HOW TO LIMIT THE ENVIRONMENTAL IMPACT

Mar Capeans

2nd Joint ECFA-NuPECC-ApPEC *JENAS-Seminar*
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EDMS **2735914**

OUTLINE

Environmental protection at CERN

Reporting

Targets

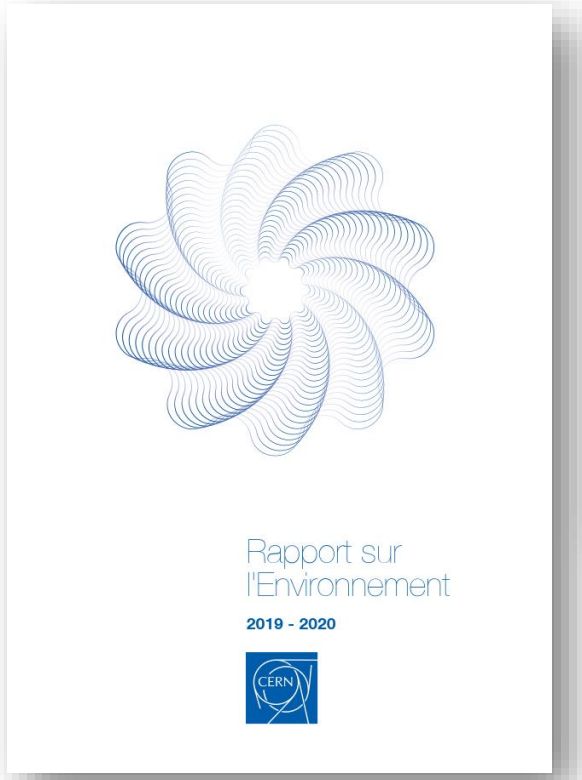
Actions

Site development

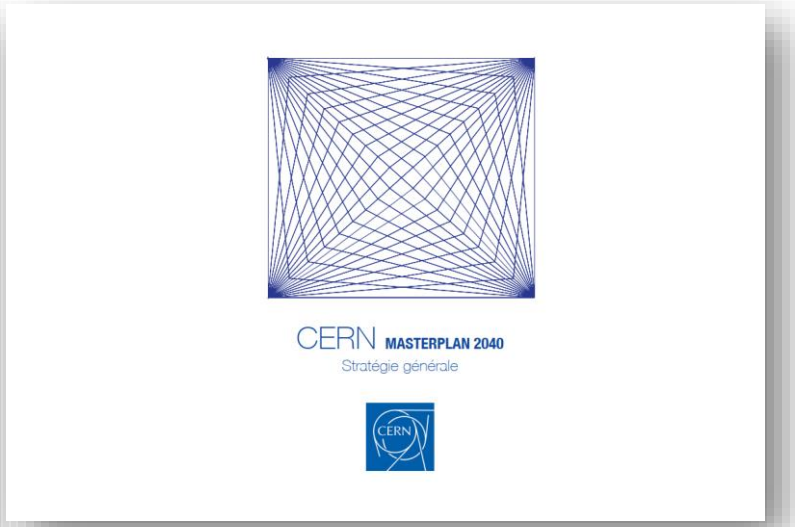
Future

Outlook

CERN Environmental Reports



CERN Masterplan 2040



ACKNOWLEDGEMENTS

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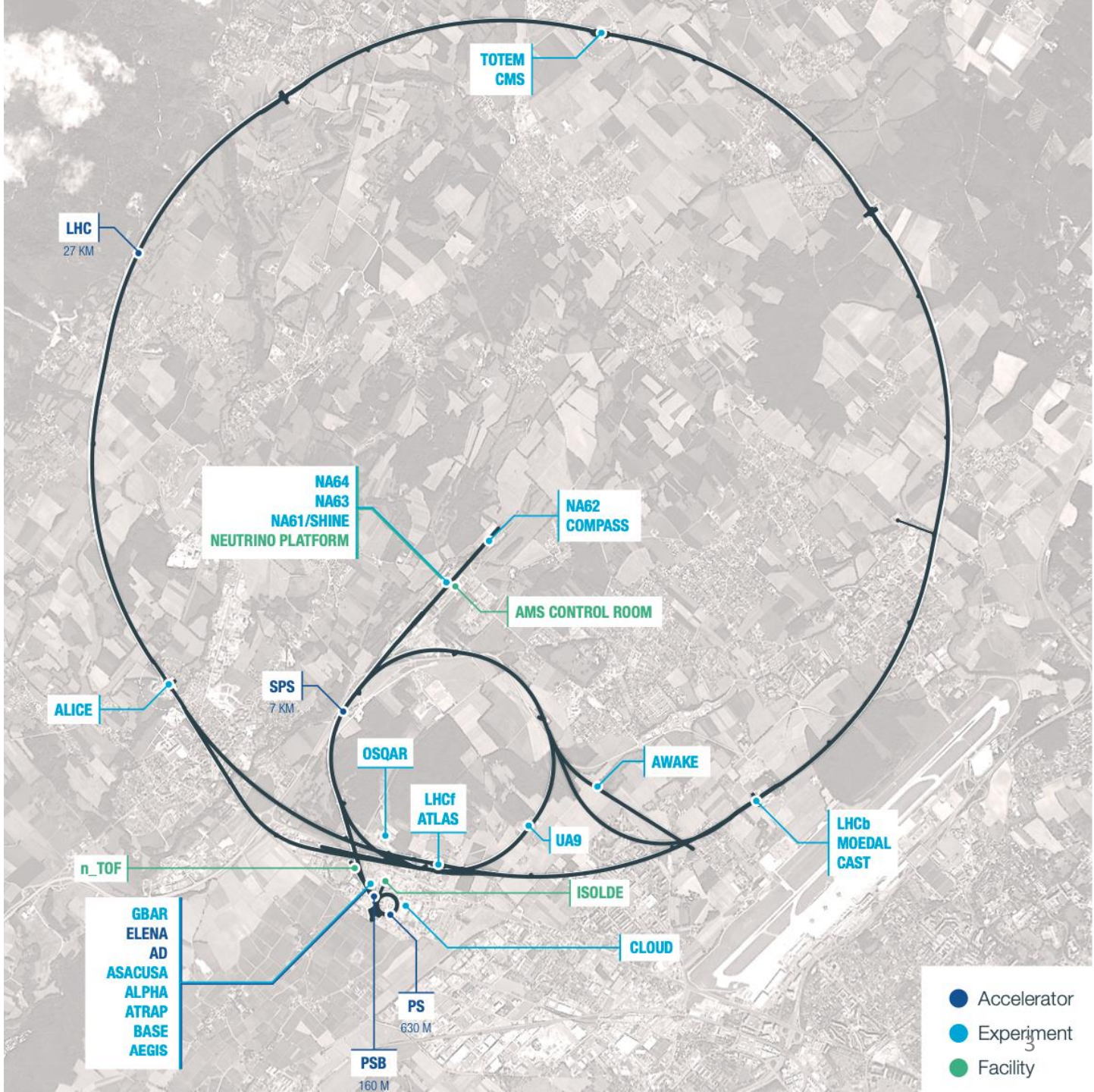
CERN

- 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

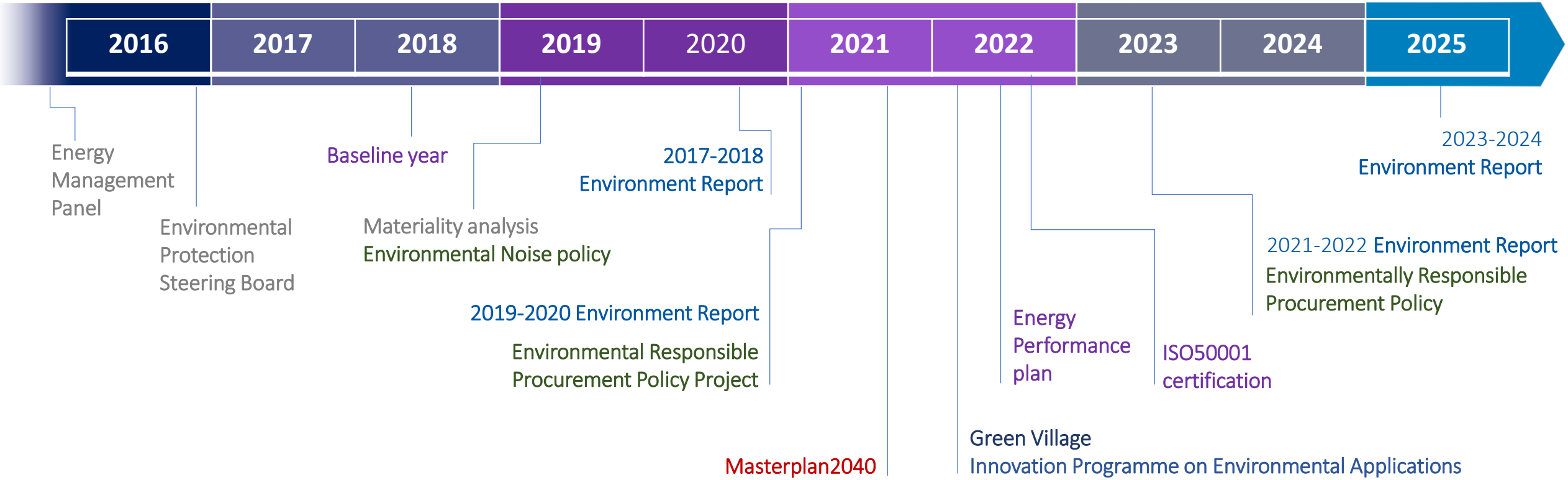
- 590 ha (220 fenced)
- 2 main sites and 15 satellite sites
- 670 buildings from 10 m^2 to 20.000 m^2
- 65% built before the 70's
- 70 km tunnels and 80 caverns
- 30 km roads
- 1000 km technical galleries and trenches

- 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

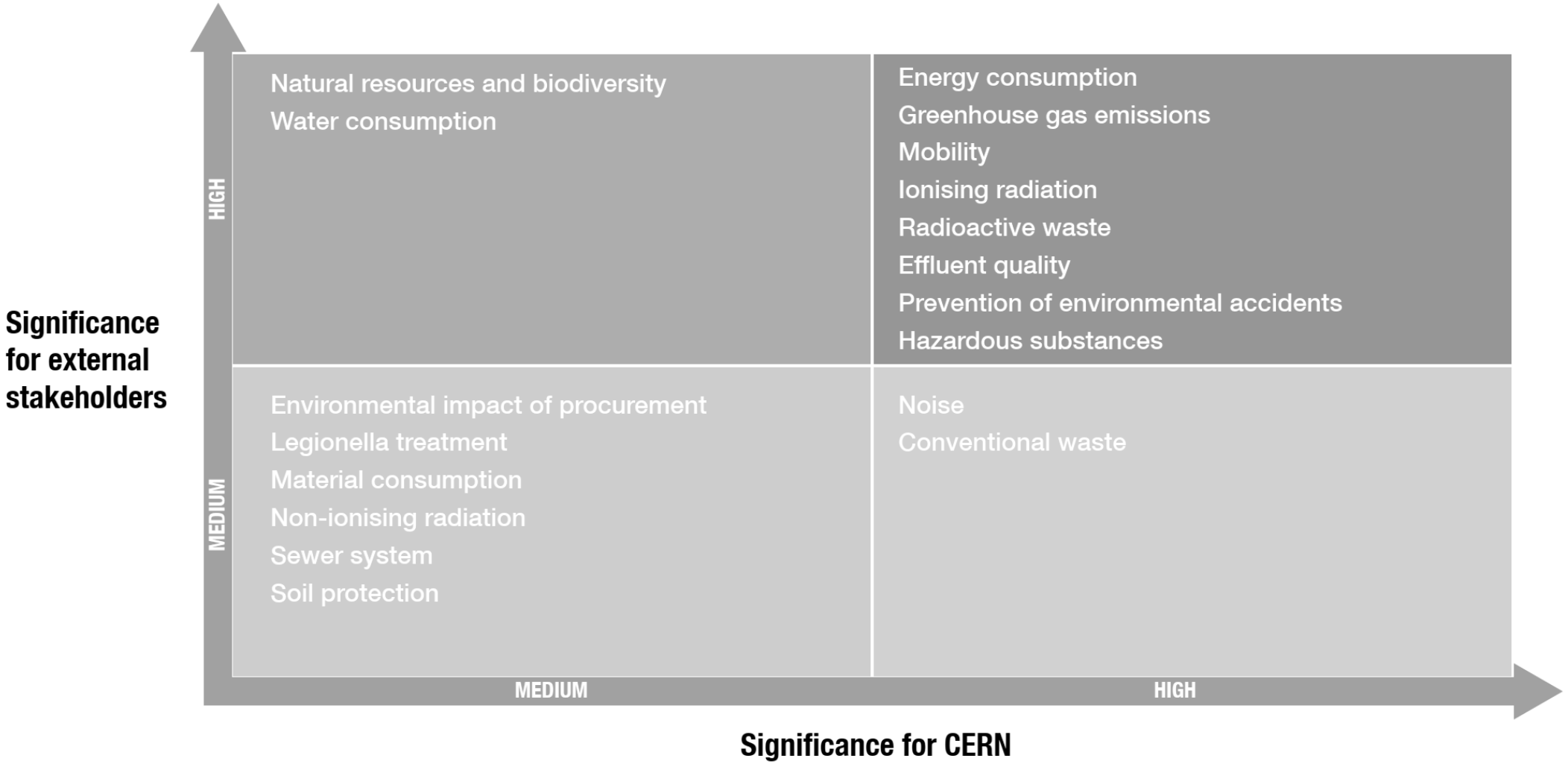
STRATEGY

- 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

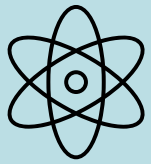


MATERIALITY



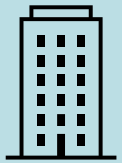
CO_2 CH_4 HFCs PFCs N_2O SF6

SCOPE 1
Direct



Particle Detectors
Accelerators

Vehicles



Assets

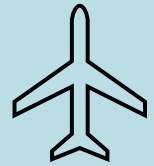
SCOPE 2
Indirect

Purchased electricity

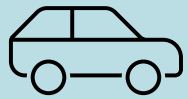
SCOPE 3
Indirect

Waste treatment

Water purification



Business Travel



Employee Commuting

Catering

Procurement

CERN AND THE ENVIRONMENT IN 2018

AT A GLANCE

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

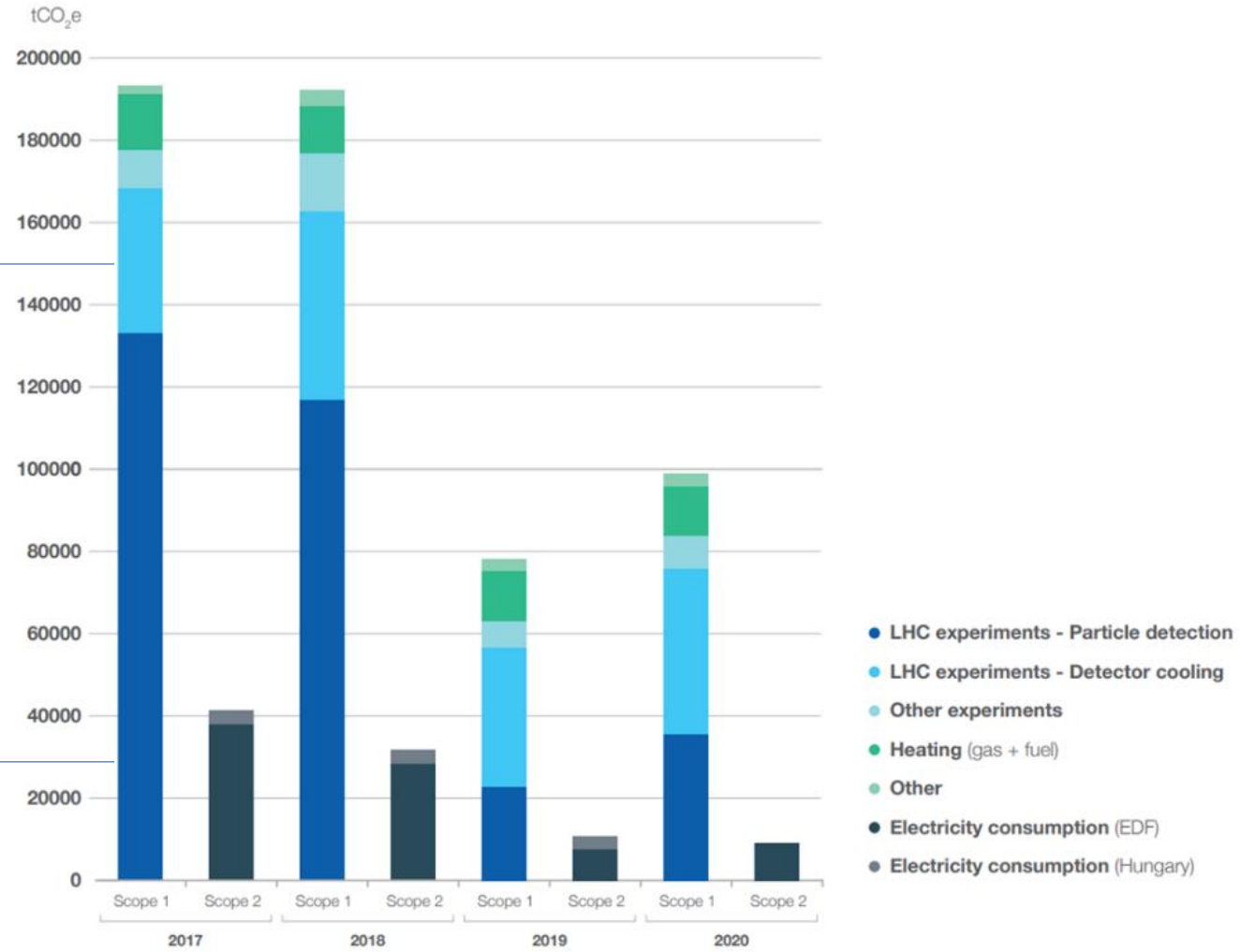
Detector cooling

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

Forecasted reduction ~40'000 tCO_2e/year

Particle detection (gases)

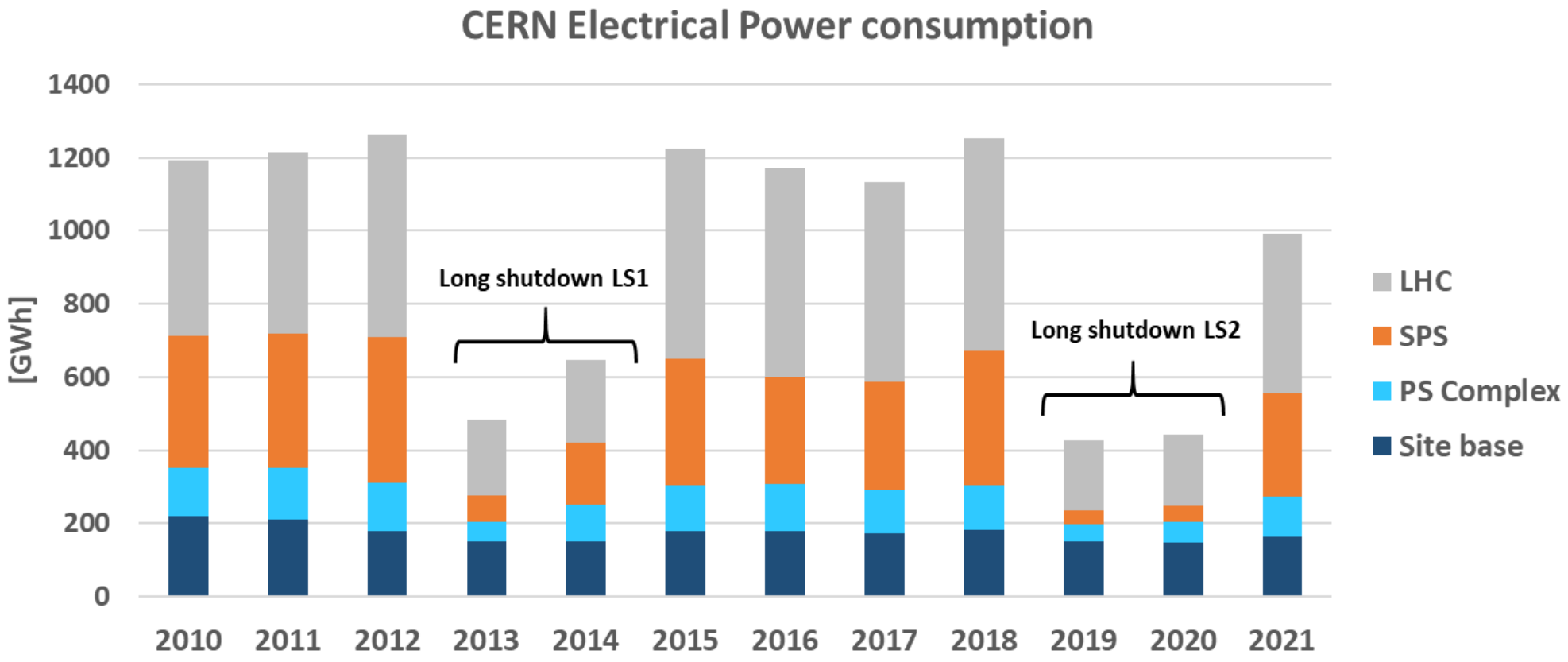
Reduction target ~13'000 tCO_2e/year



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.

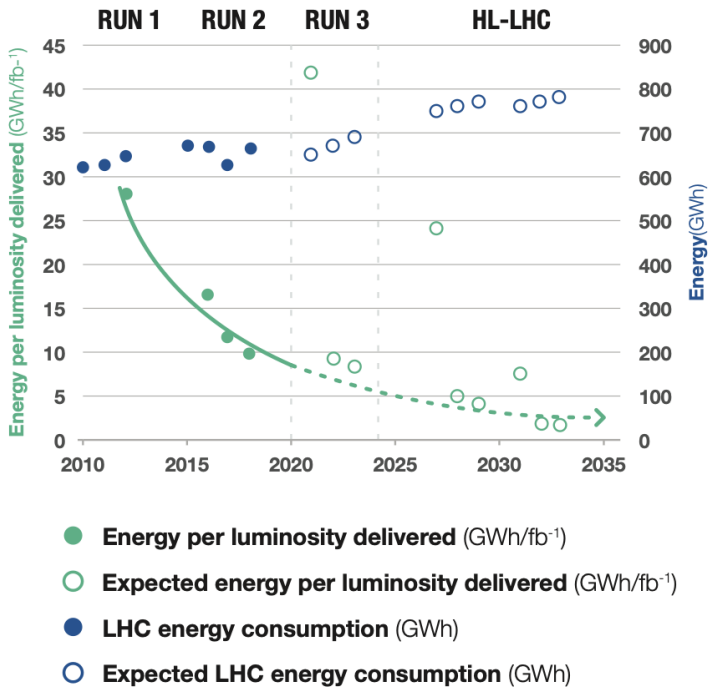
SCOPE 2: INDIRECT EMISSIONS



SCOPE 2: ACTIONS ON ENERGY CONSUMPTION

INCREASE EFFICIENCY

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

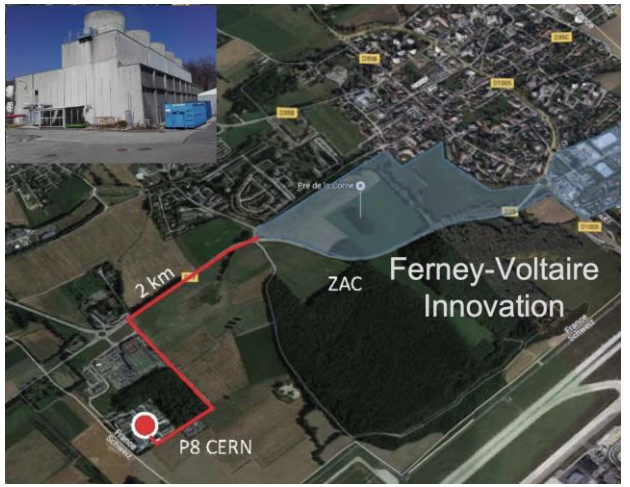


USE LESS

- 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

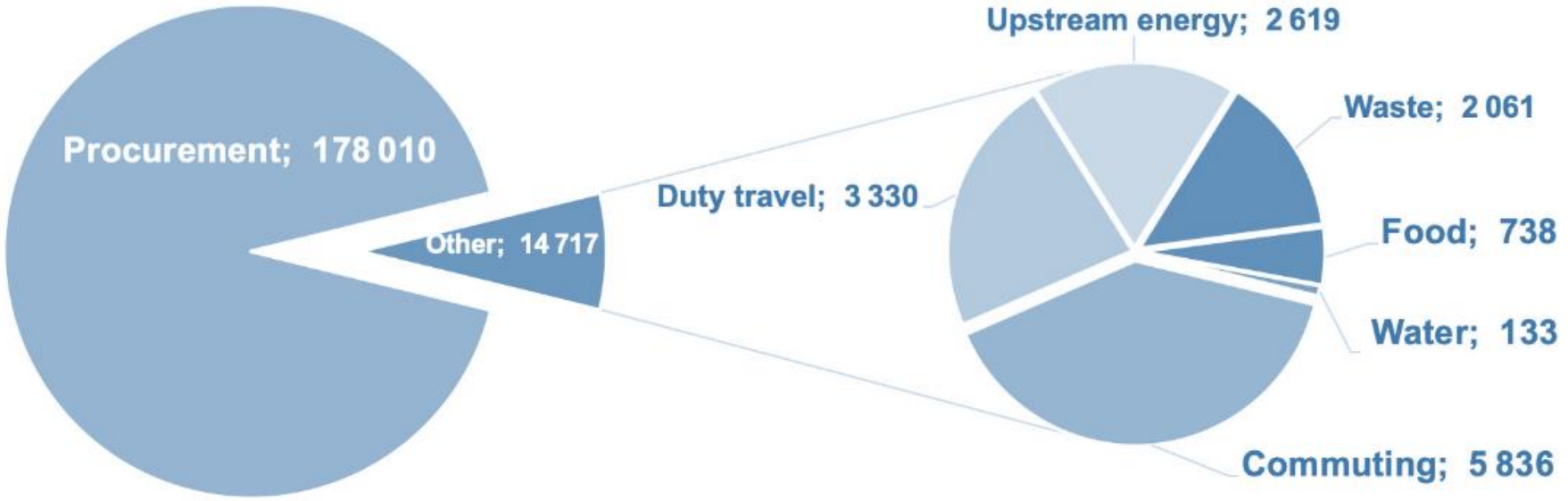
- Hot water from LHC cooling system (P8, 2 x 5 MW heat exchangers) to heat up a residential area (*20 GWh/y at peak*).



- 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

Total: 192'727 tCO_2e



SCOPE 3: ACTIONS

CERN Environmental Responsible Procurement Policy Project (2021)

Courtesy E. Cennini

WHY BUYING

Challenge the need!

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

HOW DO WE BUY

Fair competition
Payment deadline

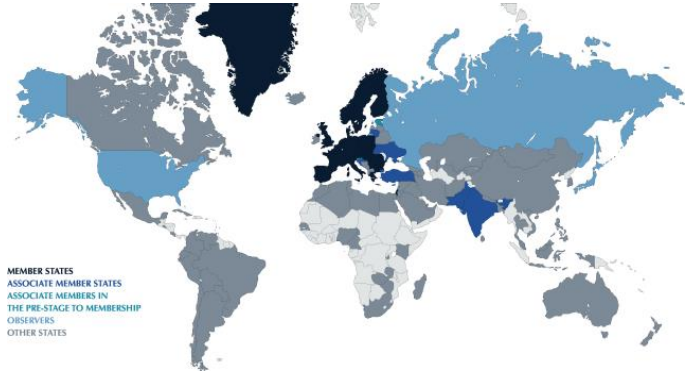
Reasoned negotiation
Suppliers' performance
Respect of commitments

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)



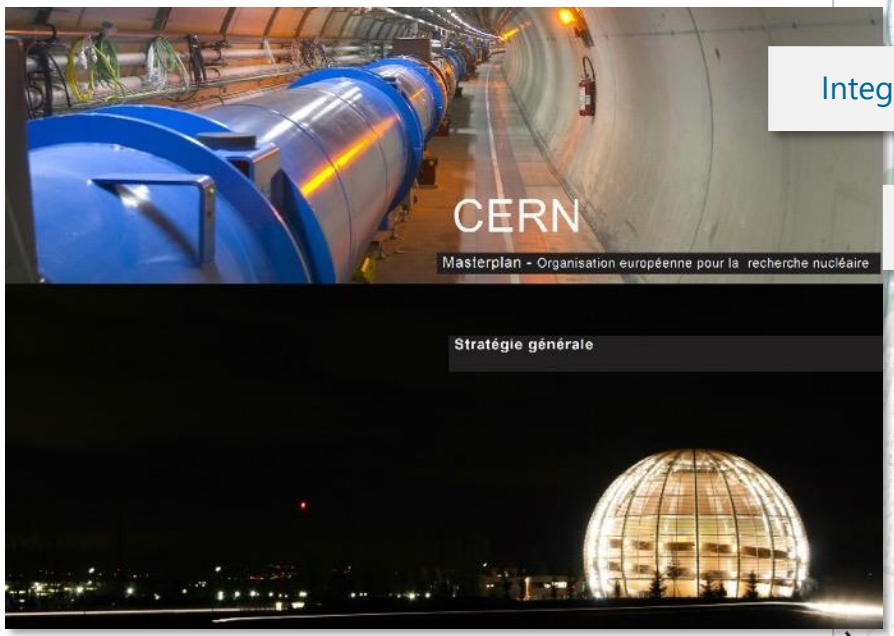
WHO WE BUY FROM

Countries/people exposed
Duty of vigilance/Compliance

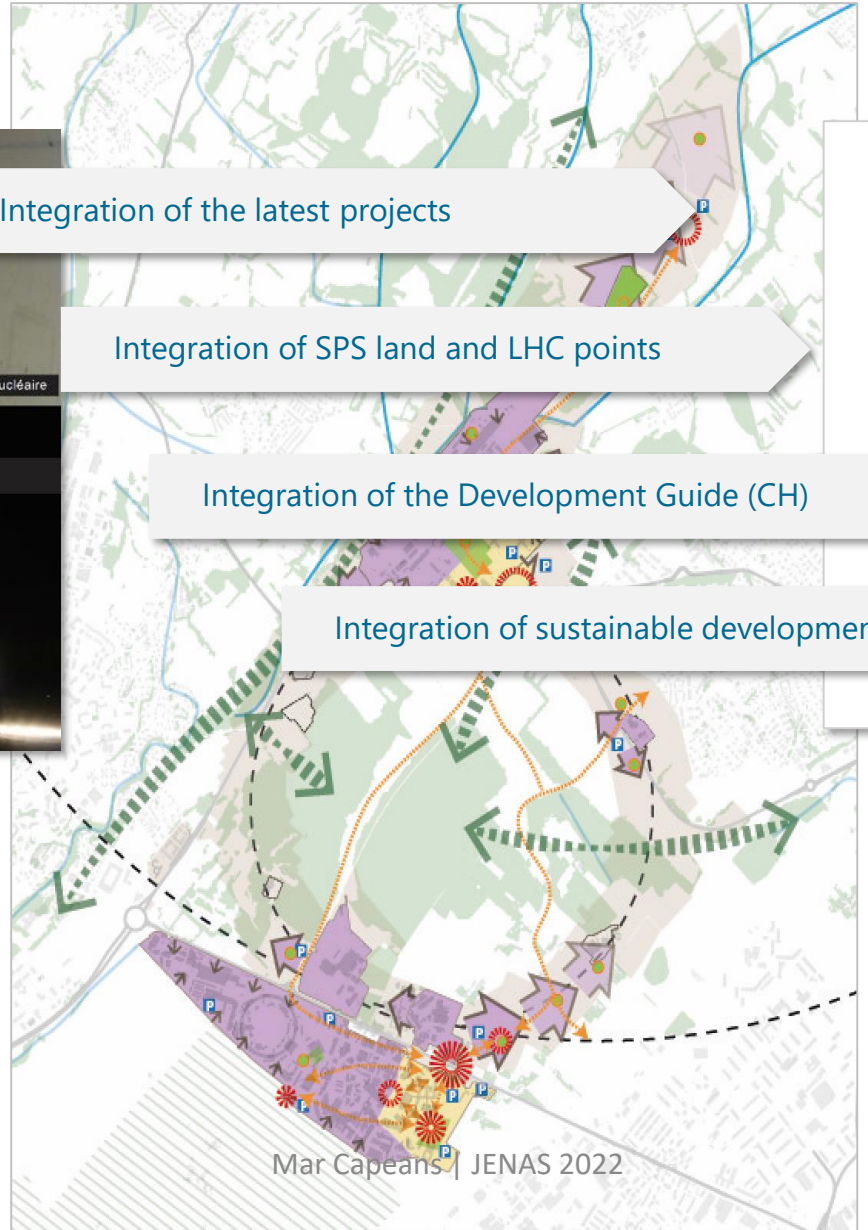
(Very) Poorly balanced Countries
Labels/Certification
Local purchase/Diversity

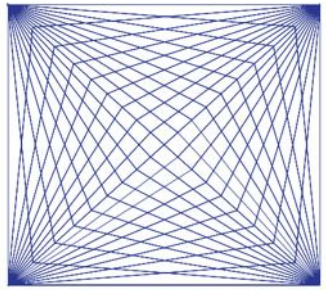
ISO 20400

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

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

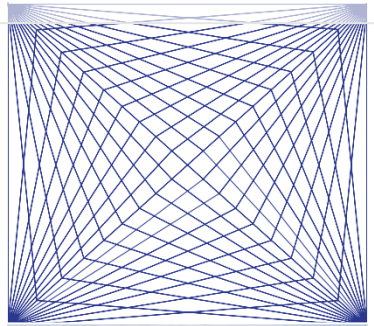
Initiate an action plan in favour of biodiversity, green spaces and protected species:

- 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

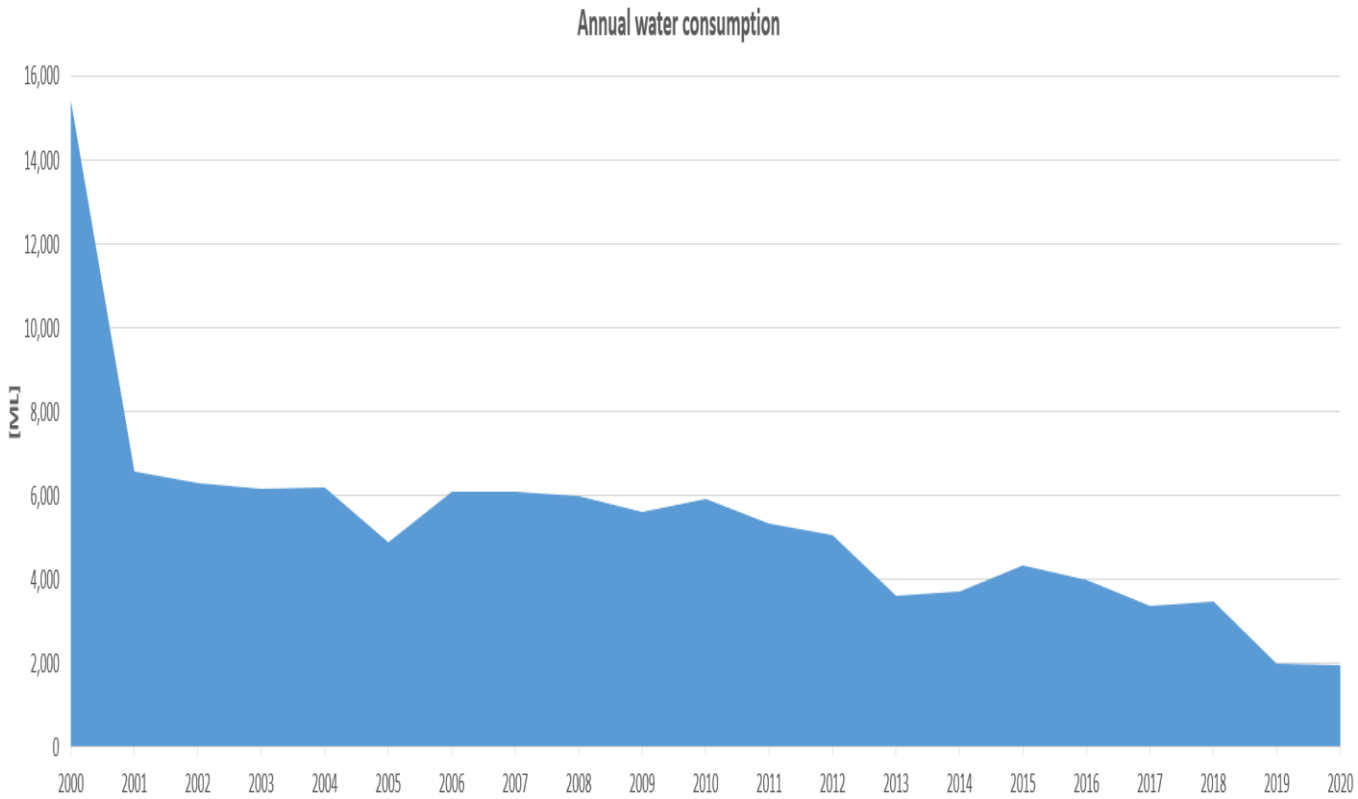
Control and mitigate CERN's environmental pollution:

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

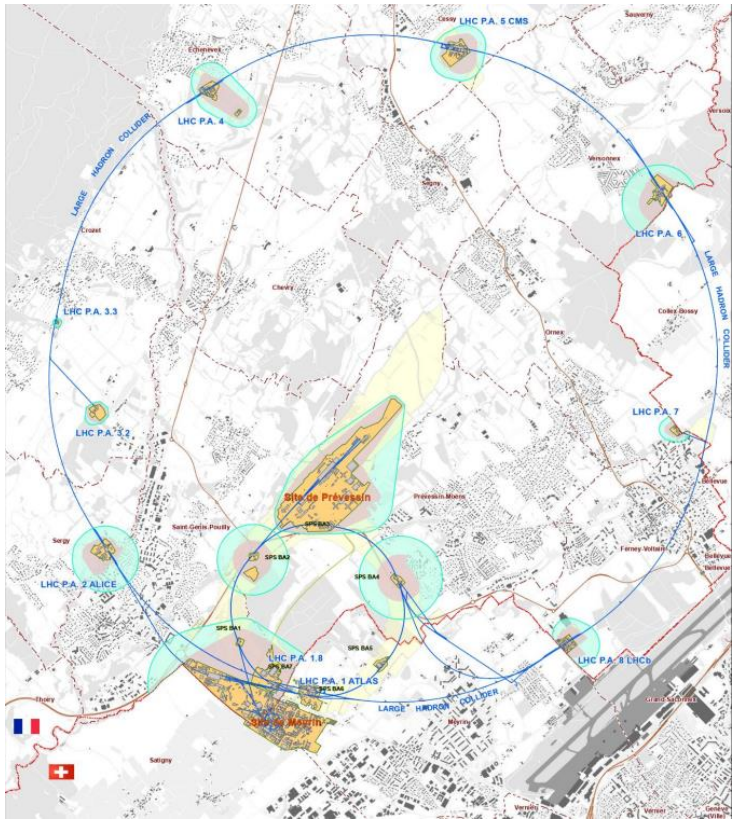


MASTERPLAN 2040: Environment

WATER



NOISE



MASTERPLAN2040

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

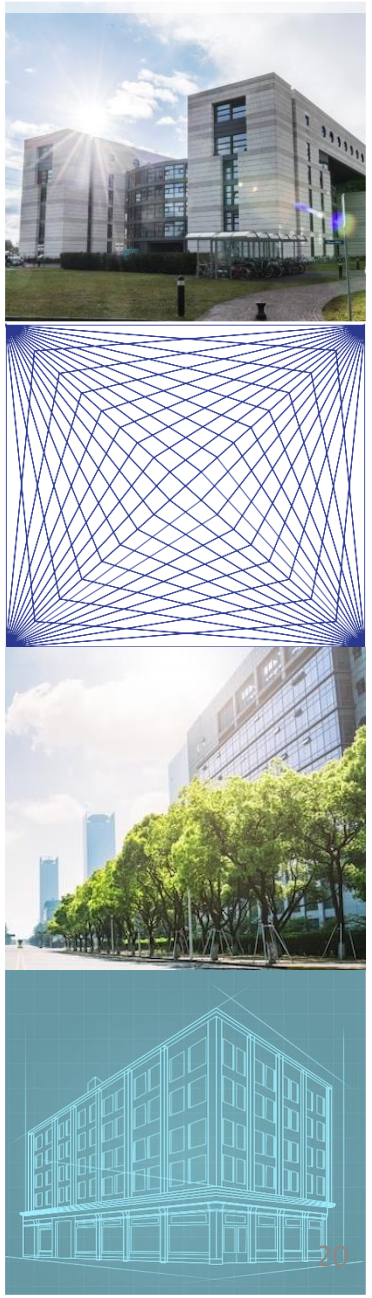
Standardise the use of built-up areas:

- 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

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



2021 - 2026 PLAN

MEYRIN

- New construction
- Renovation
- Demolition

PREVESSIN

- Planned and funded
- Planned, not yet funded

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

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

SITE CONSOLIDATION

PRIORITIES

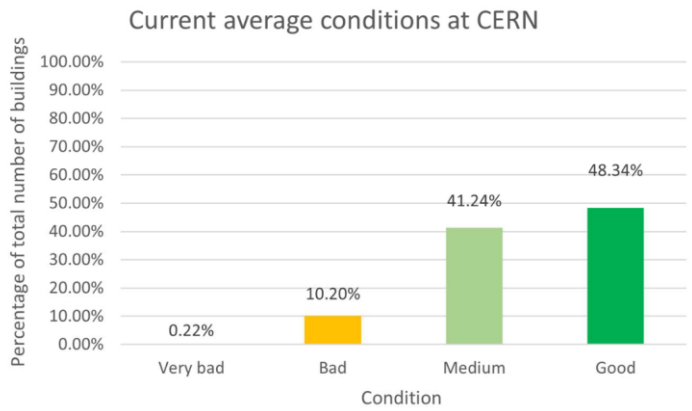
- Safety
- Strategic value wrt scientific goals
- Sustainability: durability, environmental impact, energy performance

AMBITIONS

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

PROCESS

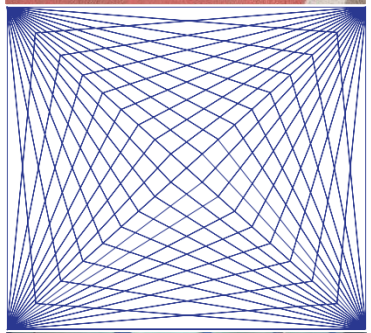
- Data-driven decisions



- 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



MASTERPLAN2040

PARKING

Optimise the car-parking facilities and their management :

- Limit car parking
- Privilege car parks close to the main road network
- 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.
- 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 foot and cycle paths on site.

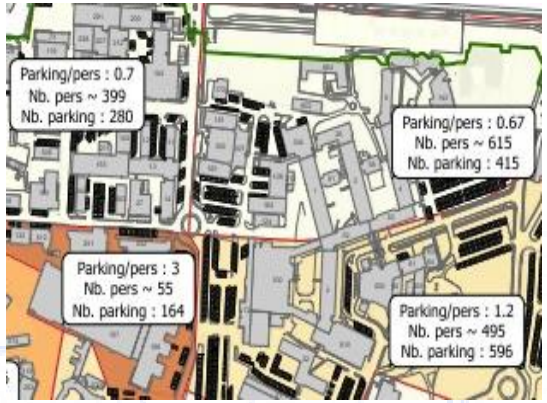
MOBILITY

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

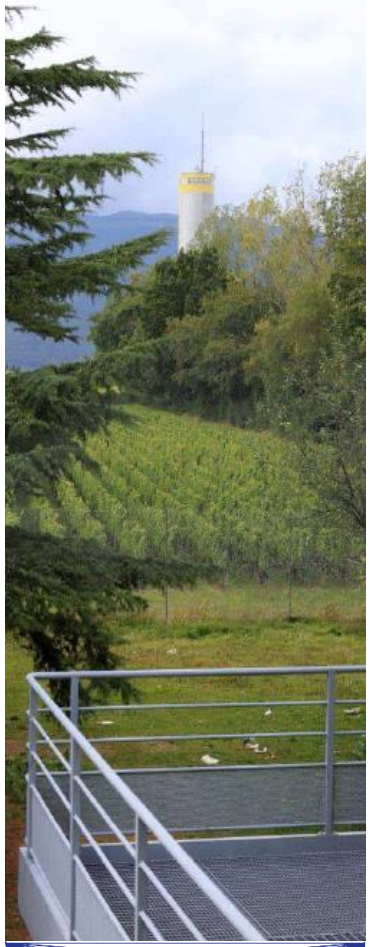
- Data driven
- Targets
- KPIs



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)**

MASTERPLAN2040



INTEGRATION WITH SURROUNDING LANDSCAPE

Integrate the CERN sites with the surrounding landscape :

- Integrate sites harmoniously with the existing features of the overall landscape and with the views onto that landscape
- Enhance the CERN site perimeters by planting diverse hedgerows that will contribute to the overall ecological network
- Implement an architectural strategy to enhance the image of CERN's buildings and emblematic public areas

LANDSCAPE IDENTITY

Develop a landscape identity :

- Harmonise and enhance the attractiveness of the landscape developments and gathering areas, and create a furniture and signage catalogue
- Reduce islands of heat and plant trees and shrubs close to existing and future paved or tarmacked spaces, car parks and roads

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

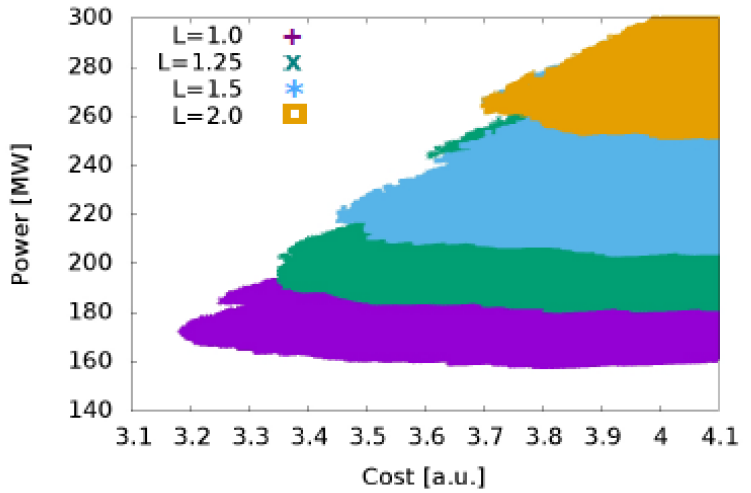
FCC

- 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)

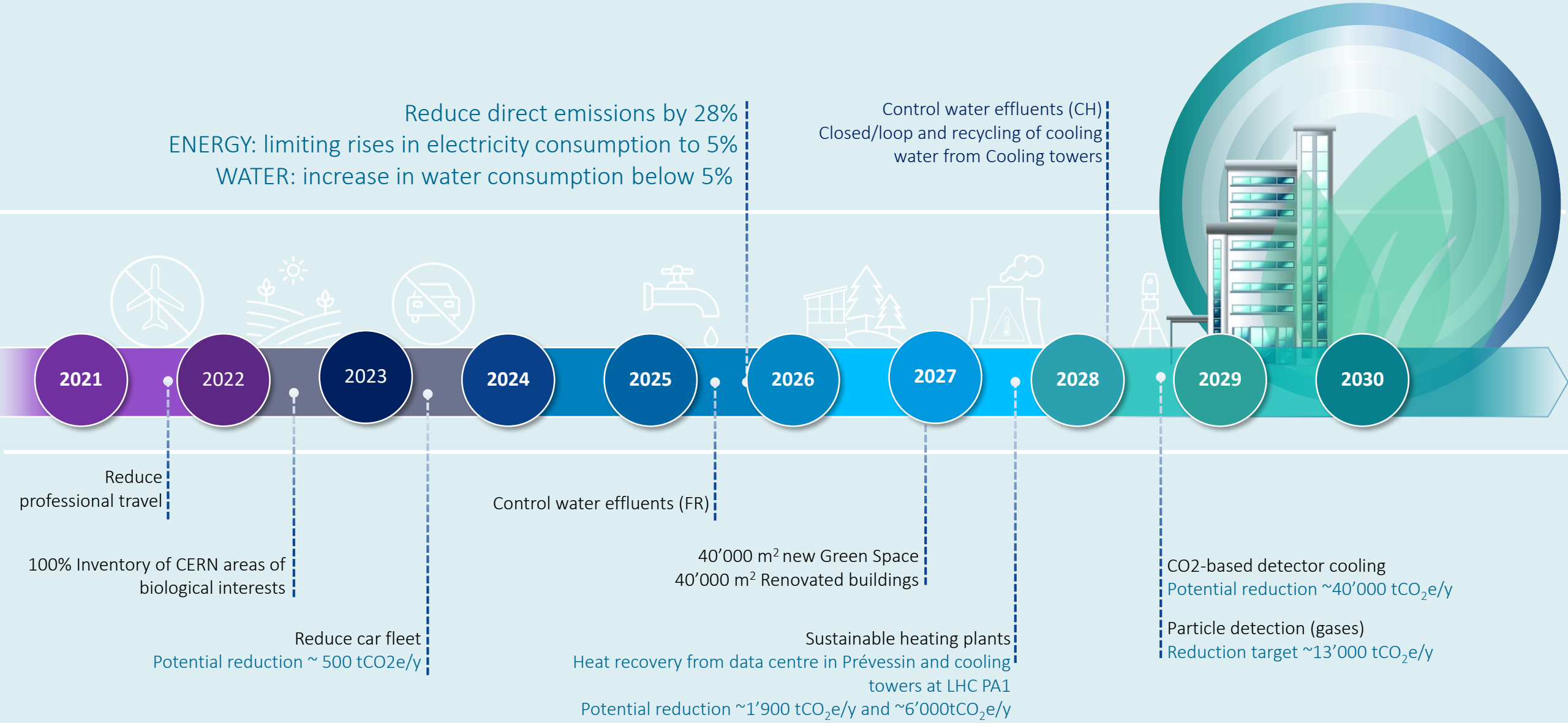
CLIC

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



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.