Le réseau de transport d'électricité

FUTURE CIRCULAR COLLIDER

# How to plug FCC ?

**Preliminary study for electricity grid connexion of the FCC project**
**FCC WEEK 2023, London (UK)**

# 1 The continental European grid & RTE the French TSO

# European interconnected grid in figures

*Following ENTSOE-E Statistical Factsheet 2021*

Total Net Generation Capacity : **1 155 920 MW**

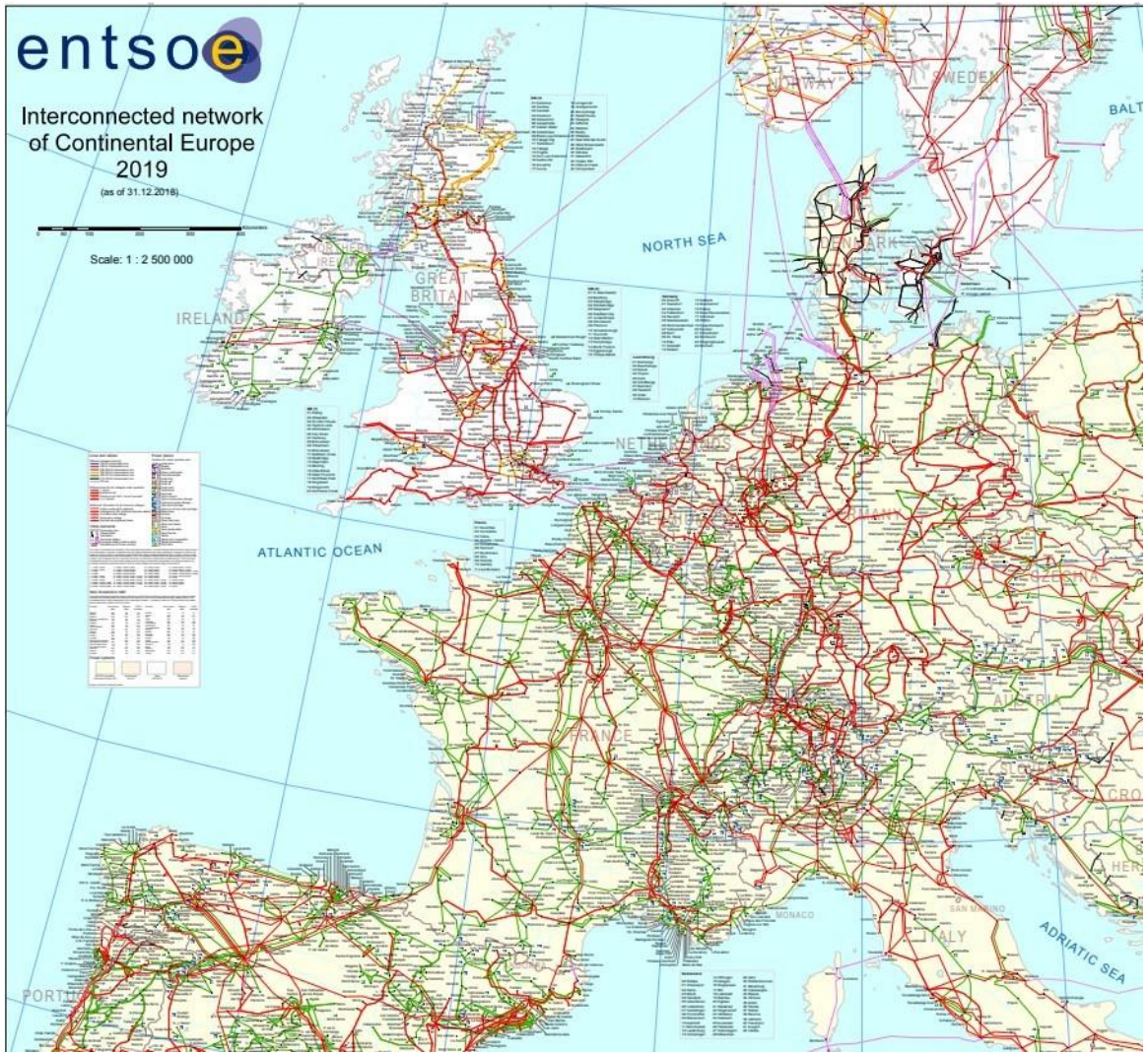
*FCC supply will represent 0.03 percent (400 MW)*

*Only France : 130 560 MW*

Total Net Consumption : **3 186.5 TWh**

*FCC consumption will represent 0.04 percent (1,2 TWh per year)*

*Only France : 465.8 TWh*



## POWER GENERATION

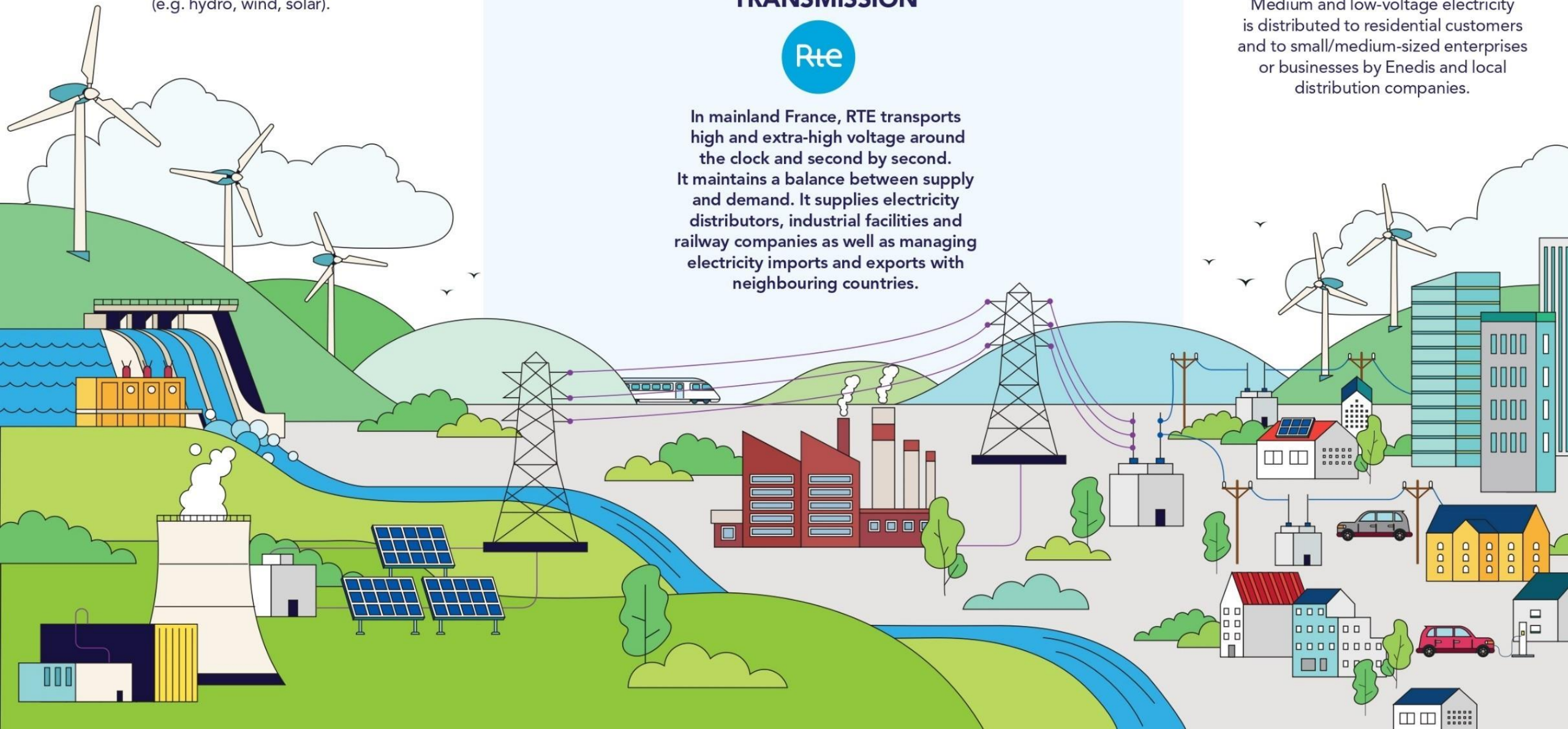
Electricity is generated by various sources of energy, the main ones being nuclear and renewables (e.g. hydro, wind, solar).

## TRANSMISSION

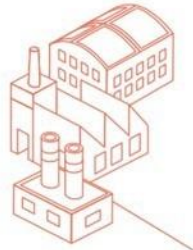
**In mainland France, RTE transports high and extra-high voltage around the clock and second by second. It maintains a balance between supply and demand. It supplies electricity distributors, industrial facilities and railway companies as well as managing electricity imports and exports with neighbouring countries.**

## DISTRIBUTION

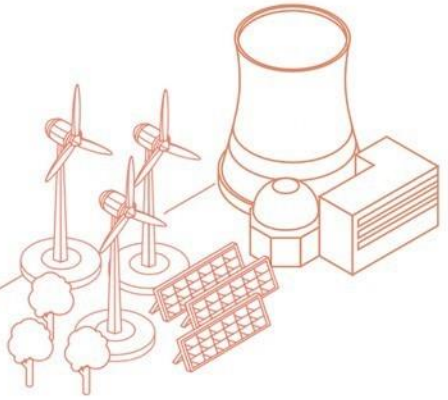
Medium and low-voltage electricity is distributed to residential customers and to small/medium-sized enterprises or businesses by Enedis and local distribution companies.



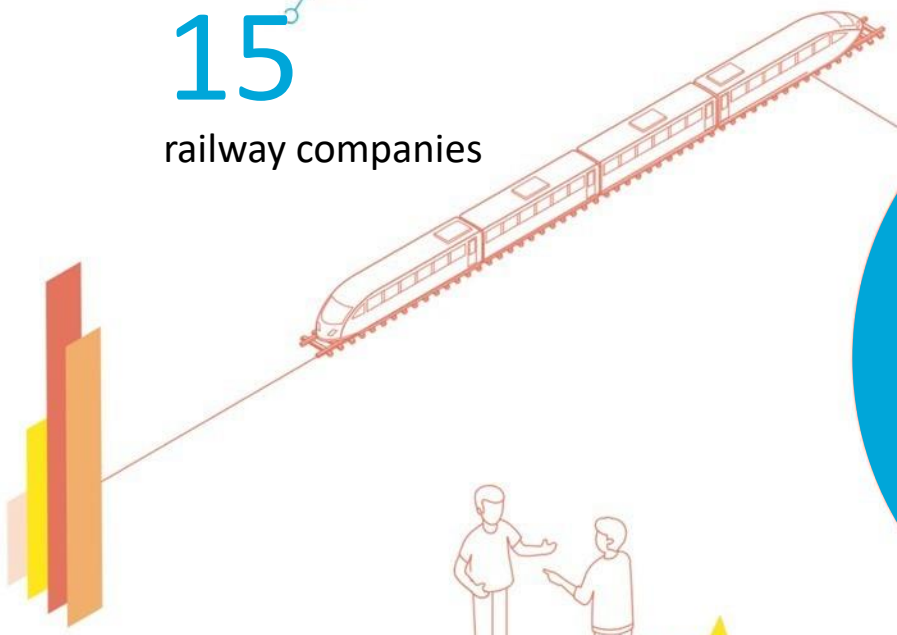
# Between producers & consumers



**380**
industrial consumers on 650 sites



**170**
power producers



**15**
railway companies

**920**
CUSTOMERS

**240**
market players
(balance responsible entities, adjustment actors, demand-side response operators, obligated parties or capacity-mechanism certification entity holders, etc.)

**32**
distribution companies
(Enedis and tier-1 local distribution companies)

# RTE the French TSO in figures…

Europe's leading

TRANSMISSION SYSTEM OPERATOR IN TERMS OF GRID SIZE AND INVESTMENT

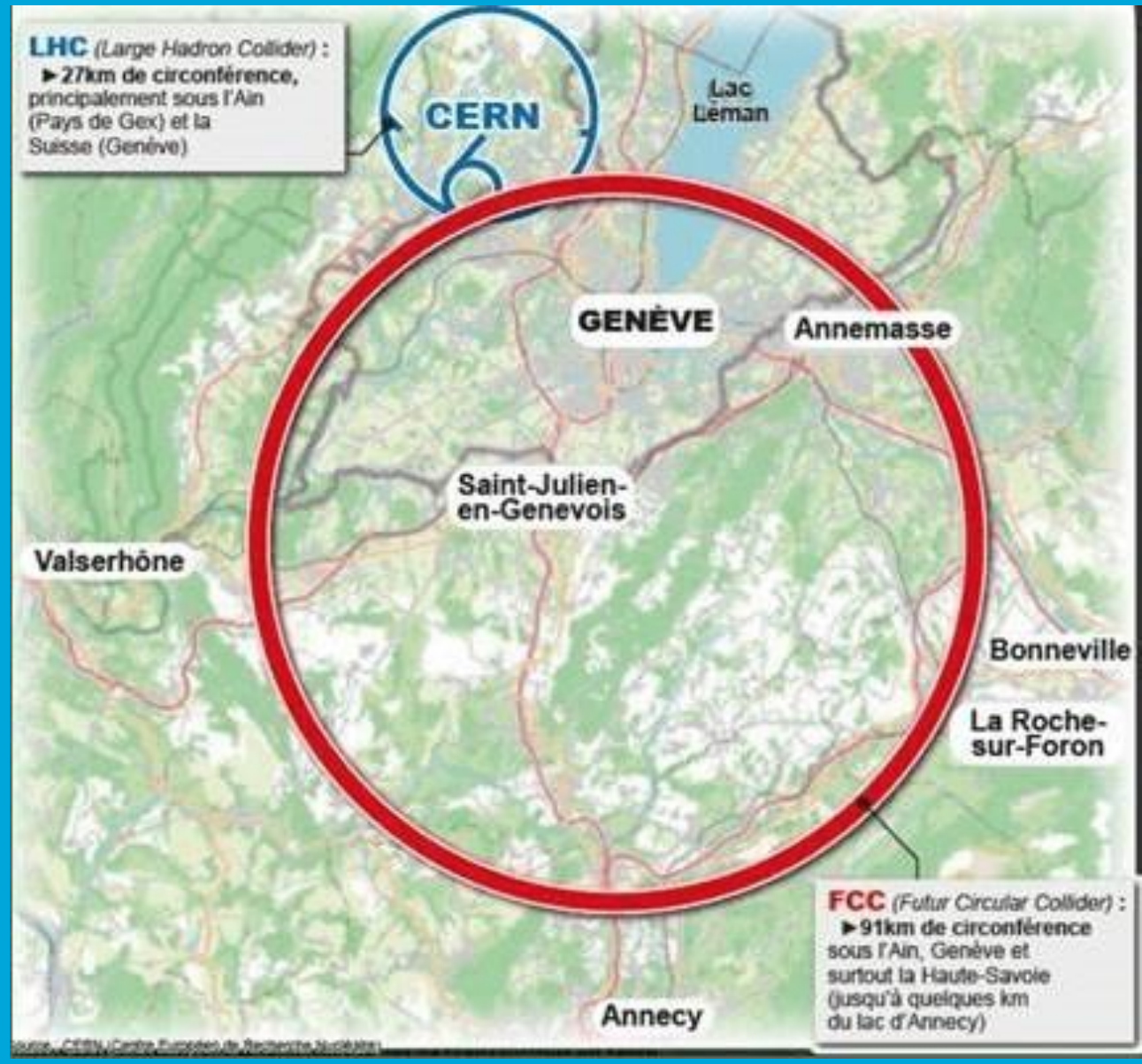
51
cross-border connections

>106,047 km
of power lines
and 2 783 substations currently in operation

22,750 km
of optical fibres

# 2 FCC electricity demand

*Power grid connexions*



# CERN/LHC : present electricity supply

**LHC and other devices are connected to French public grid by 2 lines from BOIS-TOLLOT 400 kV substation**

Installed transformation power : 600 MW,

Max authorised power : **290 MW**

Reel max consumed : 200MW.

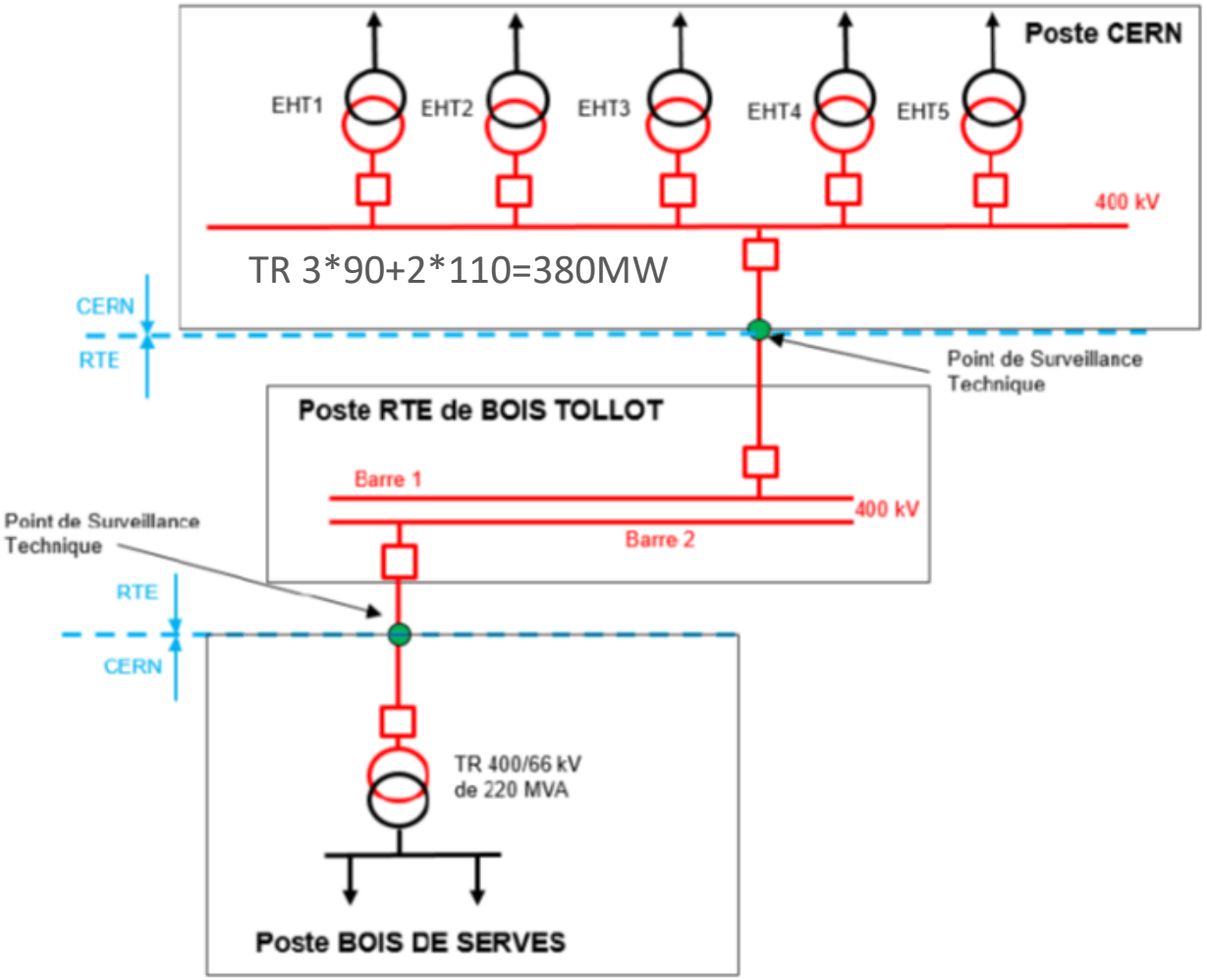
**2 points of connexion :**

- Main : CERN 400 kV
- Complementary : BOIS-DE-SERVES 400 kV

At each point of LHC installation :

- External back-up supply, delivered in HTA voltage, by 8 links connected to the French distribution grid
- Internal back-up supply, delivered by 8 power groups

Another back-up supply come from Swiss 225 kV substation of VERBOIS (**60 MW**) associated to a global power limit in case of unavailability of Bois-Tollot-Genissiat 400 kV line



# FCC electricity demand : main figures

## Building

Electricity supply in HTA voltage :

**8 points of connection** of max. 14 MW each for drilling (currently in study by distribution operators)

## Operating

Global operating supply of **400 MW** delivered in HTB :

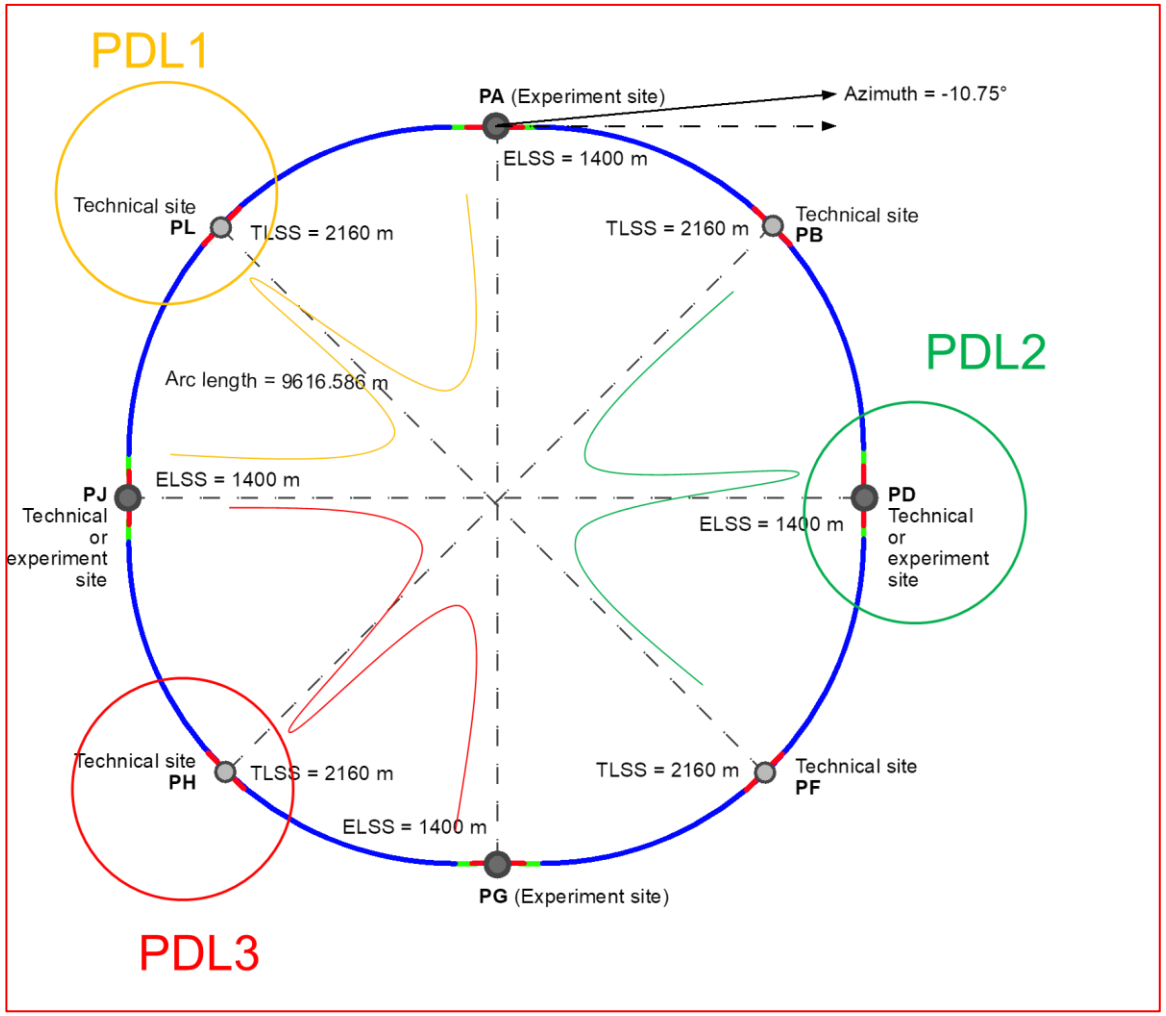
**2 main points of connexion (PH, PL)**

**+ 1 point for redondancy (PD)** with intern mutual back-up

*Also to be considered : up to 90 MW demand at historical point of connexion from Bois-Tollot substation.*

## Other solution in study

<u>One unique point of connexion</u> for both FCC (PL) and historical devices from BOIS-TOLLOT substation



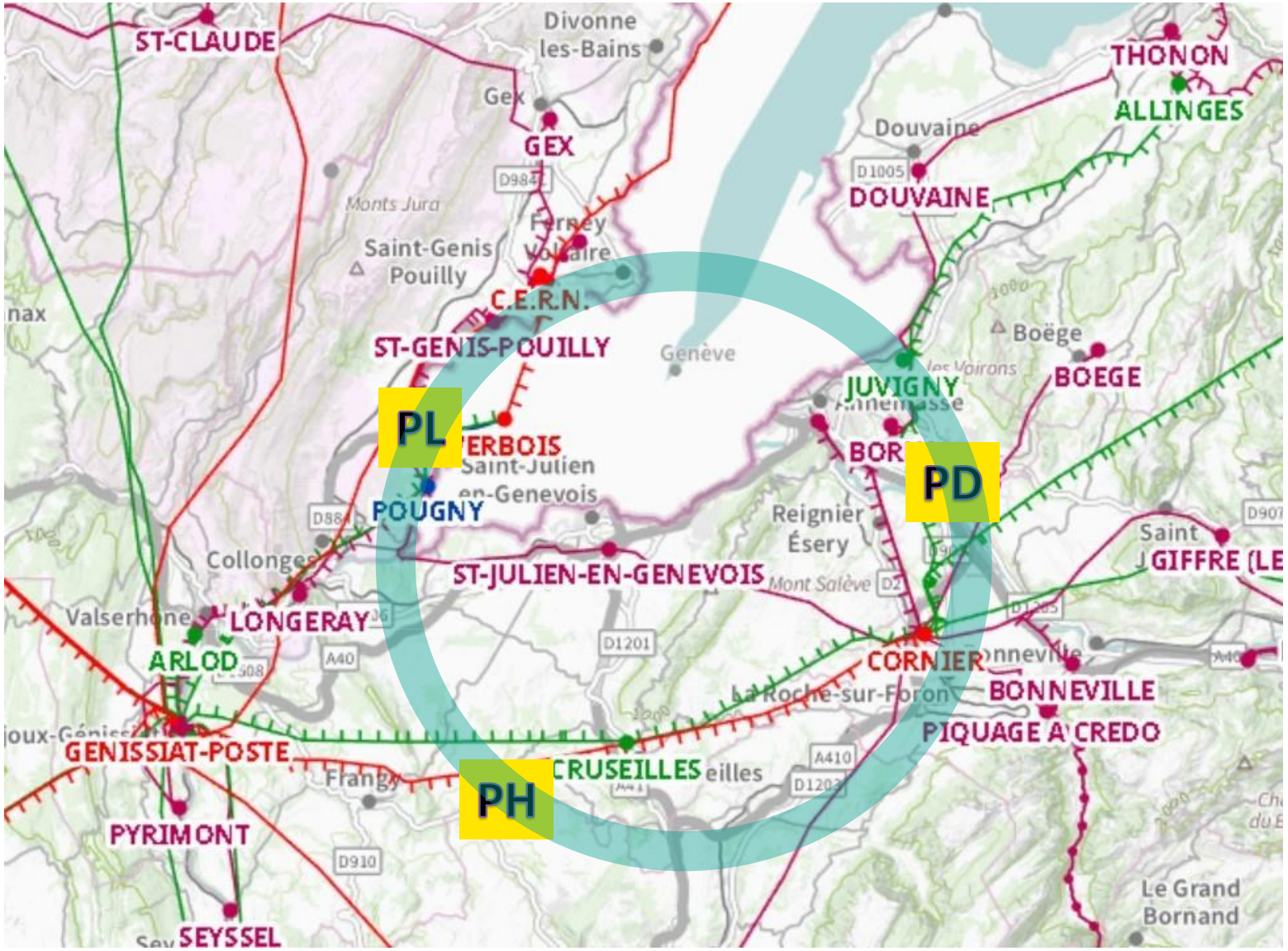
# Existing power grid and points of connexion forecasted

For each point of connexion,

RTE studies <u>at a first step</u> :

- ***The available capacity*** for power demand (transmission limit of existing infrastructure)

- ***The electric infrastucture*** to be built to connect the point to the grid (grid extension)



# 3 Grid connexion prestudy results

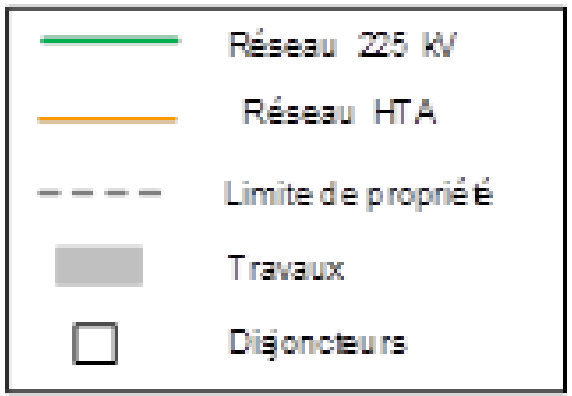
# Connexion of PD (220 MW) - Nangy (74)

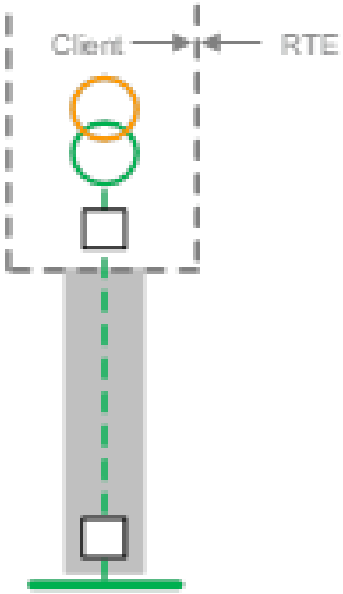
The 220 MW demand can be delivered by CORNIER substation in **225 kV** voltage.

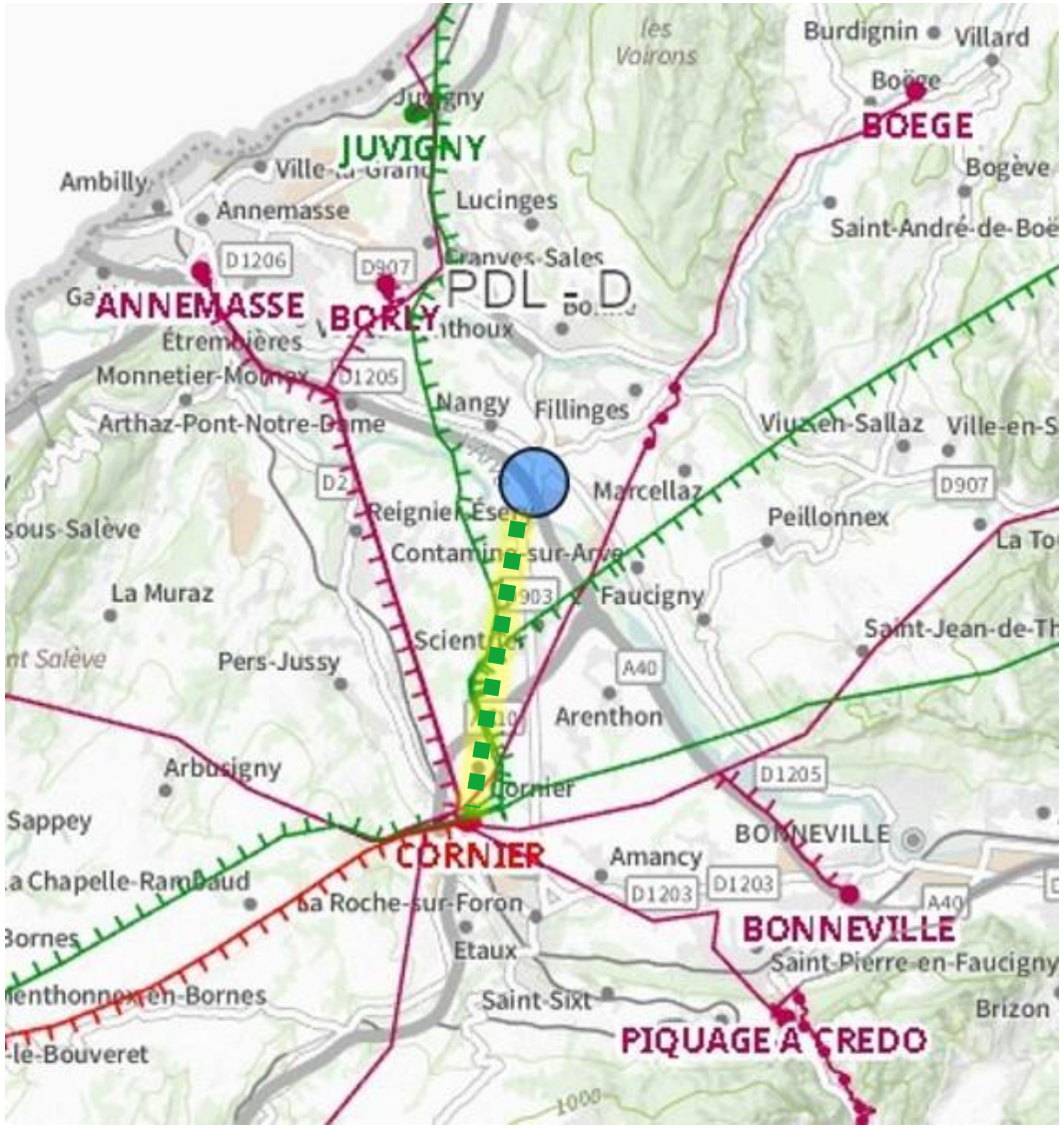
The forecasted grid extension to be built :

- ✓ **11 km underground line between CORNIER 225 kV substation and PD** (design : Al 2000 mm²).
- ✓ 1 new circuit breaker cell in CORNIER substation

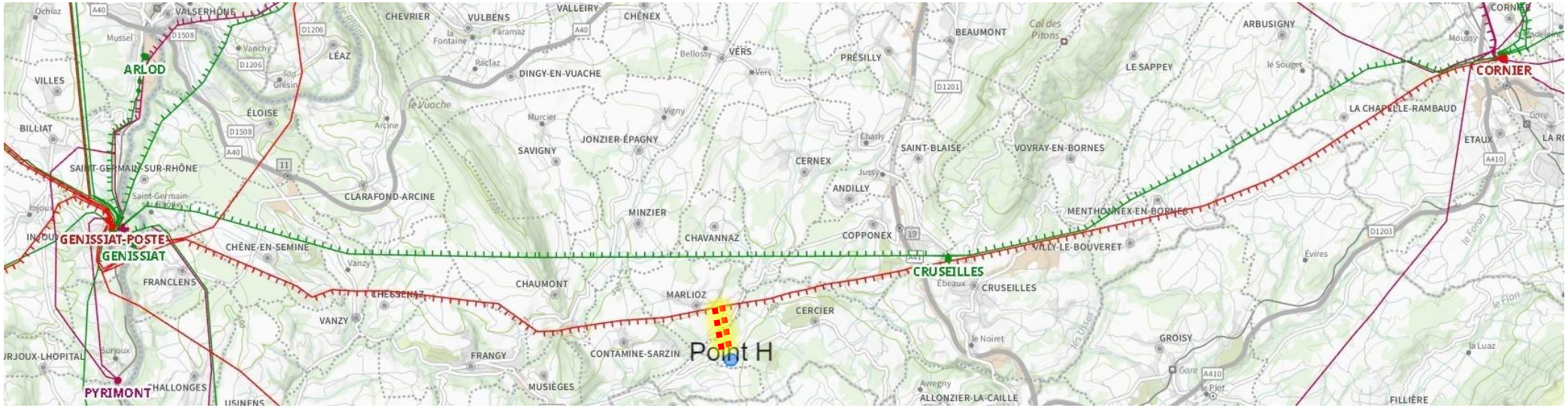
The studies & civil works will have to deal with some technical crossings like A40 highway and the Arve river.



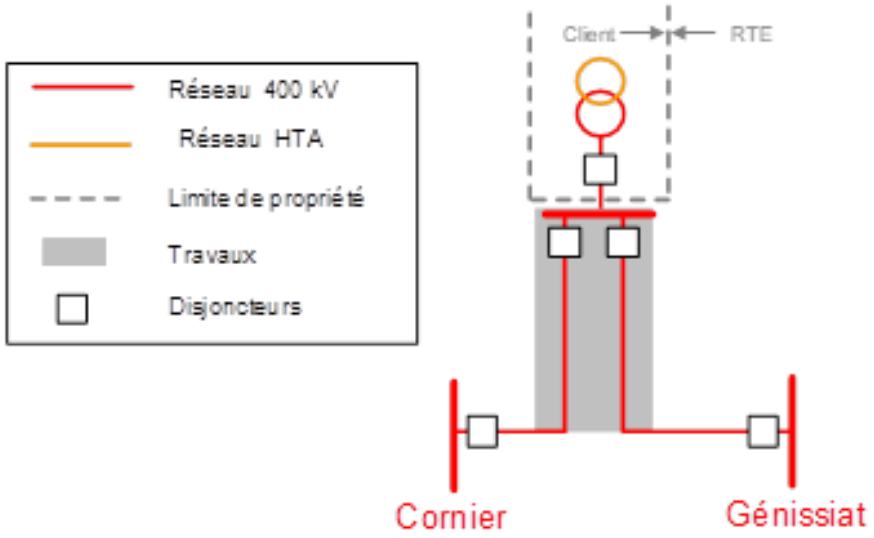
# Connexion of PH (220 MW) - Cercier (74)




The 220 MW demand can be delivered from CORNIER-GENISSIAT or CORNIER-MONTAGNY overhead line in **400 kV** voltage.

The forecasted grid extension to be built :

- ✓ **1.6 km double-circuit overhead line between CORNIER-GENISSIAT 400 kV existing line and PH**.
- ✓ **1 new 400 kV substation at PH** in costumer site

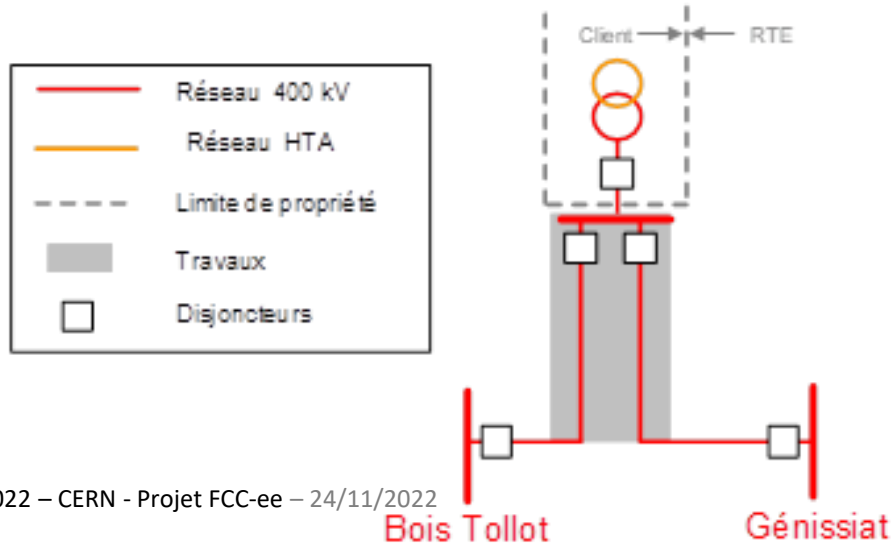


# Connexion of PL (200 MW) - Challex (01)

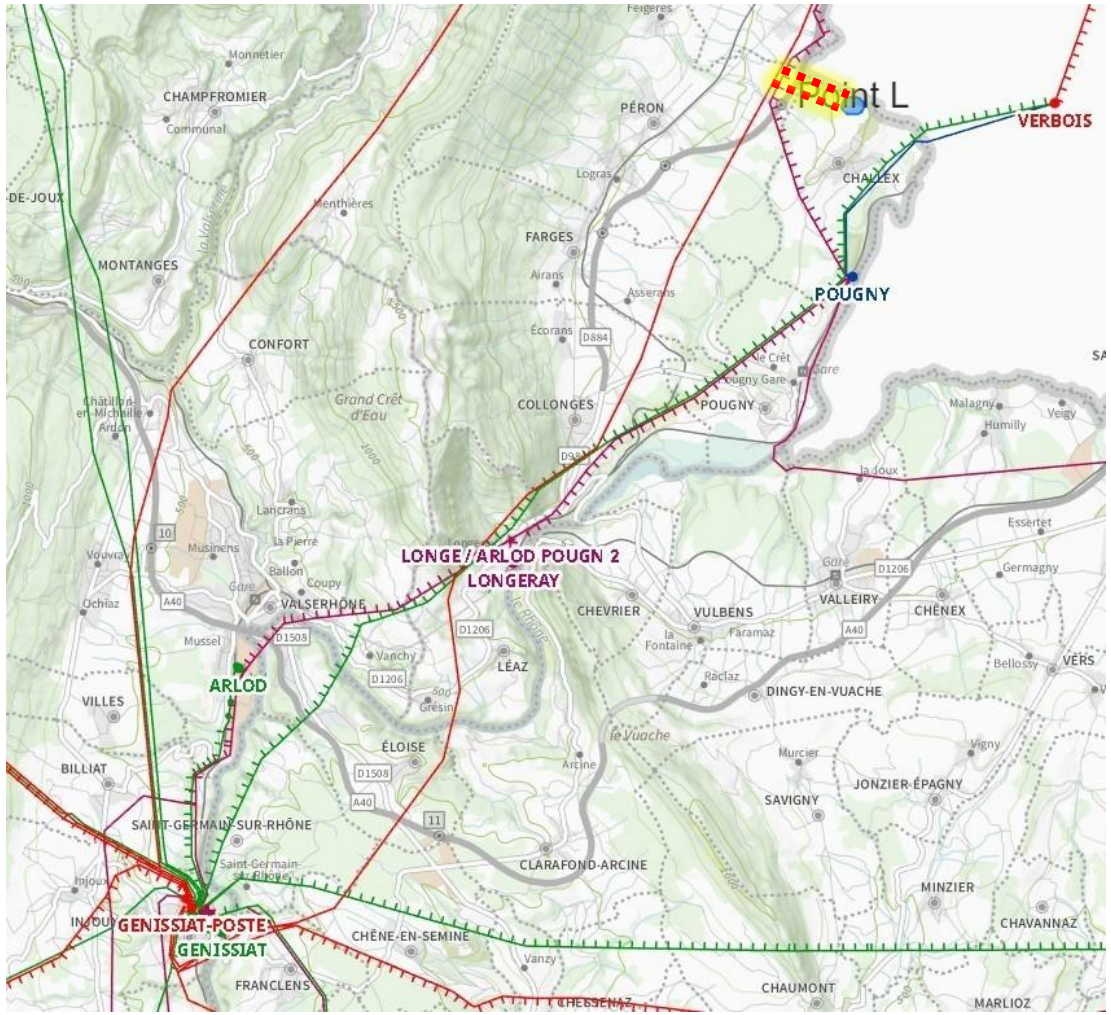
The 200 MW demand can be delivered from BOIS-TOLLOT-GENISSIAT overhead line in **400 kV** voltage, but will reduce Swiss-France interconnexion capacity (equal to present, if HLC demand will reduce to 90 MW max. at BOIS-TOLLOT historical point of connexion)

The forecasted grid extension to be built :

- ✓ **1.5 km double-circuit overhead line between BOIS-TOLLOT-GENISSIAT 400 kV existing line and PL**.
- ✓ **1 new 400 kV substation at PH** in costumer site




To BOIS-TOLLOT 400 kV substation

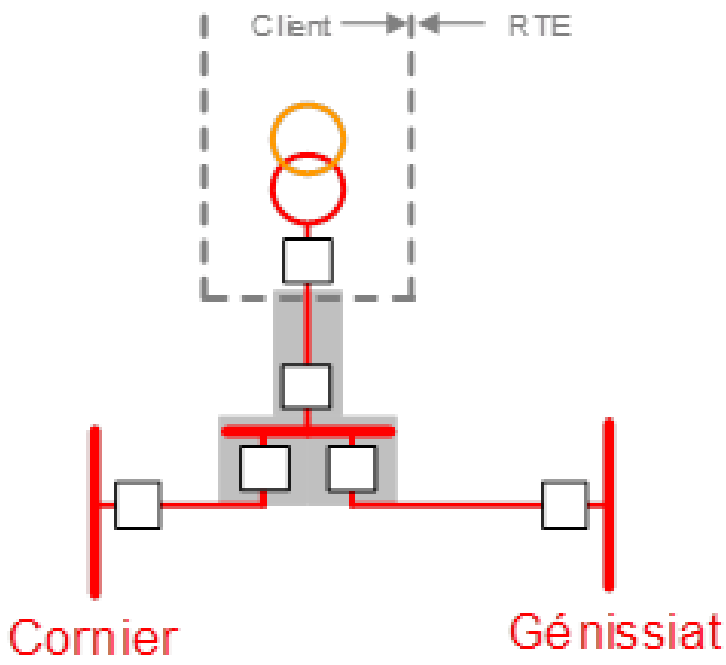


# Alternative solutions for points H and L

For environnemental purposes (mostly : landscape perception), **underground technology** could be prefered for connexion of points H and L, but :

- It supposed to localise the **new 400 kV substation** under the existing OHL
- This strategy leads to approximately 50% additionnal costs

**A 2-km underground line** between existing 400 kV OHL and costumer site has to be build.



# Forecasted costs and delays

| Point of connexion | Voltage | Total grid extension costs | FCC participation | Delay from firm command |
|---|---|---|---|---|
| PD | 225 kV | **25 M€** | 70% or 100% (*) | 5 years |
| PH | 400 kV | **19 M€** | 70% | 8 years |
| PL | 400 kV | **18 M€** | 70% | 8 years |
| Global | | **62 M€** | 43-55 M€ | |
| Option : Underground 400 kV | | **+ 18 M€** | + 13 M€ | |

**Be aware** :

The costs do not include HTB costumer infrastructure (HTB circuit breaker, transformers, etc.) but only public grid extension.

The final costs could vary by +/- 30 percents from the forecast.

These costs are for 400 kV overhead line technology.

(*) in case of redundancy

# 4 To go further

# Grid connexion : a regulatory process

3 months instruction

3 months validity

Request for Technical and Financial Proposal (TFP) → TFP → TFP acceptance → Technical studies & legal autorisation → Connection agreement


Draft studies of the most suitable solution

Commitment for costs (+/- 15%) and delays

2027

*6 months after TFP agreement*

Protections and metering **specifications** required by RTE sent to the customer

Defines the characteristics of the infrastructure needed

Defines the metering and the power of the connection.

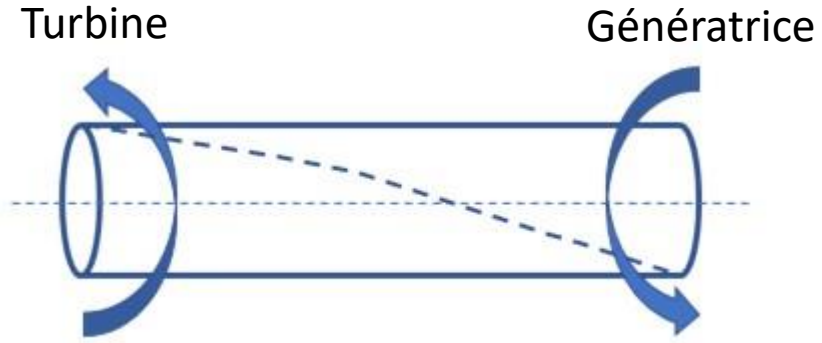
Works → Operating agreement + Grid Access Contract → Commissioning

2035

# Complementary studies to be led

**Further electrical studies (TFP)**

- Voltage drop (reactive power)
- Short-circuit power capacity
- Protection and safety (overload, short-circuit…)




Study of electrical phenomena such as potential **Torsional Interaction against Devices** (TI-D)

- Power pulse can damage the turbine shafts of the generators in the electric « neighboroud »
  (the CIGRE classifies it among the Subsynchronous Oscillations)

To anticipate in reason of studies delay and potential influence on FCC design or grid equipment (capacitors)

**Engineering design of infrastructures to buid & legal autorisations (after TFP acceptance)**

# 5 Thank you for your attention

*Discussion*