



The role of Nuclear in climate change mitigation in the post-Covid context

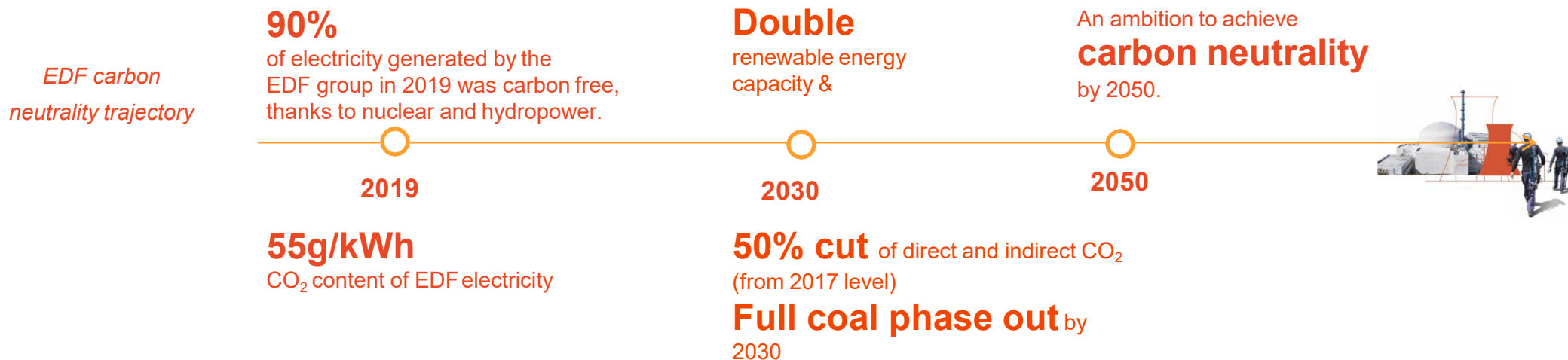
SNETP Forum

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EDF/DIPNN/DT

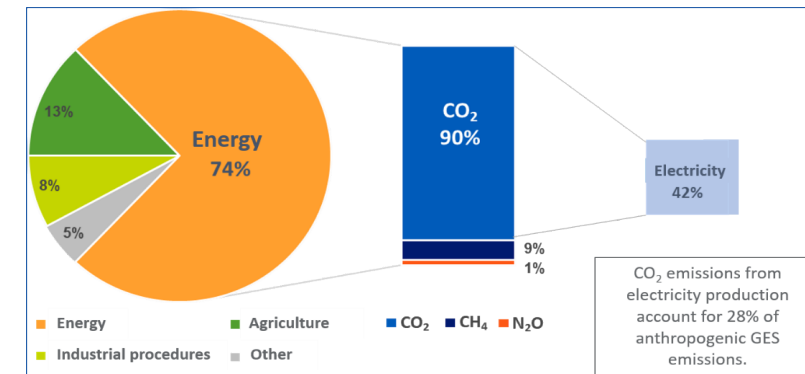
Feb. 2nd 2021



1. NUCLEAR POWER IS A LOW CARBON ENERGY SOLUTION FOR GLOBAL WARMING MITIGATION



- Electricity is a key vector for limiting CO₂ emissions, but the share of fossil fuel remains high in electricity generation (65% in 2020 / world scale)
- France is committed to **carbon neutrality by 2050**
- 2035: **50% nuclear + renewables + hydro**
- 2050: with **nuclear**, power system is **more resilient** and more **cost efficient**
- The decision to start a new nuclear program in France in the coming years keeps **all options opened for 2050**.

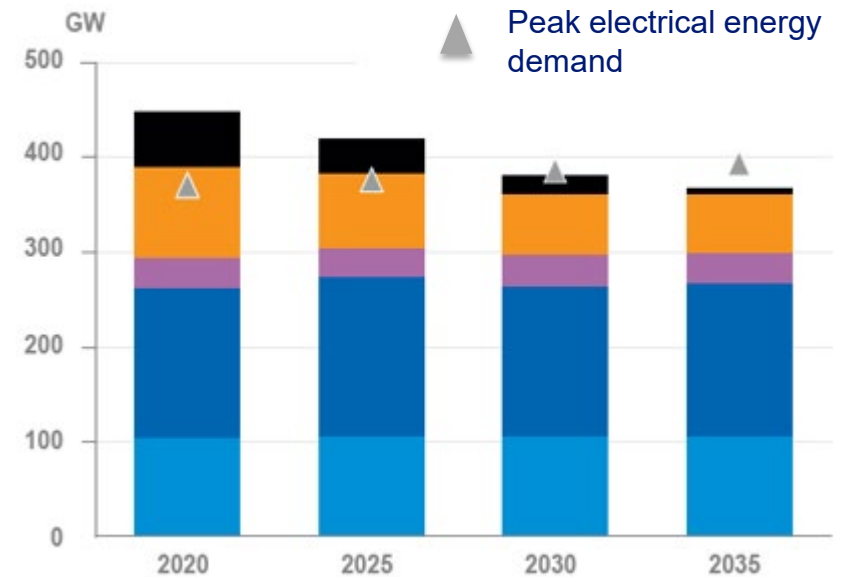


*Emissions exceed 50 Gt_{CO2e} per year,
3/4 of which is energy-related*

2. BY 2030-35, DISPATCHABLE RESOURCES WILL NO LONGER COVER PEAK DEMAND

- By 2030-2035, around 100 GW of dispatchable power will be withdrawn from the European grid, including around 23 GW of nuclear (including 13 GW in France), 70 GW of coal and 10 GW of gas or fuel oil.
- In the event of particular climatic conditions such as prolonged lack of wind, peak demand is no longer covered by dispatchable production by 2035 on the France and neighboring countries plate. Under these conditions, electricity supply security becomes uncertain.
- Hydraulic pumping station sites are already nearly all equipped in Europe and large hydrogen & battery energy storage are still technical challenges.

Nuclear Technology is both an available and reliable technical solution, and a carbon free dispatchable energy



Forecast of dispatchable electrical assets in Europe

3. NUCLEAR POWER IS A POST-COVID 19 SOLUTION

- The covid pandemic crisis has highlighted the European dependency of key sectors activities such as industry and pharmacy ;
- Production of electricity, regarding its economical, social and human role, should remain a sovereign matter: nuclear power is an industry controlled at European level ;
- Once the crisis solved, development of new nuclear power plant projects will be a good way to establish a rapid economic recovery and to boost local employment.

COVID – 19:
LESSONS LEARNED AND
NEW CHALLENGES IN
ENERGY PRODUCTION



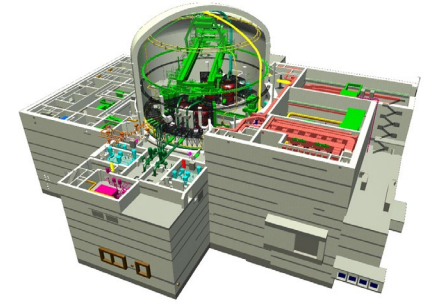
4. A CONTINUOUS SAFETY IMPROVEMENT, TAKING INTO ACCOUNT CLIMATE CHANGE

- Periodic safety reviews of existing plants allow to upgrade safety level by integrating design changes in order to cope with climate change ;
- New Nuclear Reactors integrate climate change in their design ;
- Climate change is taken into account to assess the risks of production losses linked to compliance with current regulations & occurrence of scenarios inducing supply chain ;
- On this basis, EDF defines various solutions such as:
 - Modifying unit shutdown schedules to avoid heatwave periods for certain sites,
 - Managing stocks of materials / fuels,
 - Modifying logistics flows, etc.

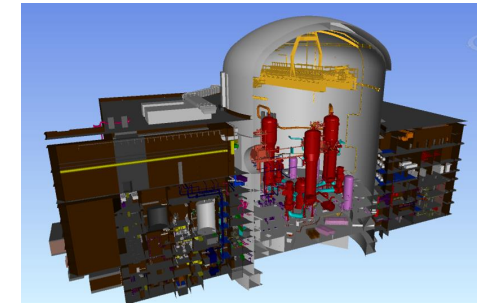


5. EDF IS DEVELOPPING A FULL RANGE OF REACTORS

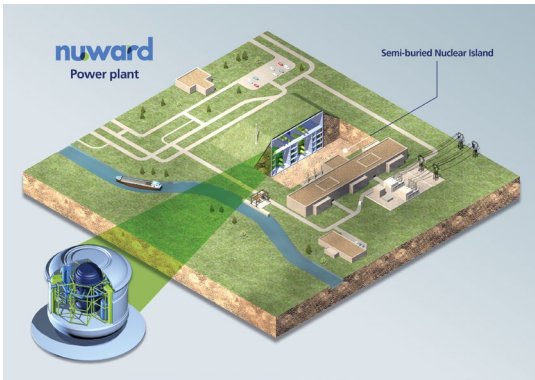
To answer operators and market expectancies, EDF is developing a full range of reactors, from the large power to the small reactor.



- EPR 2: high power reactor integrating feedback from the design, construction and operation of EPR reactors and the EDF fleet – 1750 MWe
 - Simplification of design to improve constructability
 - Involvement of manufacturers and operators from the design stage
- EPR 1200: 3 loops version of EPR2 – 1200 MWe



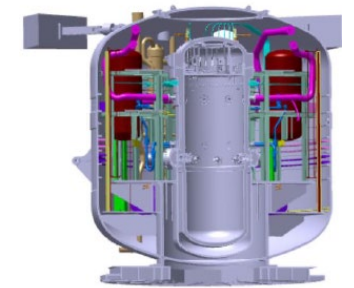
- SMR – Nuward™ : a safe, simple and competitive reactor
 - **Innovative integrated reactor** : architecture without primary loops, compact primary components especially steam generators located inside the pressure vessel
 - **High level of safety** : resistance to hazards, passive systems with large grace period (no classified power supply/no external heat sink/no operator action), severe accident management, for a safe operation during several days
 - **Two independent reactors facility** : simplified and optimized architecture with a modular design and fabrication
 - **Low carbon energy, flexible and continuous generation** : complementary with renewable intermittent sources and with large nuclear power plants, alternative to existing fossil sources and allowing other applications (Combined Heat & Power, desalination...)
 - Lower network size and economic constraints.



6. TO IMPROVE SAFETY AND PERFORMANCE, INTENSIVE RESEARCH PROGRAMS ARE NEEDED

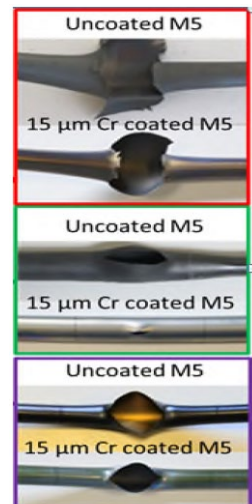
Research & Innovation to enhance safety and performance, to reduce nuclear waste

- Improve our knowledge of physical phenomena and ageing mechanisms, reinforce mechanical and safety margins management, develop computational tools and artificial intelligence approach
- Strengthen our climate change knowledge and improve our climate hazards models in order to design optimal protection;
- Take benefit of digitalization and digital twins to improve safety and maintenance program ;
- Study and test SMRs innovations for safety and competitiveness : submerged clusters, boron-free core, passive systems for increasing grace time ;
- Develop fuel with better tolerance to design basis accidents, including LOCA : Accident Tolerant Fuel ;
- Improve our vision of fuel cycle closing including waste reduction and resource optimization.



Reduction of high temperature creep providing additional margins during LOCA

Strengthening effect leading to significantly smaller clad ballooning and/or crack opening with respect to core coolability





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