HPC at the service of energy efficiency

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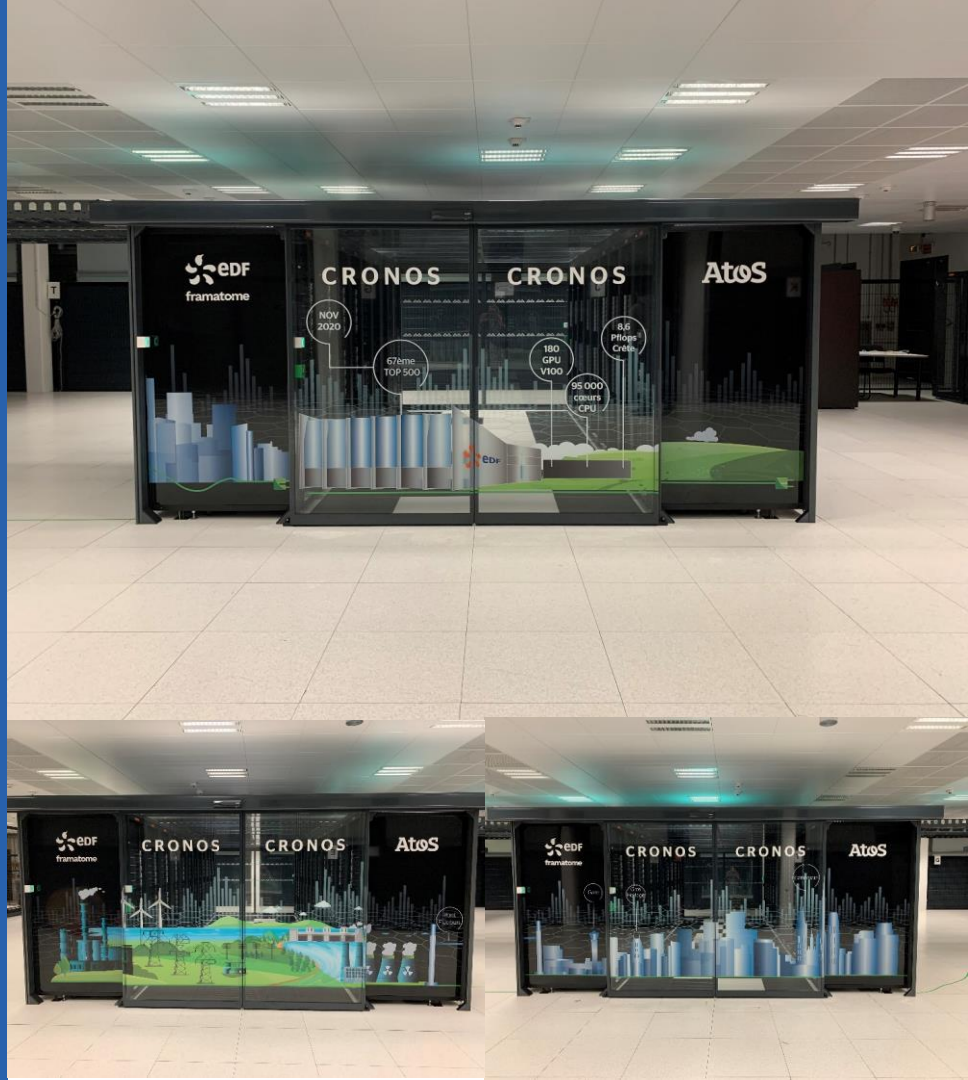


EDF GROUP PRESENTATION

EDF
IN BRIEF

AIM:

Be the leading electricity company and global leader for low-carbon energy production.

WORLD'S No. 1 ELECTRICITY COMPANY

Particularly well established in Europe, especially France, the United Kingdom, Italy and Belgium, the Group's energy production, marked by the rise in renewable energy, relies on a diversified low-carbon energy mix based on nuclear power.

LEADER IN LOW-CARBON PRODUCTION

No. 1 producer of nuclear electricity in the world

No. 1 producer of renewables in Europe

No. 3 European operator of energy services

EDF COVERS ALL ELECTRICITY ACTIVITIES

Generation

Transmission and distribution

Supply

Energy services

A PURPOSE TO GUIDE EDF

"Build a net zero energy future with electricity and innovative solutions and services, to help save the planet and drive wellbeing and economic development"




OUR STRATEGIC PROJECT

Stepping up a gear to build a carbon-neutral energy future

The EDF group undertook a major commitment in 2020 by including its raison d'être in its articles of association. This decision places equal importance on decarbonising energy and the economy in general, safeguarding the environment and supporting growth. Pursuing a pathway to achieve carbon neutrality by 2050 has motivated us to ramp up the targets we set to reduce our direct and induced CO2 emissions by 2030. We stepped up our CAP 2030 strategy accordingly, as we need to go even further and faster to fulfil our commitments.

EDF R&D

4 STRATEGIC PRIORITIES

in line with the EDF Group's CAP 2030 project

DEVELOP & TEST
new energy services for customers
Find out more

PREPARE
the electrical systems and networks of the future
Find out more

CONSOLIDATE AND DEVELOP
competitive and zero-carbon production mixes
Find out more

SUPPORT the Group's international growth by developing research partnerships
Find out more

3 AREAS OF RESEARCH

LINE 1
The **ELECTRICAL SYSTEM** transition
Find out more

LINE 2
The **CLIMATE CHANGE** transition
Find out more

LINE 3
The **DIGITAL AND SOCIAL** transition
Find out more

6 TECHNOLOGICAL TARGETS

Smart cities
Find out more

Nuclear of the Future Initiatives
Find out more

Electrification of end uses
Find out more

Small Modular Reactor
Find out more

Low carbon electrical power system
Find out more

Energy storage
Find out more

EDF POLICY : SOME CONTEXTUAL ELEMENTS TO INTEGRATE

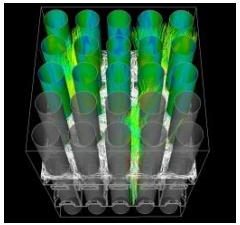
- **Plants operated over 40 – 100 years**
  - Guarantee safety, minimize environmental footprint
  - Maintain assets

- **Fast changing operating conditions**
  - More competitive markets,
  - Tougher regulations, ageing, environment

- **New business models and services**
  - Data science, Open Data, Artificial Intelligence, Blockchain, ….
  - Cloud computing
  - Smart meters

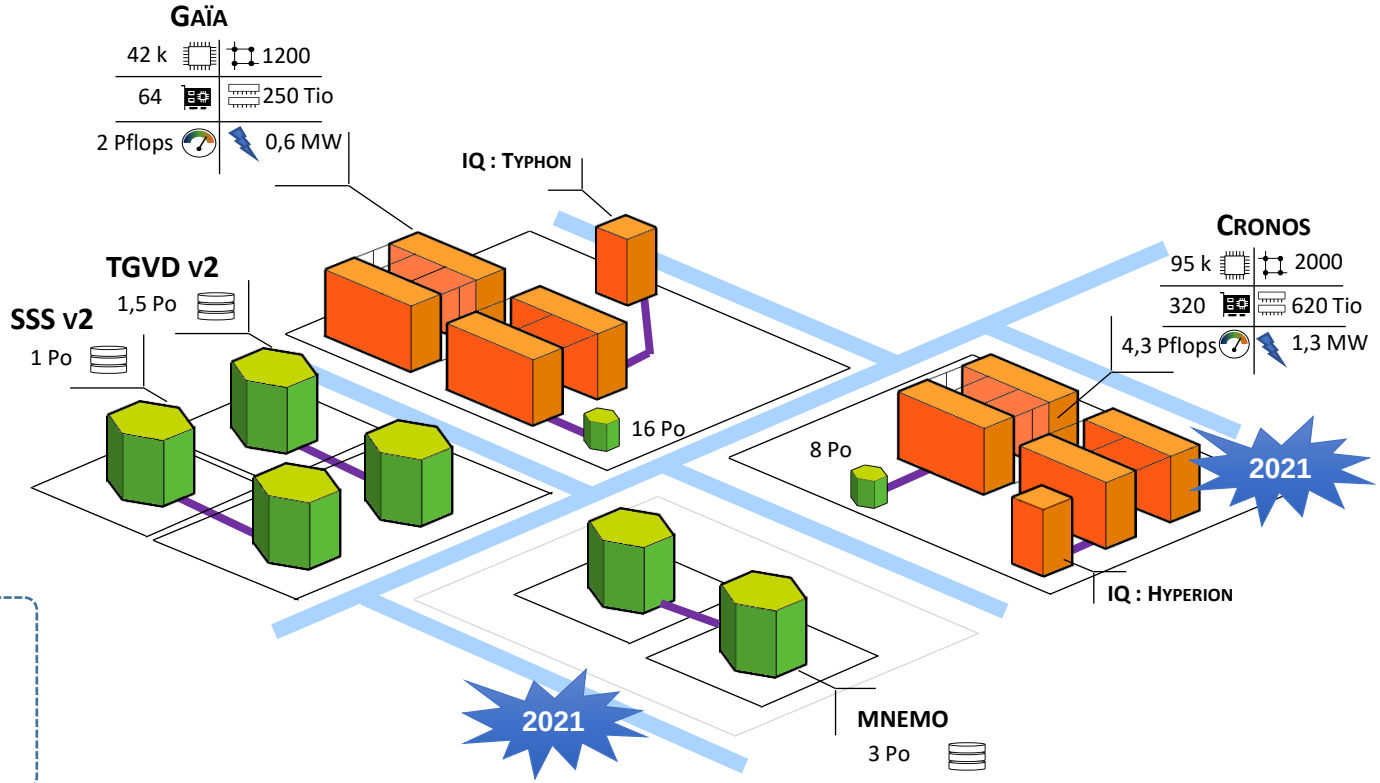
Figure 2 : Emprise et bathymétrie du modèle 3D.

- **Energy Transition**
  - Diversified energy mix (nuclear, renewables,…)
  - Products and services, energy-saving solutions, help customers to manage their consumption
  - A dual digital and energy transition for both society and the economy



EDF is active in **all areas** of energy from **generation** to **trading** and **network management.**

EDF High Performance Computing Facility



Main domains of HPC applications (both Physical Simulation and Data Analysis)

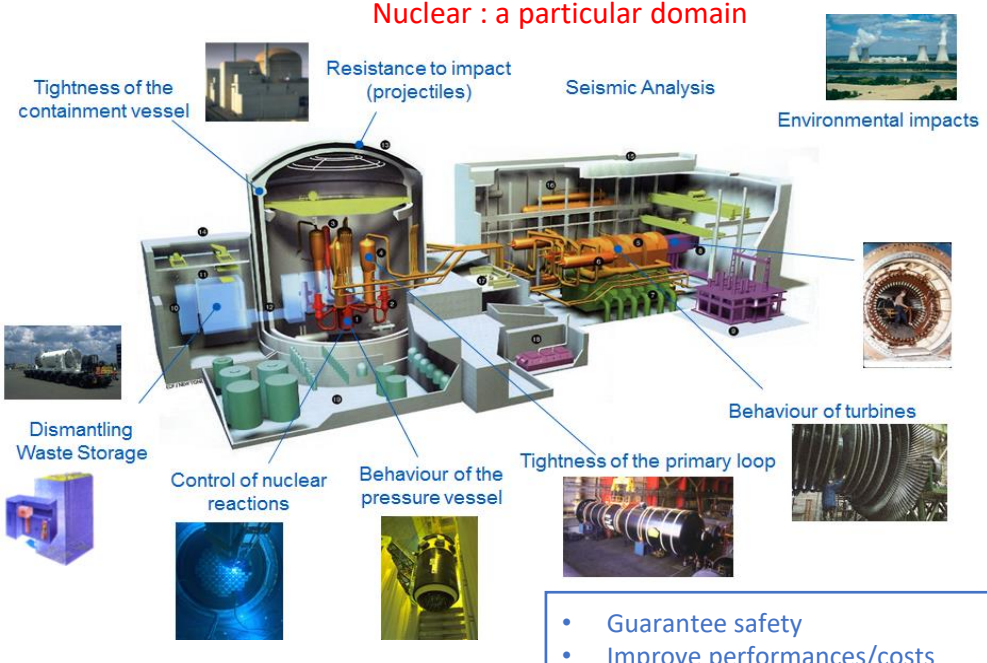
ENERGY PRODUCTION (Nuclear, Renewable, Hydraulic, Thermal, Environment)

Network / Smarties (smart-grids, smart-cities)

Marketing

Energy Management

Nuclear : a particular domain



- Guarantee safety
- Improve performances/costs
- Maintain assets
- Face unexpected events
- Ageing issues…

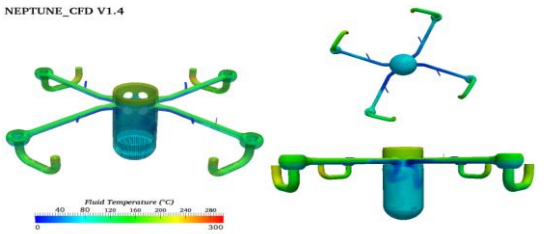
Benefits of the HPC :

- ✓ Less simplifying assumptions
- ✓ More information
- ✓ More calculation scenarios
- ✓ Take into account incertainties

SOME CHALLENGES TO COME FOR HPC… AND AI

- **Simulation of multi-scales and/or multi-physics phenomena**
  - EX : simulation of a whole energy system (power plant, electrical networks, buildings)
- **Probabilistic simulation : the use of uncertainties / calibration / assimilation methods**
  - Ex : impact of intermittency on the network
- **Pre-processing of input data and post-processing of simulation results**
  - Efficient tools to mesh complex geometries and **vizualize a deluge of results** (including uncertainties) !
- **Connection between HPC and ROM (Reduction Of Model)**
  - Modelisation of complex and heterogeneous systems
- **Connection between HPC and Data Science / Data Analytics / Artificial Intelligence**
  - Real time calculation, assimilation and analysis
  - Analysis of significant data
  - Validation, qualification of codes
  - Quality of numerical simulations
  - Improvement of Security / Cybersecurity
- **(The last but not least) Impact of quantum computers**
  - How to re-write existing codes ?

Figure 2 : Emprise et bathymétrie du modèle 3D.

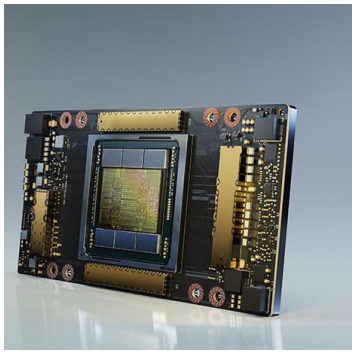


HPC, ENERGY EFFICIENCY AND ENERGY TRANSITION

On the datacenter side :

- In 2015, EDF obtained AFNOR ISO 50001 energy management certification
- In 2022, for the 7th year, EDF renews its ISO 50001 certification which recognizes balanced and efficient energy use in the operation of its Datacenters
- Continuous improvement of energy performance (scientific contribution):
  - Virtualization of IT equipment (license server, VDI, …)
  - Technological upgrades (renewal of HPC, GPGPU, …)
  - Optimization of the cold chain (cold doors -> confinement)
  - Adaptation to climate change (cold / hot water cooling)
  - The set temperature of the IT rooms
  - Decommissioning of IT equipment

https://www.intel.fr/content/dam/www/central-libraries/us/en/images/xehpc-xe-core.png.rendition.intel.web.720.405.png



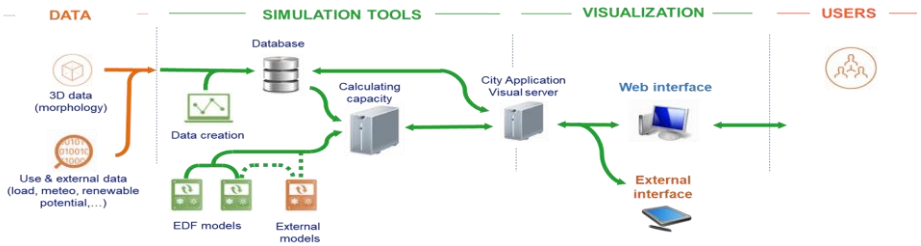
https://www.nvidia.com/content/dam/en-zz/Solutions/Data-Center/a100/nvidia-a100-hero-bb460_420-d.png

On the apps side :

- We develop a significant part of our codes
  - Eco-design is taken into account for new codes
  - Integration of new technologies (GPGPU, NEC Aurora, …): optimization of energy consumption (Flops/watt)

HPC, ENERGY EFFICIENCY AND ENERGY TRANSITION

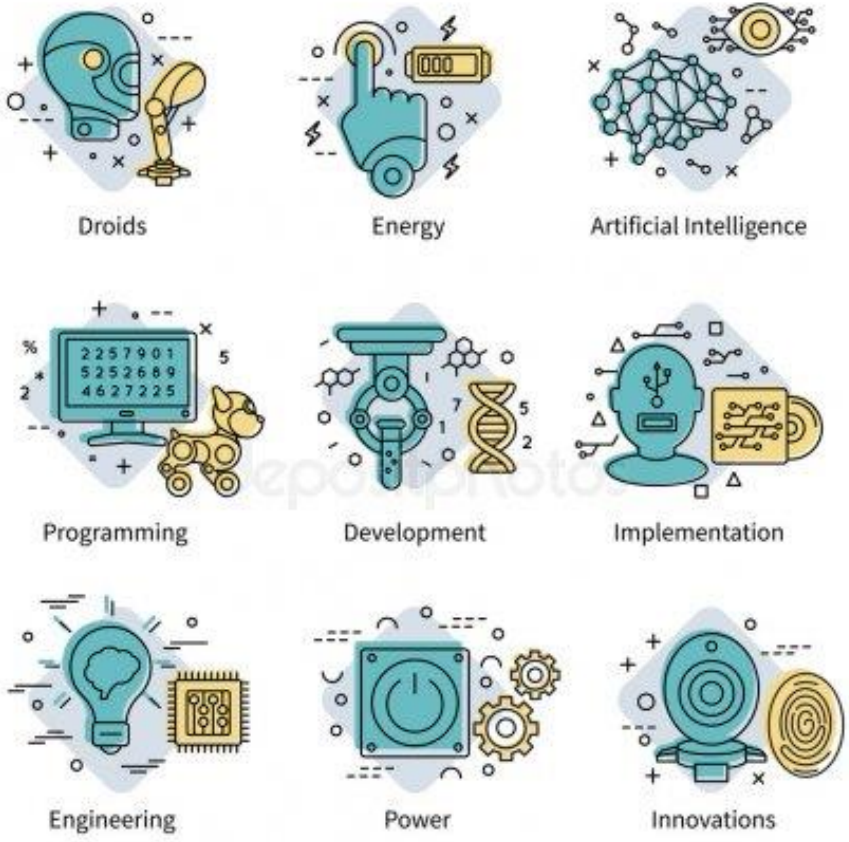
- **On the users side :**
  - A lot of studies in link with Energy Transition and CAP 2030:
    - Small Modular Reactor
    - Electricity Storage Plan
    - Renewable Energy
    - Smart Cities, Smart Grids, …
    - Digital Twins



3D City simulation platform - data & model driven decision support

  - Communication to users of Energy Consumption in link with HPC and data storage
    - 2 POCs just started : energy_scope (INRIA) and EAR (BSC)
      - Report energy consumption per job, per study to user/management
      - Define an energy footprint per code (balance between nodes, consumption per node, network and compute consumption, …) to optimize usage
      - Reduce the consumption of nodes for a small extended calculation time
    - Reduction in the number of compute hours potentially lost (analyze time out, jobs failed, jobs cancelled, …)
    - Convince users to keep only useful data

Energy needs modelization, simulation … and more and more artificial intelligence !



Thanks you for your attention