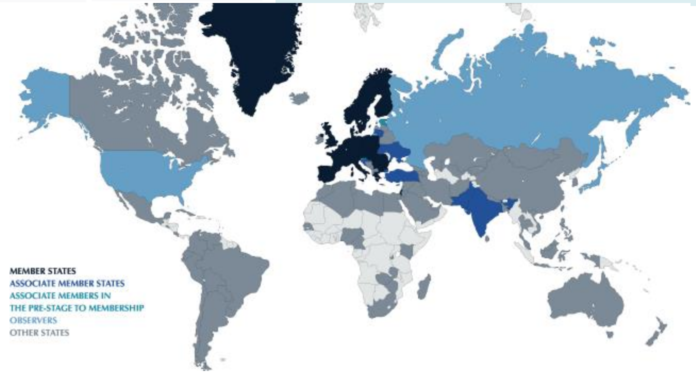


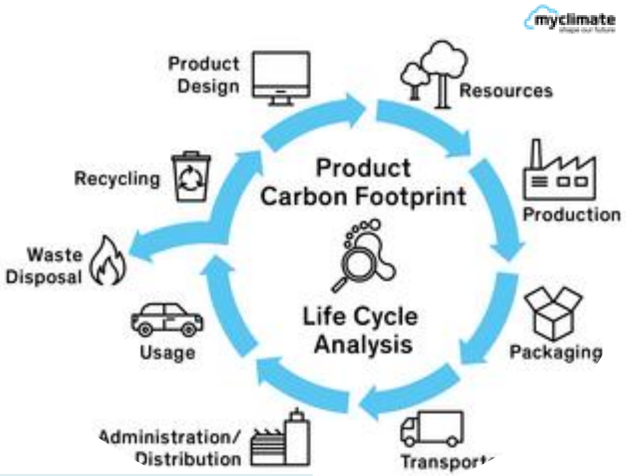
Poorly Balanced	Well Balanced	Very Poorly Balanced
Belgium	Austria	Bulgaria
Croatia*	Czech Republic	Denmark
Cyprus*	France	Estonia*
Finland	Hungary	India*
Germany	Italy	Israel
Greece	Slovak Republic	Latvia*
Lithuania*	Switzerland	Norway
Netherlands		Serbia
Pakistan*		United Kingdom
Poland		
Portugal		
Romania		
Slovenia*		
Spain		
Sweden		
Turkey*		
Ukraine*		

Countries/people exposed
Duty of vigilance/Compliance

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

WHO WE BUY FROM





WHAT DO WE BUY

Polluting materials?
Carbon footprint?
Social impact?

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

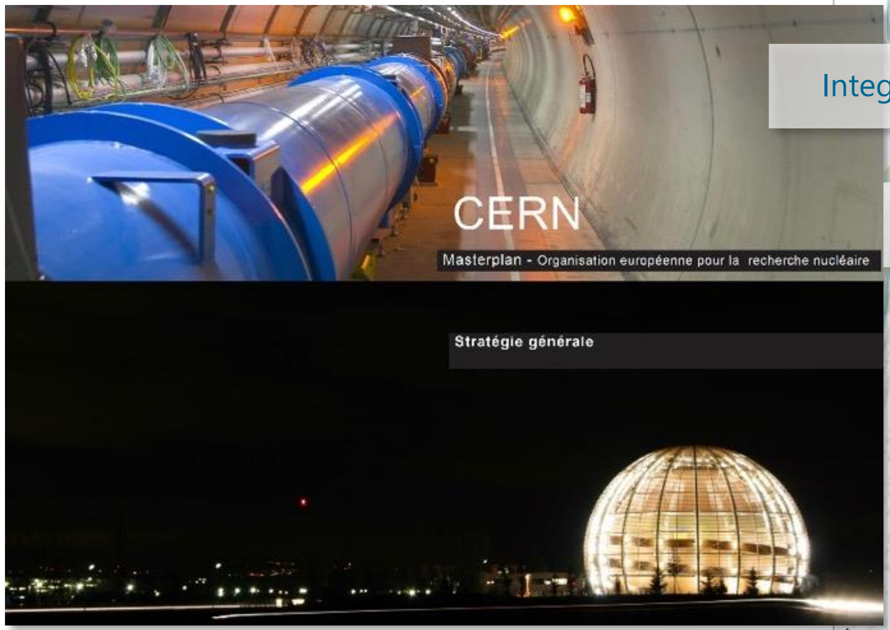
HOW DO WE BUY

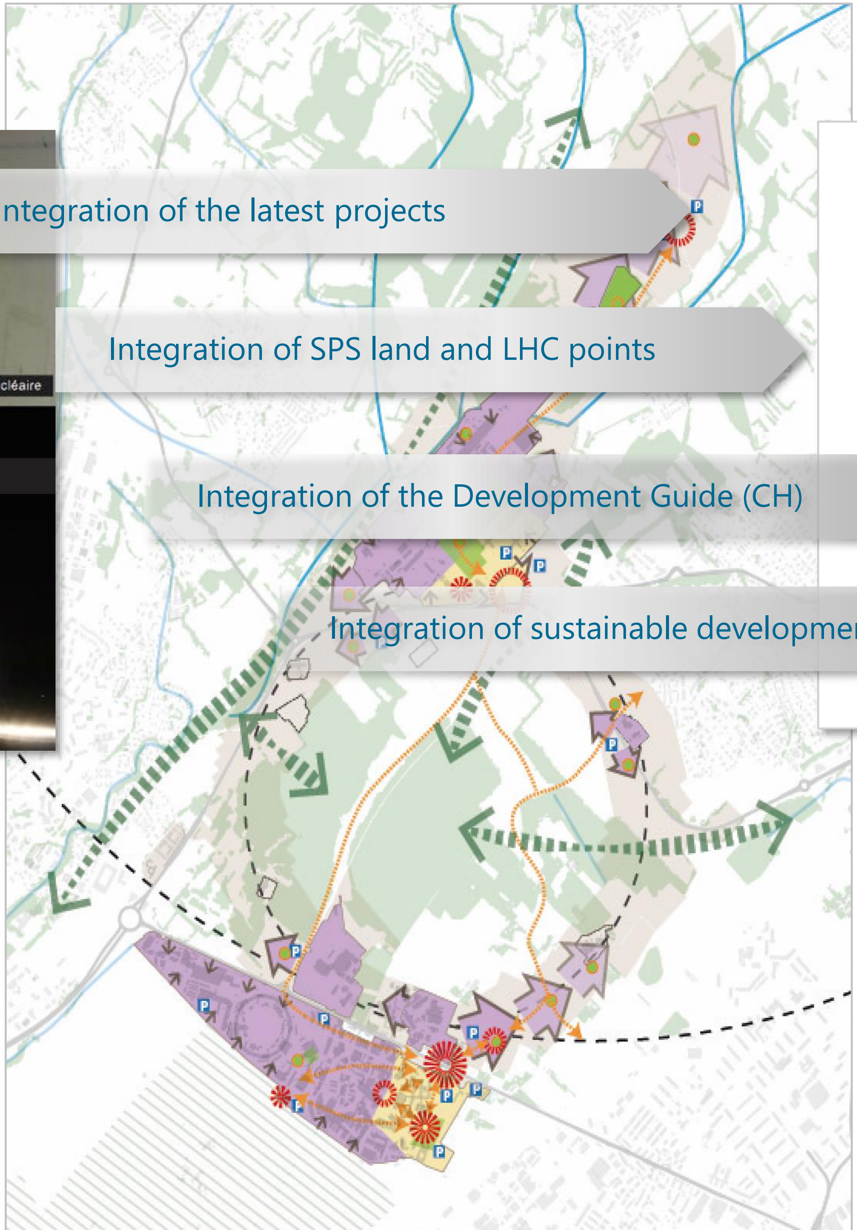
Fair competition
Payment deadline

Reasoned negotiation
Suppliers' performance
Respect of commitments

ISO 20400

CERN MASTERPLAN 2040





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

MASTERPLAN 2040

Framework objectives and measures

MANAGEMENT OF RESSOURCES

Control the resource requirements for the operation of tertiary infrastructures:

- Improve energy consumption and reduce greenhouse gas emissions
- Promote new energy-generation technologies
- Limit the increase in water consumption.

BIODIVERSITY

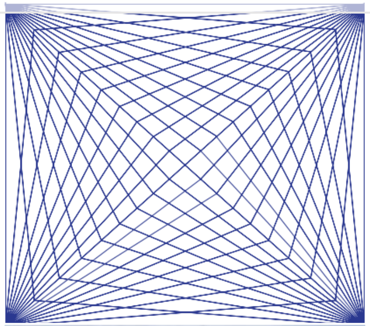
Initiate an action plan in favour of biodiversity, green spaces and protected species:

- Continue to implement the rainwater management strategy at CERN
- Draw up an inventory of the existing biodiversity, protected species and green spaces
- Continue the development of the ecological continuity of environments and wildlife corridors.

POLLUTION

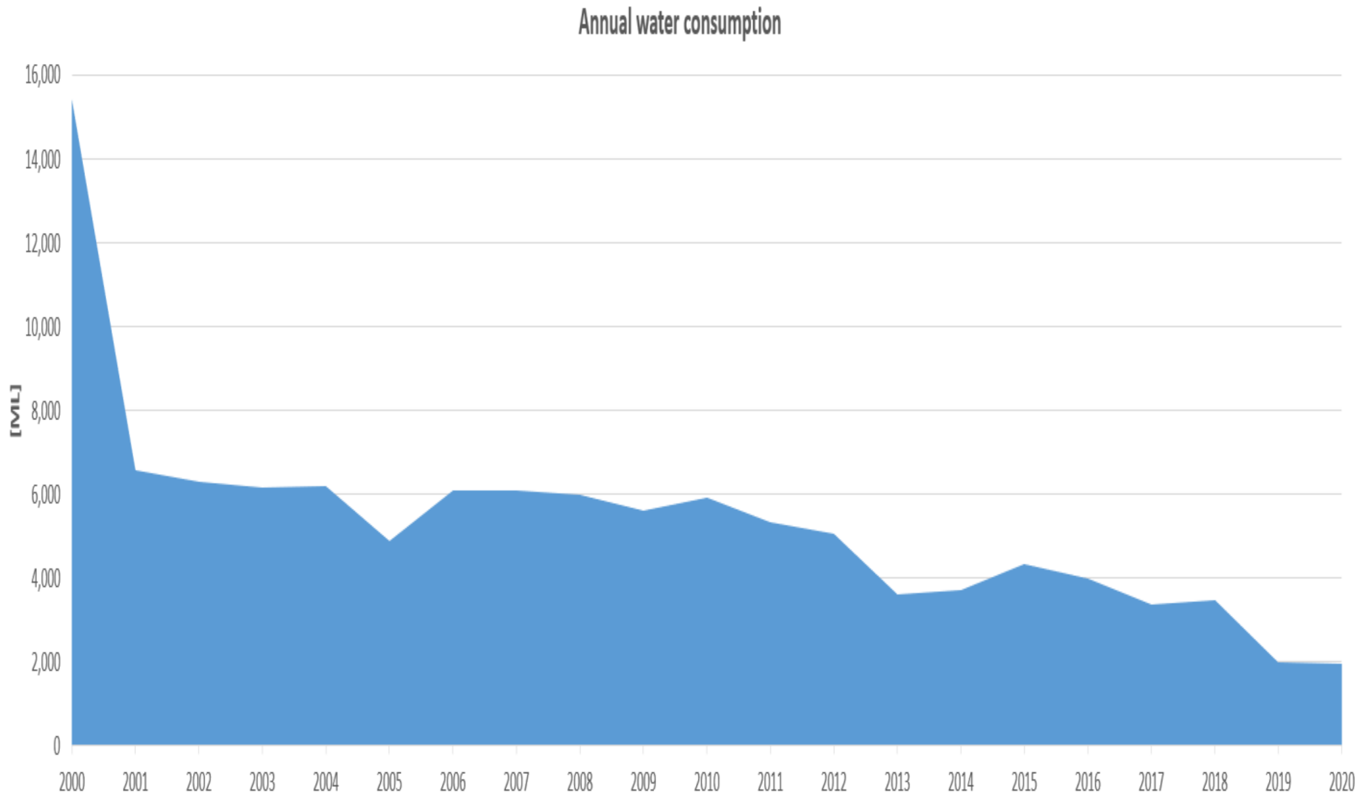
Control and mitigate CERN's environmental pollution:

- Limit noise pollution
- Increase the recycling rate and reduce waste production

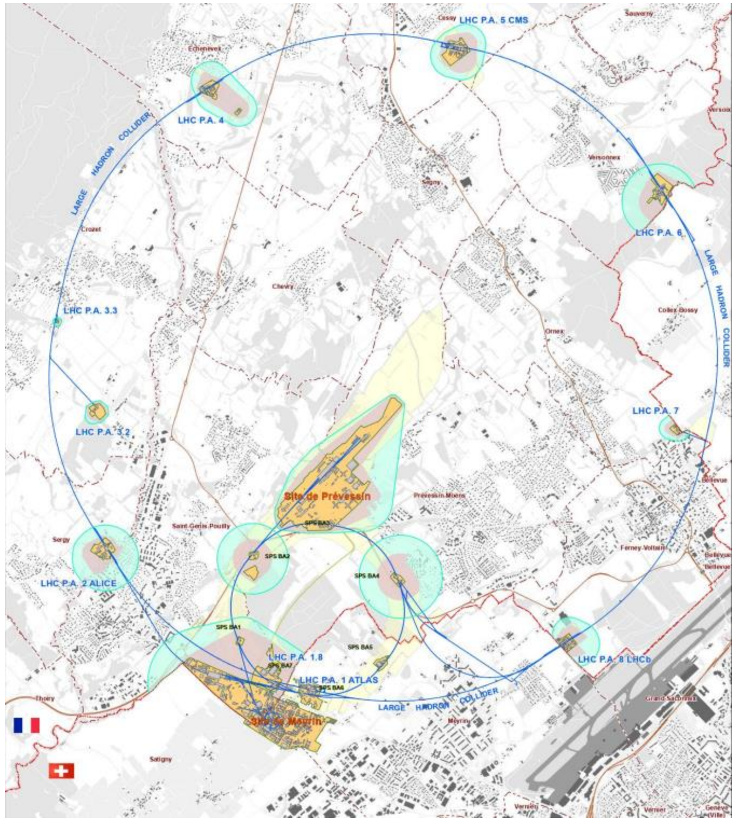


MASTERPLAN 2040: ENVIRONMENT

WATER



NOISE



MASTERPLAN 2040: SPACE MANAGEMENT

DENSIFICATION

Densify land occupation by ensuring flexibility of use

- Identify the areas set aside for development and define priorities
- Continue to monitor CERN's development
- Draw up a land improvement plan
- Favour taller buildings where site conditions and building use so permit

BUILDING MANAGEMENT

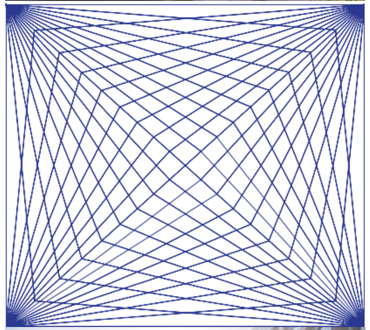
Standardise the use of built-up areas:

- Develop a policy for the management of built-up areas with a specific strategy for each purpose
- Continue monitoring existing buildings
- Continue the renovation programme
- Propose a specific land-use area on the Swiss side of the CERN site and define regulatory provisions

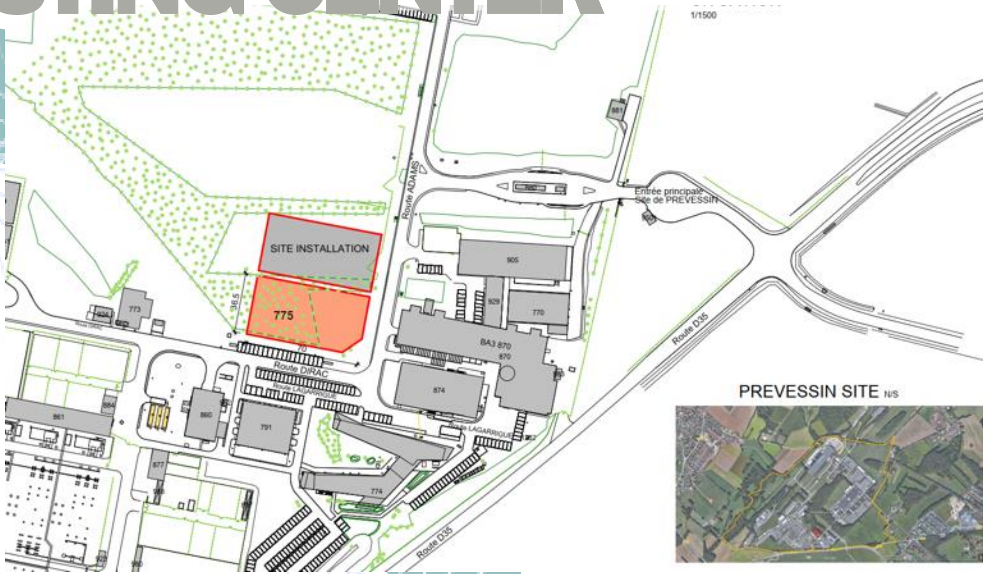
FUNCTIONALITY & READABILTY

Consolidate the functionality of the Meyrin and Prévessin sites and the experiment sites, and make the Prévessin site autonomous :

- Enhance the organisation and coherence of the sites by creating specific zones: visitor, academic, scientific–technological .
- Create one or more decentralised service hubs on the existing and future sites, notably bringing together amenities, restaurants, public spaces, lawns, gathering areas, etc



PREVESSIN COMPUTING CENTER



Purpose : The Contract is for the design, construction and 10-year M&O of the building and equipment.

Needs : 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 :

- The PCC is 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

CIVIL WORKS EXECUTION :

- Building foundations – 80%
- Ground level concrete works – 50%
- Below slab networks – 25%

TESTING & COMPLETION :

- PCC Testing – Mar to Sept 23
- Operational from October 23

PREVESSIN HEATING PLANT :

- Operational from 2026

PREVESSIN OFFICE CENTER

Reference Design

Key design information:

- Tertiary building (475 p.) + new restaurant (500 s.) + Parking
- Compliance Master Plan 2040
- Compliance RE 2020 (environmental regulation) ;
- Low embodied energy (mass timber structure)
- Preservation of near by forest
- Integrate soft mobility ;

2026 : end of works

- Procurement: 2022 - 2023
- Beginning of works: December 2023

SITE CONSOLIDATION

PRIORITIES

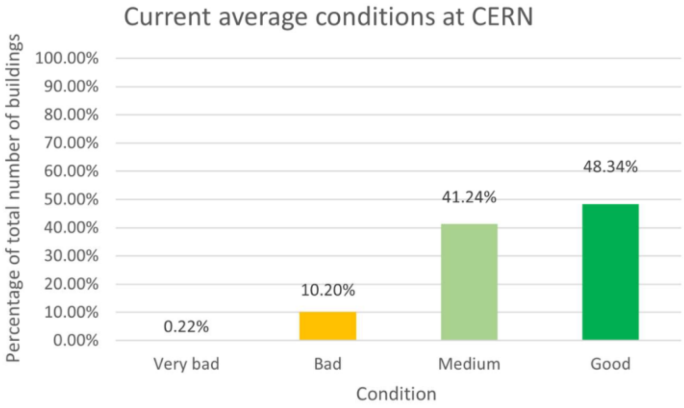
- Safety
- Strategic value wrt scientific goals
- Sustainability: durability, environmental impact, energy performance

AMBITIONS

- Global renovation of up to 2 buildings/y
- Densify consolidated space
- New space management policy
- Demolish depreciated space

PROCESS

- Data-driven decisions

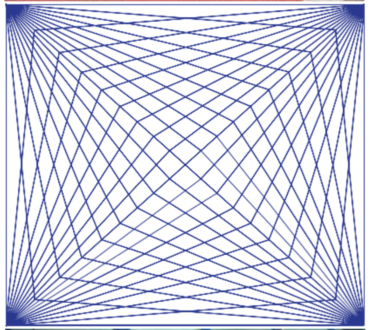


- Standardization of requirements definition according to Masterplan objectives and approval process for execution
- 5-year view

SPECIFICATIONS

- Global renovations
- Regulations compliance
- Energy efficiency improvement: > 60%
- Monitoring heating, electrical and lighting consumption
- Operation of HVAC, Heating and lighting consumption according to the outdoor temperature, occupation of the premises, eco-mode
- Favor centralized networks

MASTERPLAN 2040: MOBILITY



PARKING

Optimise the car-parking facilities and their management :

- Limit car parking
- Privilege car parks close to the main road network in the context of new developments
- Continue the development of facilities for soft-mobility
- Develop communication promoting a reduction of the impact of people's mobility at CERN

CIRCULATION

Promote efficient and fluid access to and circulation on the CERN sites :

- Optimise the fluidity of access to the CERN sites.
- Improve the hierarchy of the road network inside the CERN site.
- Continue developing accessible facilities for people with reduced mobility.

ALTERNATIVES

Encourage alternatives to individual motorised transport for commuting :

- Encourage car sharing.
- Improve the continuity, safety and comfort of soft-mobility routes and provide parking for bicycles.

INTERSITE TRANSPORT

Promote alternatives for travelling between the CERN sites :

- Continue developing facilities associated with collective transport on site.
- Optimise the management and supply of CERN vehicles
- Expand and diversify CERN's bicycle fleet.
- Continue developing the network of footpaths and cyclepaths on site.

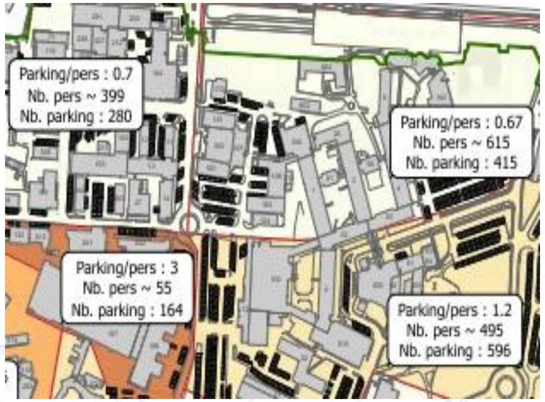
MOBILITY

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
- 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, …

- Objective 2022: mode of operation & 2 pilot projects

https://sce-dep.web.cern.ch/cern-green-village

HEP & ENVIRONMENT

SUSTAINABILITY HEP CONFERENCES

Discuss the transition to a sustainable future in the fields of high-energy physics (HEP), cosmology and astroparticle physics (APP) and share best practices examples and sustainability initiatives in the university and research centre contexts.

1st Edition

2nd Edition

SUSTAINABILITY IN HECAP

An initiative of scientists in the High Energy Physics, Cosmology and Astroparticle Physics community (HECAP) concerned about the climate crisis and advocating for a transition towards fairer and more sustainable practices in our fields.

We, researchers from the HECAP communities, are concerned about human-made climate disruption and its alarming consequences. We want to limit the impact of our research on the world's climate and ecosystems by striving for a sustainable and just future.

White Paper to raise awareness and list actions that should be taken by individuals, organizations and institutes.

FUTURE STUDIES & ENVIRONMENT

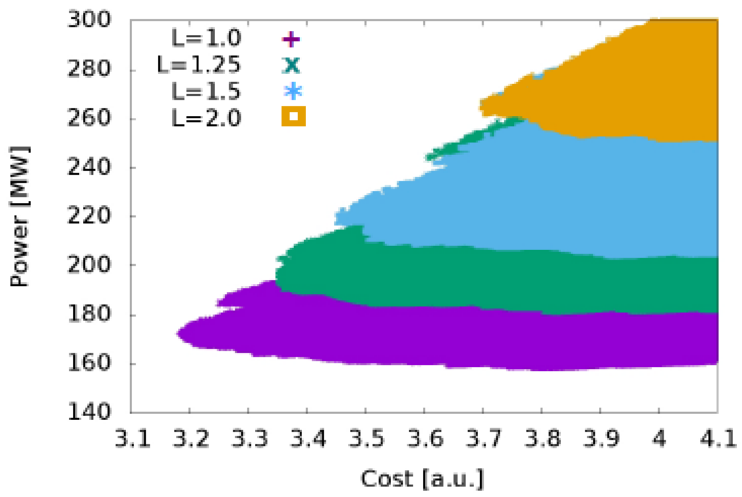
FCC

- Integration of an **"Eco-design"** from the first conceptual design phase onwards, balancing Scientific excellence, Territorial compatibility, Implementation and operation aspects
- The environmental evaluation process follows the **"Avoid-Reduce-Compensate"** approach; 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



AMBITIONS SUMMARIZED

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

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 the data centre in Prévessin and cooling towers at LHC PA1
Potential reduction ~1’900 tCO_2e/y and ~6’000 tCO_2e/y respectively

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

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

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

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
  - 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, long-lead execution, often have long RoI; ambition and long-term planning with short-term actions are key. A selection of programs for consolidating 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; exchange on carbon accountings and share experiences on reduction actions are key

- There will be no future large-scale science project without an energy management component, an incentive for energy efficiency and energy recovery among the major objectives
  - Sustainable scientific facilities (like big accelerators) require sustainability becoming a primary driver for design decisions, schedules and operational scenarios