

# Addressing the Green Innovation Challenge

Mar Capeans



NorCC – SUMMER@CERN  
June 29<sup>th</sup> 2022

# OUTLINE

Environmental protection at CERN

Reporting  
Targets  
Actions

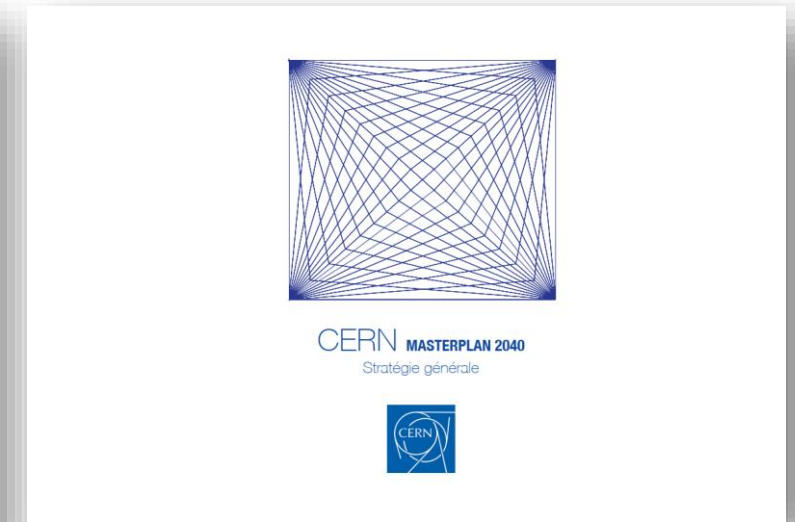
Site development

Future  
Outlook

## CERN Environmental Reports



## CERN Masterplan 2040



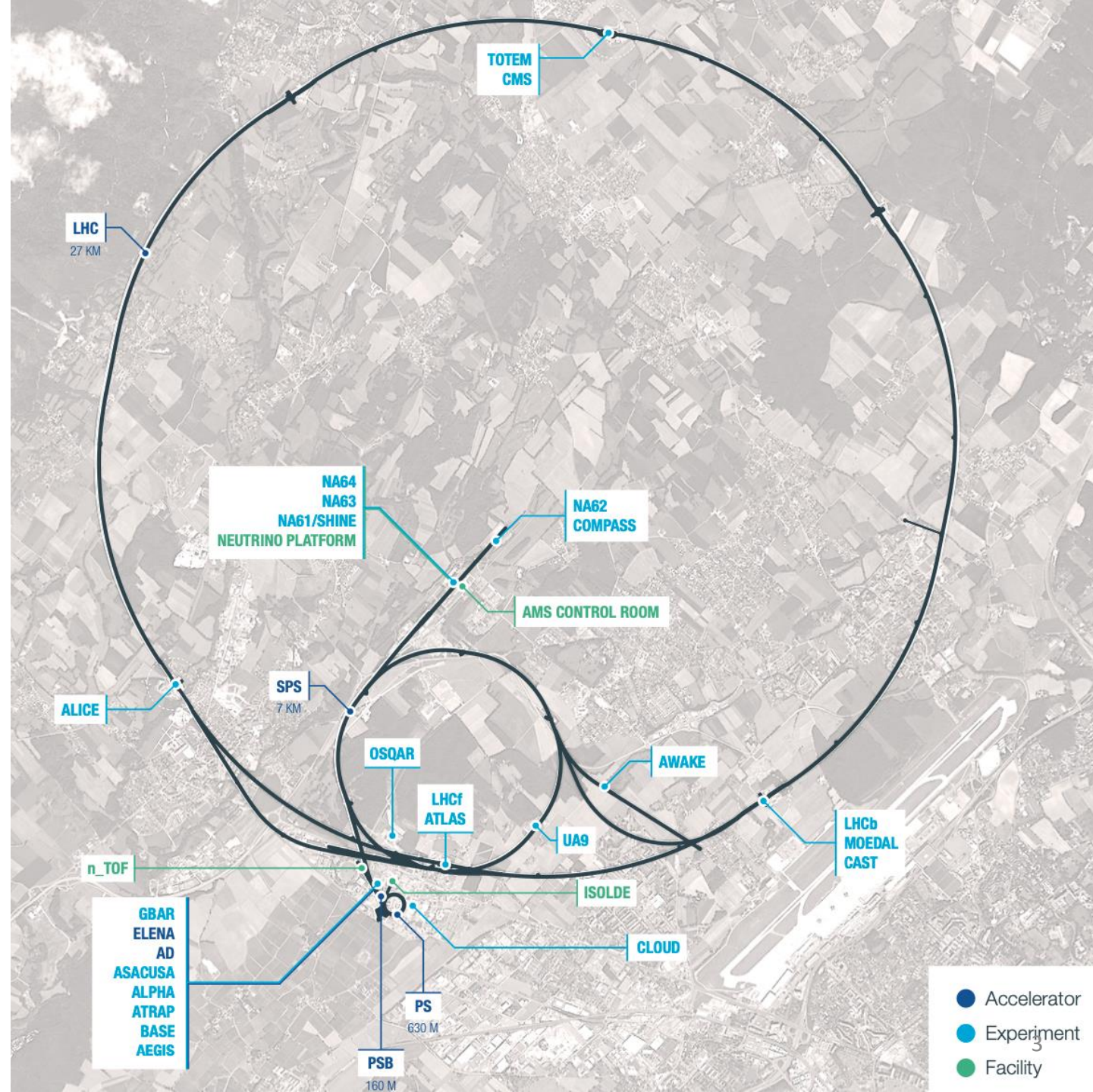
## ACKNOWLEDGEMENTS

**B. Delille and S. Klejner**, 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

# 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

May 6, 2022



● Accelerator  
● Experiment  
● Facility

# KEY FIGURES

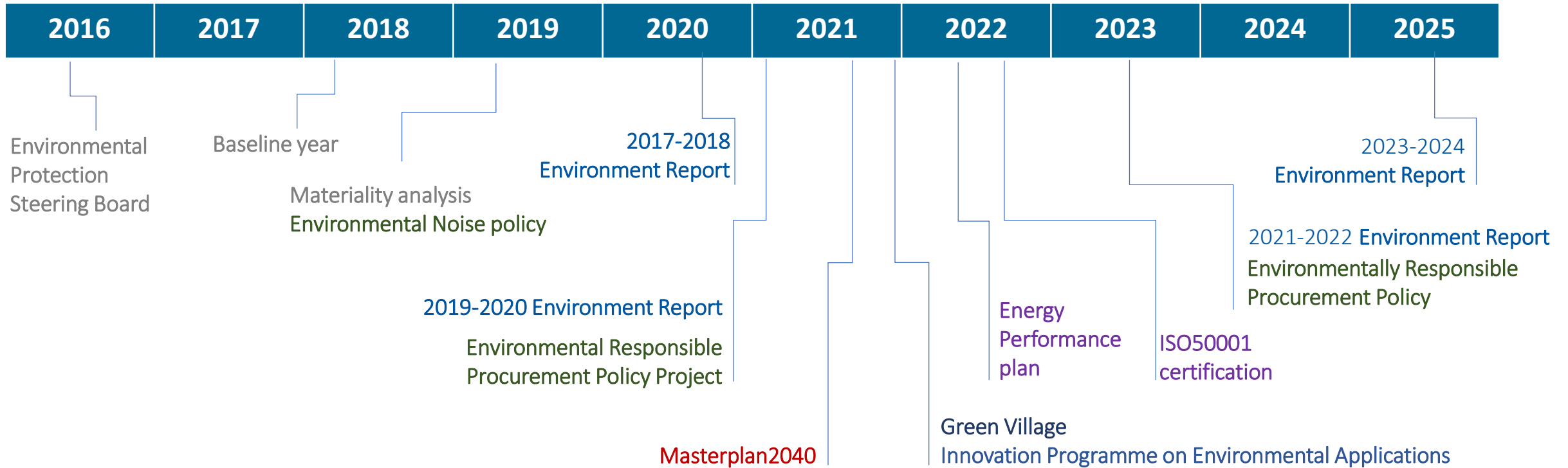
- 590 ha (220 fenced)
- 2 main sites and 15 satellite sites
- 670 buildings from 10 m<sup>2</sup> to 20.000 m<sup>2</sup>
- 65% built before the 70's
- 70 km tunnels and 80 caverns
- 30 km roads
- 1000 km technical galleries and trenches
- 9000 persons/daily
- 490 hostel rooms
- 8500 working places
- 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



CO<sub>2</sub>

CH<sub>4</sub>

HFCs

PFCs

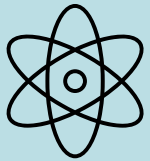
N<sub>2</sub>O

SF<sub>6</sub>

SCOPE 1  
Direct

SCOPE 2  
Indirect

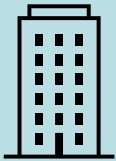
SCOPE 3  
Indirect



Particle Detectors  
Accelerators



Vehicles



Assets



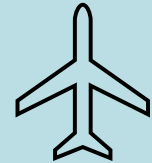
Purchased electricity



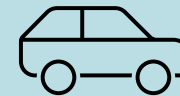
Waste treatment



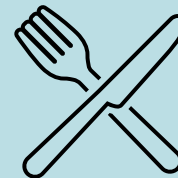
Water purification



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<sub>2e</sub>

CERN's direct greenhouse gas emissions were **192 100 tonnes of CO<sub>2</sub> equivalent, tCO<sub>2e</sub>**. Indirect emissions arising from electricity consumption were **31 700 tCO<sub>2e</sub>**. 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  
**Energy  
Consumption**  
28%

Limit raise by  
**5%**

**Water  
Consumption**

Limit raise by  
**5%**

# ENGAGEMENTS

**Waste**

Increase recycling  
rate

**Noise**

Restrict

**Commuting**

Constant

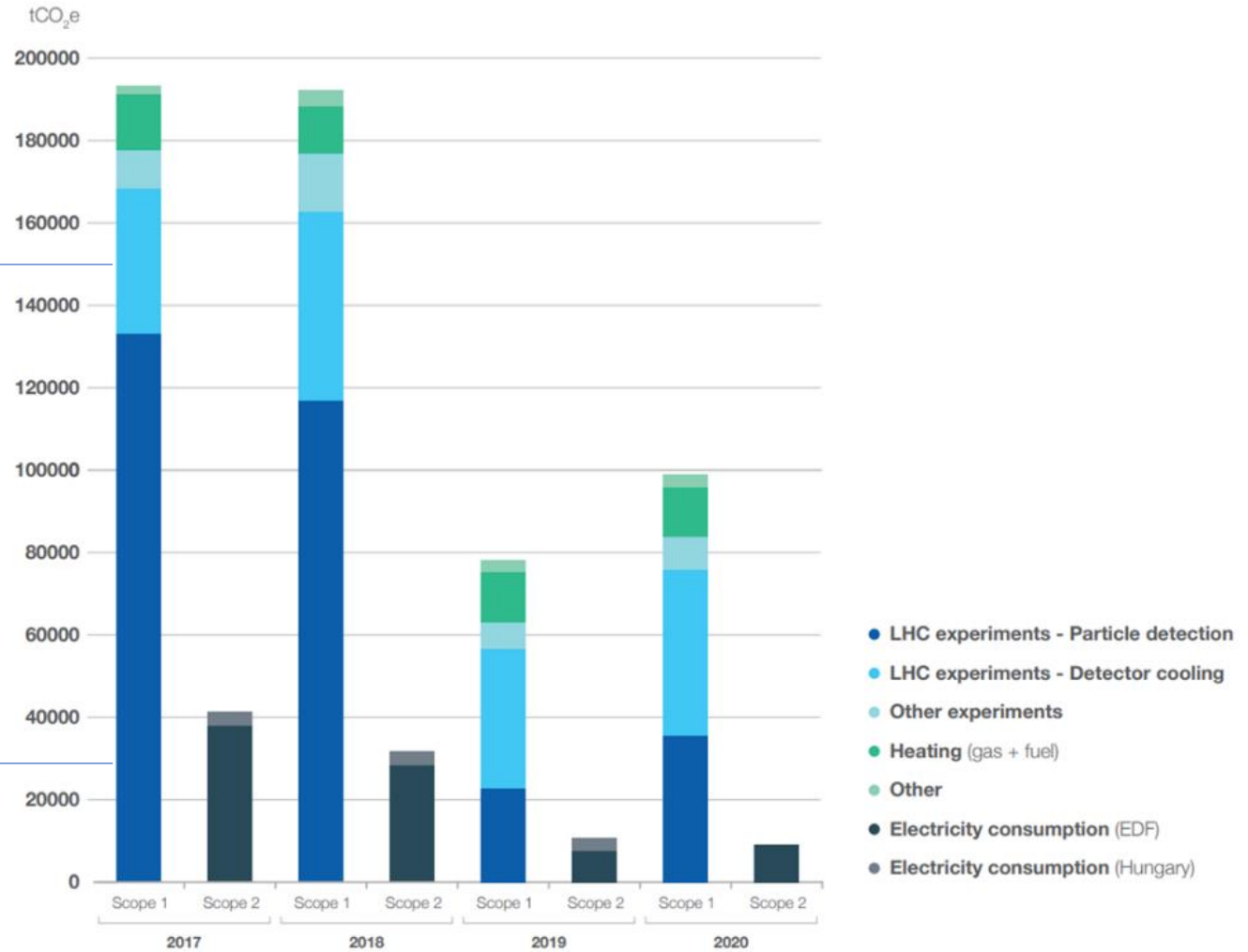
**Biodiversity**

Protect

# GHG EMISSIONS

**Detector cooling**  
 Systems using F-gases will be stopped by end of Run3 and replaced by CO<sub>2</sub> cooling for Run4  
 Forecasted reduction ~40'000 tCO<sub>2</sub>e/year

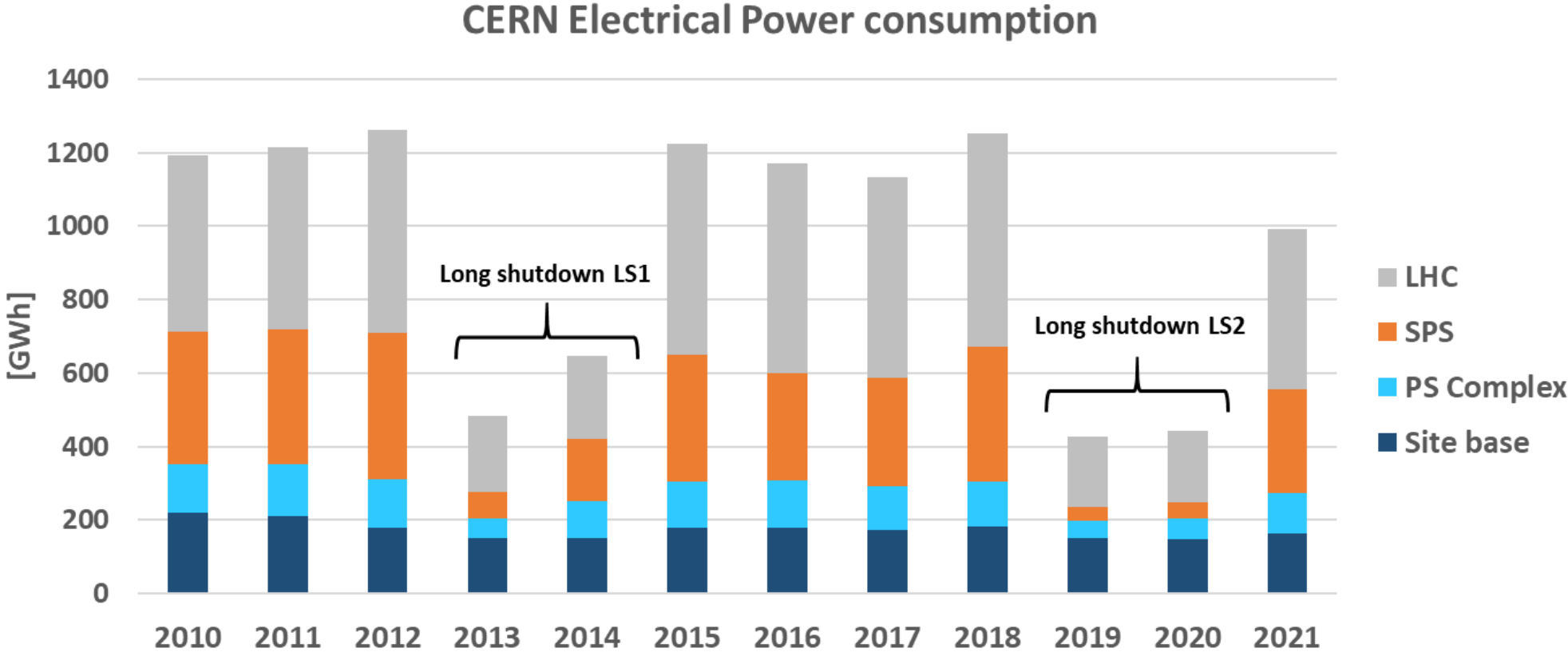
**Particle detection (gases)**  
 Reduction target ~13'000 tCO<sub>2</sub>e/year



**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.*

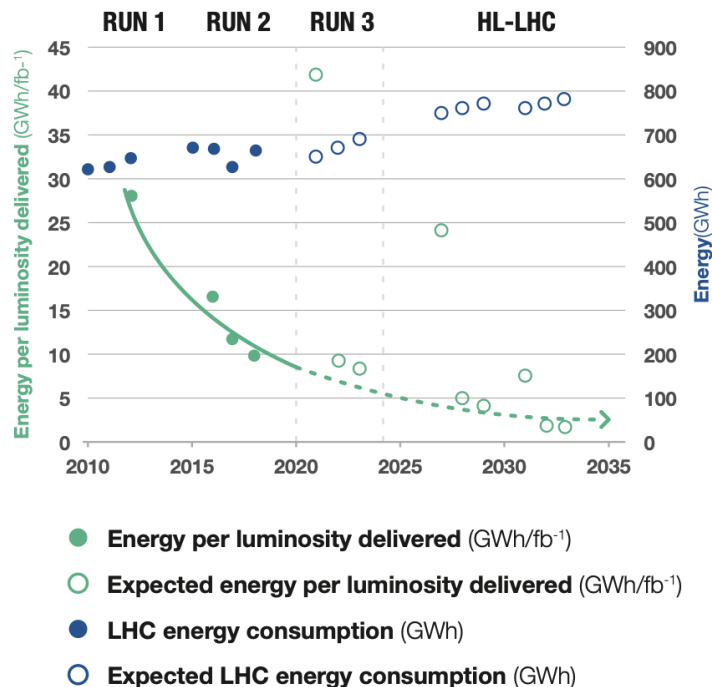
# SCOPE 2: INDIRECT EMISSIONS



# SCOPE 2: ACTIONS ON ENERGY CONSUMPTION

## INCREASE EFFICIENCY

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

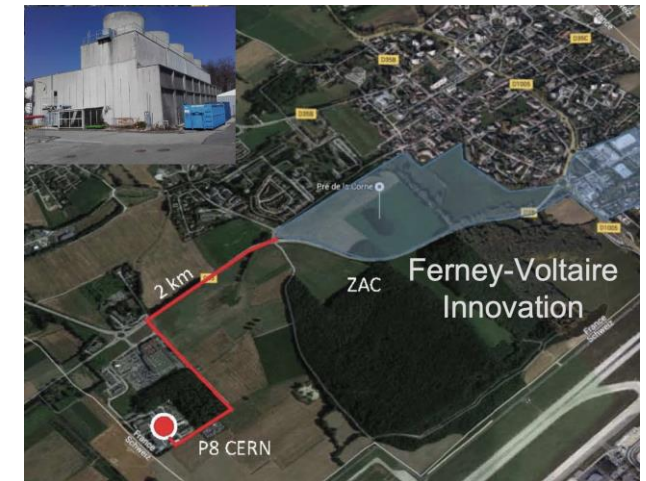


## USE LESS

- **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

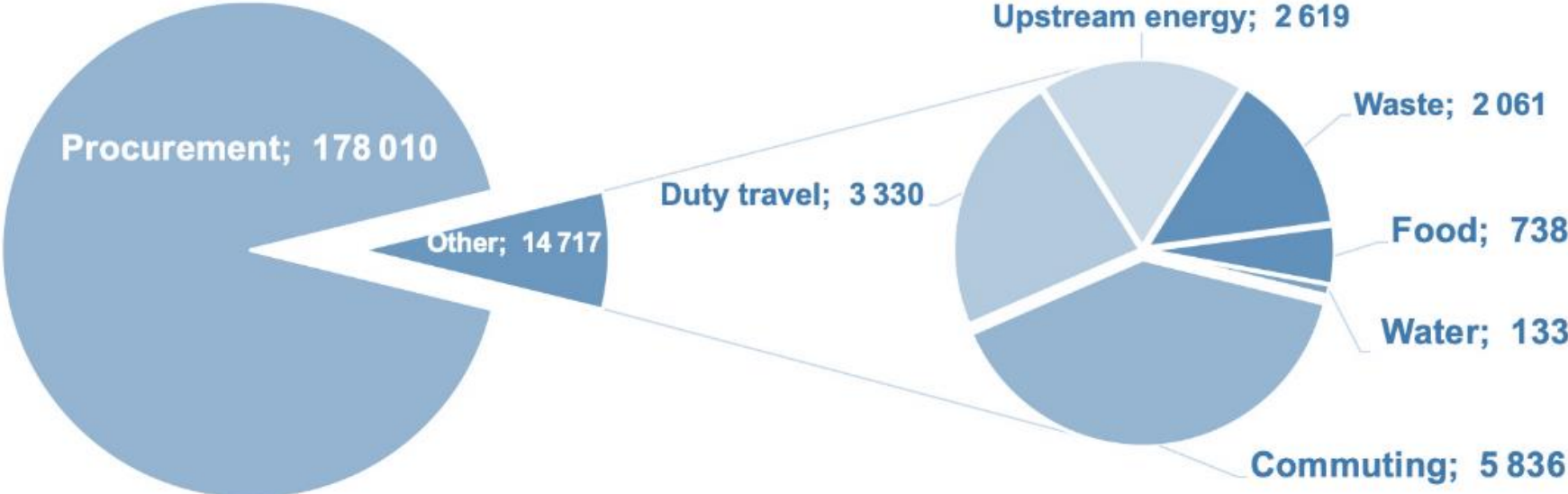
- Hot water from LHC cooling system (P8, 2 x 5 MW heat exchangers) to heat up a residential area (20 GWh/y at peak).



- PCC to heat Preveessin 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<sub>2</sub>e

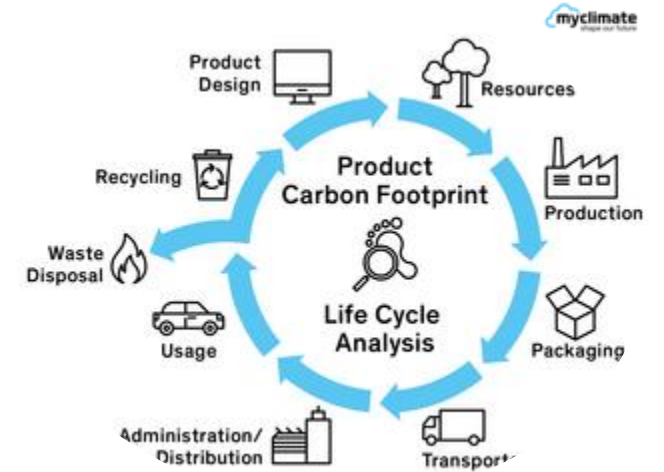


# SCOPE 3: ACTIONS

## Challenge the need!

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

## WHY BUYING



## WHAT DO WE BUY

Polluting materials?  
 Carbon footprint?  
 Social impact?

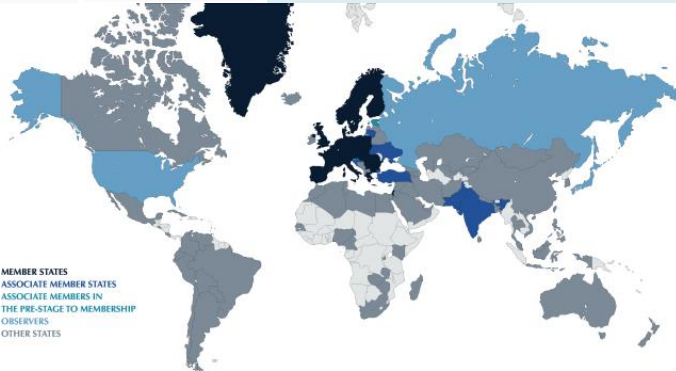
Eco-design/Life Cycle Analysis  
 Resource optimization (water/energy)  
 Total Cost of Ownership (TCO)

Countries/people exposed  
 Duty of vigilance/Compliance

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

## WHO WE BUY FROM

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



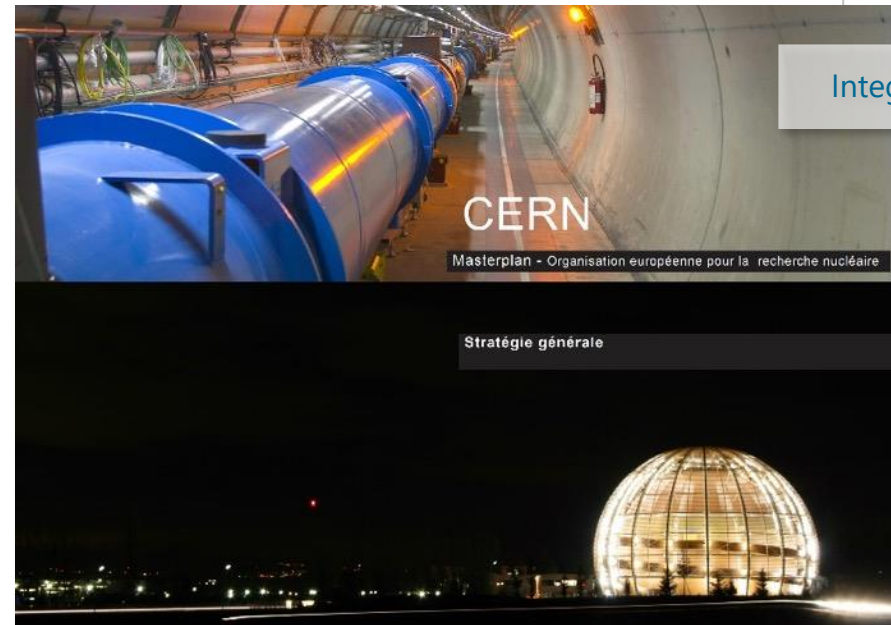
## HOW DO WE BUY

Fair competition  
 Payment deadline

Reasoned negotiation  
 Suppliers' performance  
 Respect of commitments



# CERN MASTERPLAN 2040

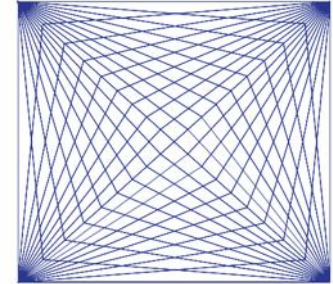


Integration of the latest projects

Integration of SPS land and LHC points

Integration of the Development Guide (CH)

Integration of sustainable development



CERN MASTERPLAN 2040  
Stratégie générale



# MASTERPLAN 2040

Framework objectives and measures

MANAGEMENT OF RESOURCES

INTEGRATION WITH SURROUNDING LANDSCAPE

BIODIVERSITY

LANDSCAPE IDENTITY

POLLUTION

ENVIRONMENT

LANDSCAPE

PARKING

DENSIFICATION

CIRCULATION

BUILDING MANAGEMENT

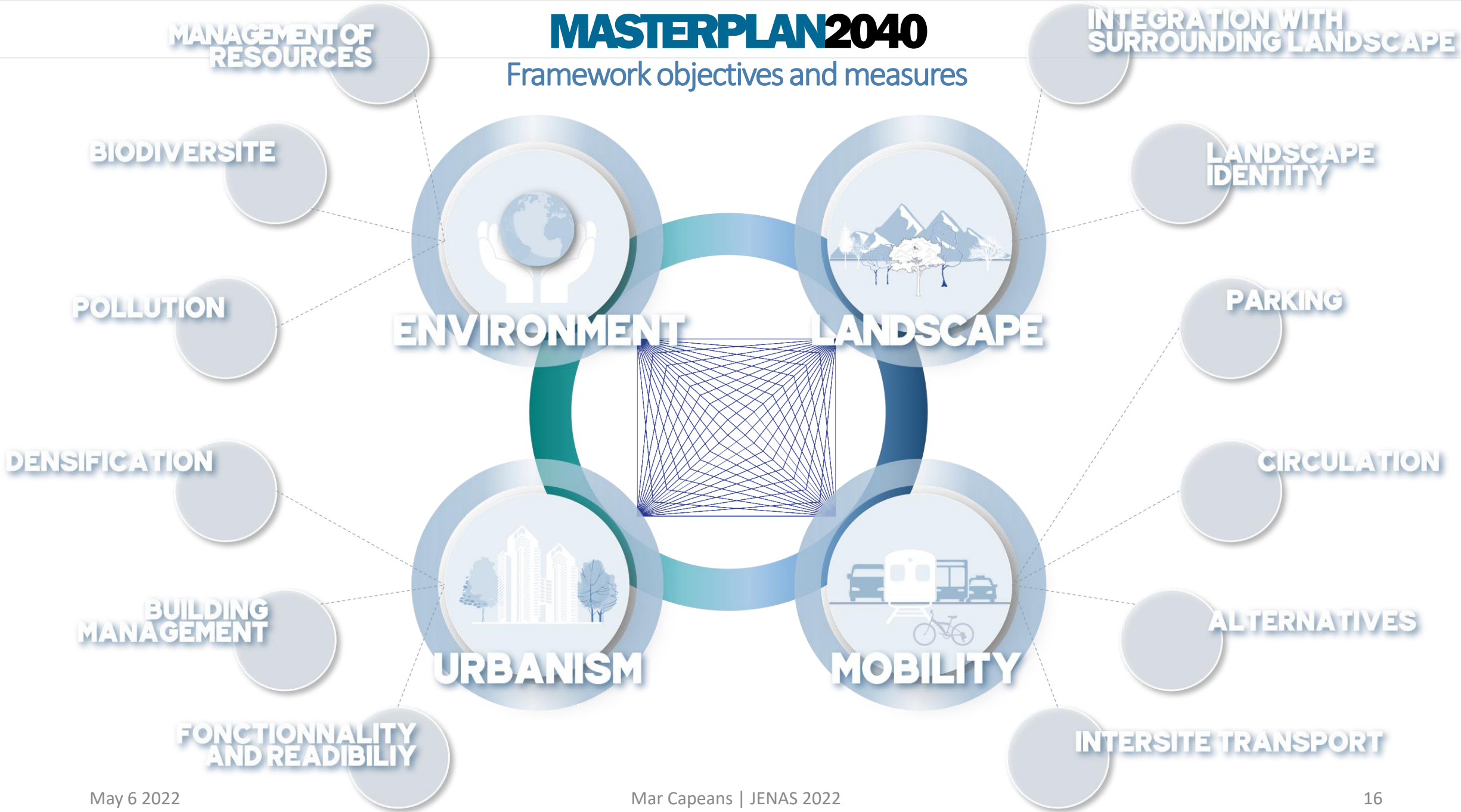
URBANISM

MOBILITY

ALTERNATIVES

FONCTIONNALITY AND READIBILITY

INTERSITE TRANSPORT





## 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:

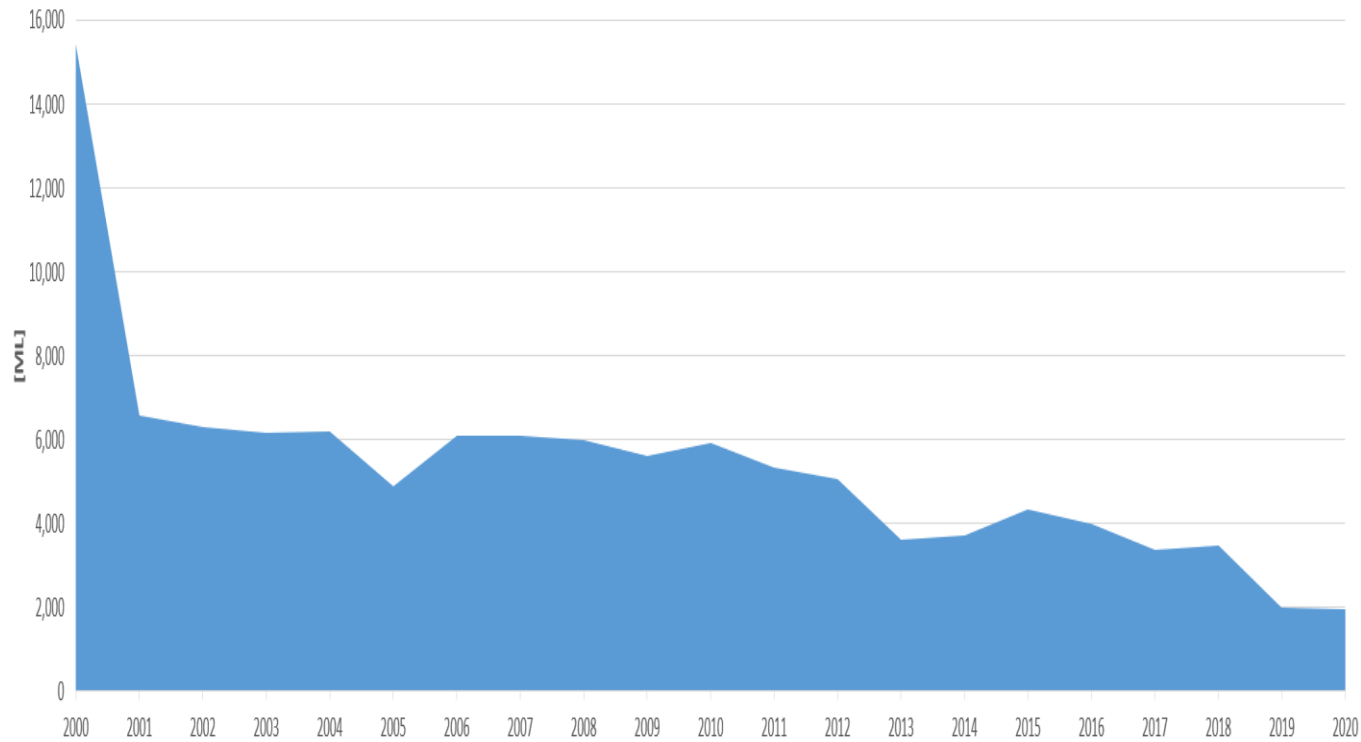
- **Limit noise pollution**
- Increase the recycling rate and reduce waste production



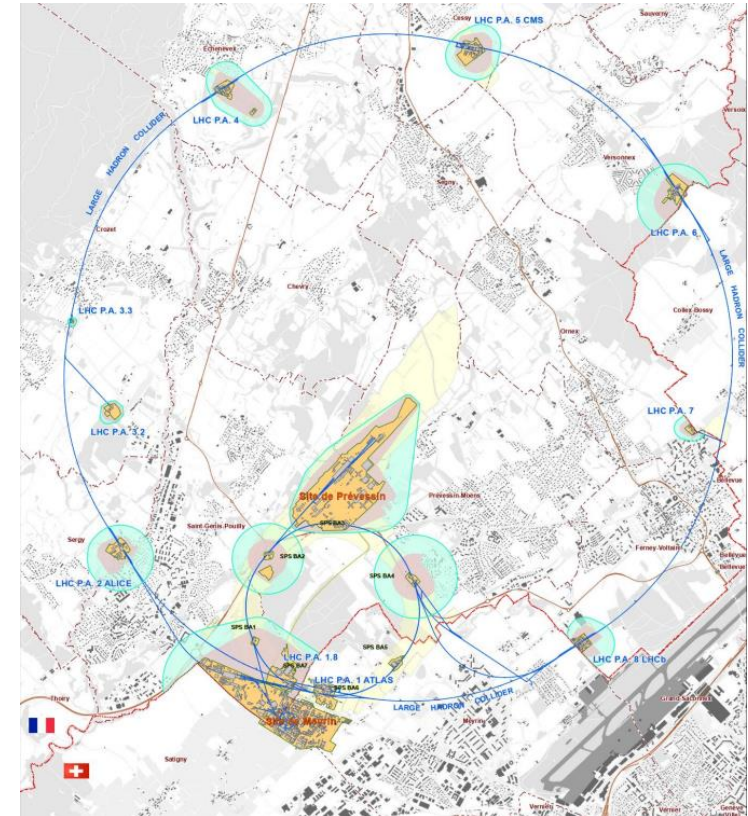
# MASTERPLAN 2040: Environment

## WATER

Annual water consumption



## 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

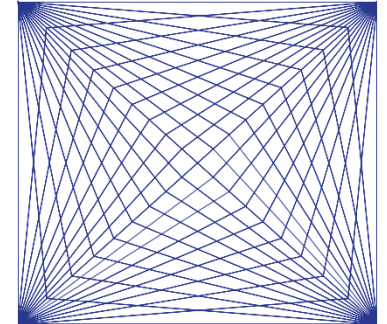
Standardise the use of built-up areas:

- 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
- Propose a specific land-use area on the Swiss side of the CERN site and define regulatory provisions

## FUNCTIONALITY & READABILITY

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 :

- MTP request 2021 and again in 2022
- Operational from 2026 if approved in this MTP

# PREVESSIN OFFICE CENTER



## 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

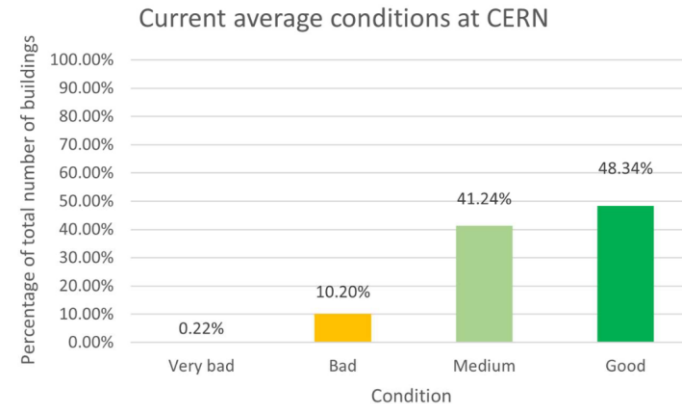
- Safety
- Strategic value wrt scientific goals
- Sustainability: durability, environmental impact, energy performance

## 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

# MASTERPLAN2040



## 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.

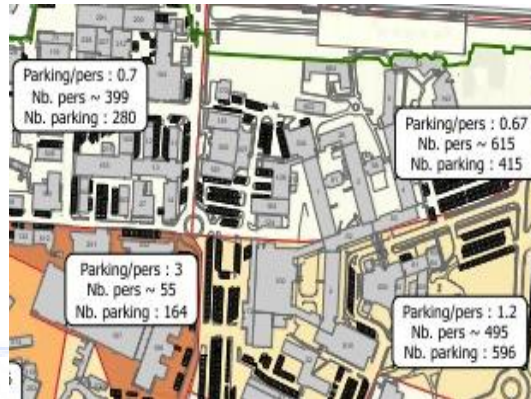
# MOBILITY

## 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 ENVIRONMENTAL APPLICATIONS

### FROM CERN TO SOCIETY

**CIPEA:** Developing advanced technologies linked to environment and sustainability

E.g. solar thermal panels derived from vacuum technology; CO<sub>2</sub> 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



# FUTURE STUDIES & ENVIRONMENT

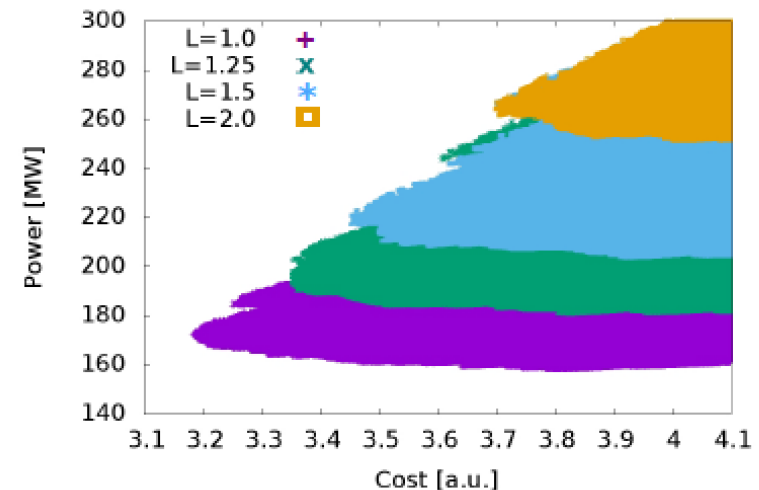
## FCC

- 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)

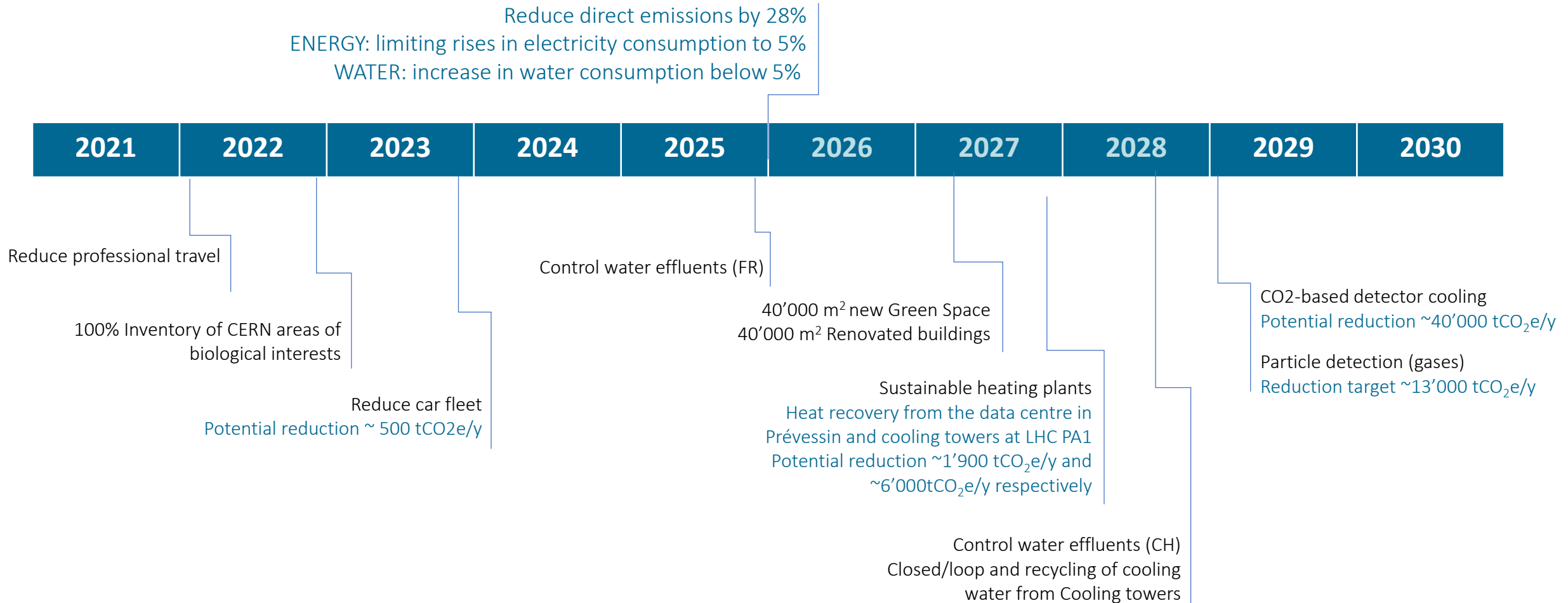
## CLIC

### 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



# 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