How to plug FCC?

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

920 CUSTOMERS

- 15 railway companies
- 380 industrial consumers on 650 sites
- 170 power producers
- 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

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

22,750 km of optical fibres

51 cross-border connections
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 redundancy (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**

One **unique point of connexion** for both FCC (PL) and historical devices from BOIS-TOLLOT substation
For each point of connexion, RTE studies **at a first step**:

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

- **The electric infrastructure** to be built to connect the point to the grid (grid extension)
3 Grid connexion pre-study 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 customer site
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
Alternative solutions for points H and L

For environnemannal 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

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

**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
To go further
Grid connexion: a regulatory process

Request for Technical and Financial Proposal (TFP)

3 months instruction

Draft studies of the most suitable solution
Commitment for costs (+/- 15%) and delays

3 months validity

TFP acceptance

Technical studies & legal autorisation

6 months after TFP agreement

Protections and metering specifications required by RTE sent to the customer

Connection agreement

Defines the characteristics of the infrastructure needed
Defines the metering and the power of the connection.

2027

Works

Operating agreement + Grid Access Contract

Commissioning

2035

EE 22-1022 – CERN - Projet FCC-ee – 24/11/2022
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 « neighborhood »
  (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 build & legal autorisations (after TFP acceptance)
Thank you for your attention

Discussion