NUWARD™

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OUTLINE OF THE PRESENTATION

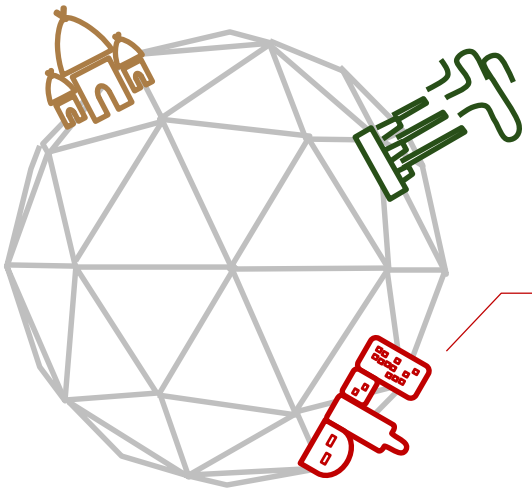
1. SMR: a new paradigm
2. NUWARD™ product, technologies & innovations
3. NUWARD™ development route
4. Conclusion

1. SMR: WHAT IS AT STAKE ?

- In the context of the Paris Agreement and while several countries are setting **ambitious goals in terms of decarbonisation of their economies to reach net zero carbon emissions by 2050**, nuclear energy and more specifically small modular reactors (SMRs) represent a significant potential worldwide.
- SMRs address
  - the need of many countries to develop or have access to nuclear power to support their transition towards a low-carbon energy mix,
  - the need for reliable and dispatchable electricity generation to complement renewable energies,
  - the need to power remote and energy-intensive industrial areas,
  - the possibility to build nuclear plants closer to the consumers thanks to their reduced power,
  - the opportunity for emerging countries to have access to nuclear power with lower investments than for large reactors,
  - risk reduction in construction and quality issues thanks to the series effect and simplification.
- A variety of SMR technologies are being developed raising the interest of several countries and governments. **Notwithstanding the growing numbers of SMR models under development, the commercial maturity of those technologies still need to be corroborated by industrial and economic feasibility.**

1. SMR: SEVERAL MARKET ORIENTATIONS

Several market orientations for heat or electricity generation, ranging from 5 to 400 MWe



5 to 15 MWe for the needs of isolated communities or military areas

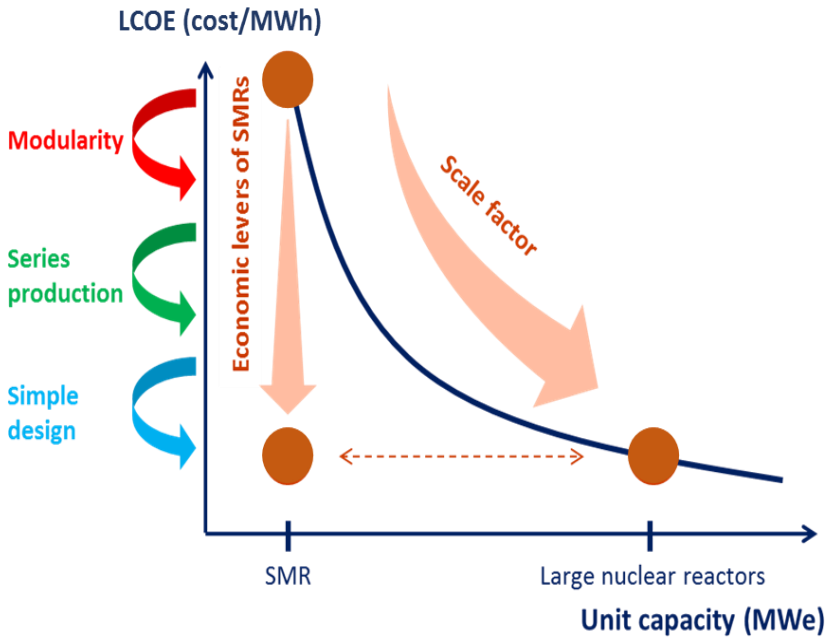
15 to 200 MWe for heat / electricity generation needs of energy-intensive industrial sites, such as mines or oil /gas extraction

~ 200 to 400MWe for electricity generation

- Replacement of fossil / coal plants
- Electrification of medium-size cities and isolated industrial sites
- Adapted for small networks with limited capacity for large power

1. SMR: CHALLENGES & SUCCESS FACTORS

In order to counter the scale effect, it is necessary to operate three levers:



- **Simple and safe conception**

Simplified architecture reduces initiating events
Lower residual heat facilitates the use of passive safety systems

- **Modular conception & manufacturing**

Modules are manufactured and tested in factories
Modules are transported in containers
Reduction of onsite construction time

- **Standardization & series effect**

Standardization, normalization
Serial production of components
Major construction program

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2. NUWARD™: MAIN FEATURES & BENEFITS

- A **340 MWe power plant** including **2 reactors** in a single nuclear building, based on a wide experience of **PWR reactors**,

- An **innovative design** with:
  - the most **compact reactor** in the world
  - **simplification** by modularization and system integration

- Integrating **the highest standards of safety** :
  - **Generation III+ reactors** meeting post Fukushima requirements
  - robust to accident scenarios with **passive safety systems**

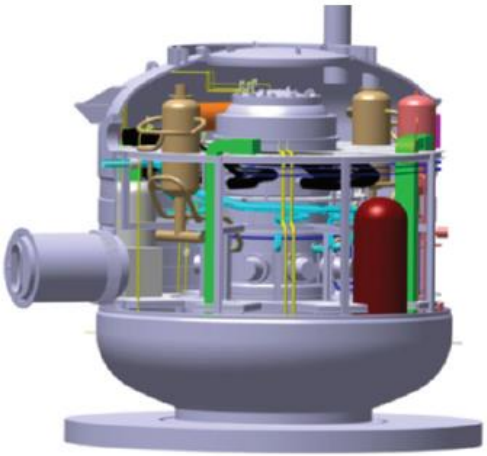
- **Low carbon energy, flexible and continuous generation**, complementary with renewable intermittent sources and large nuclear power plants to :
  - replace 300-400MWe coal-fired power plants
  - power remote municipalities and intensive industrial sites,
  - supply networks that cannot be connected to high or medium sized reactors

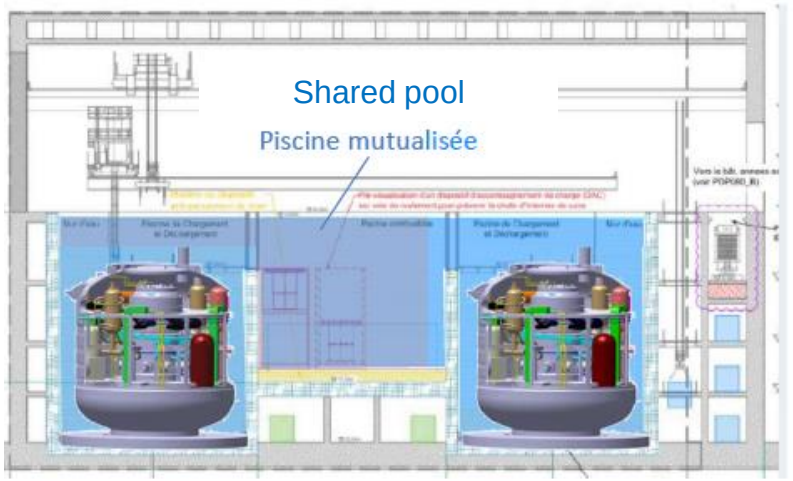
2. NUWARD™: DESCRIPTION OF THE PRODUCT

- A **340 MWe power plant** including **2 integrated reactors** (2x170 MWe) in a single nuclear building
- A combination of **proven and innovative technologies**

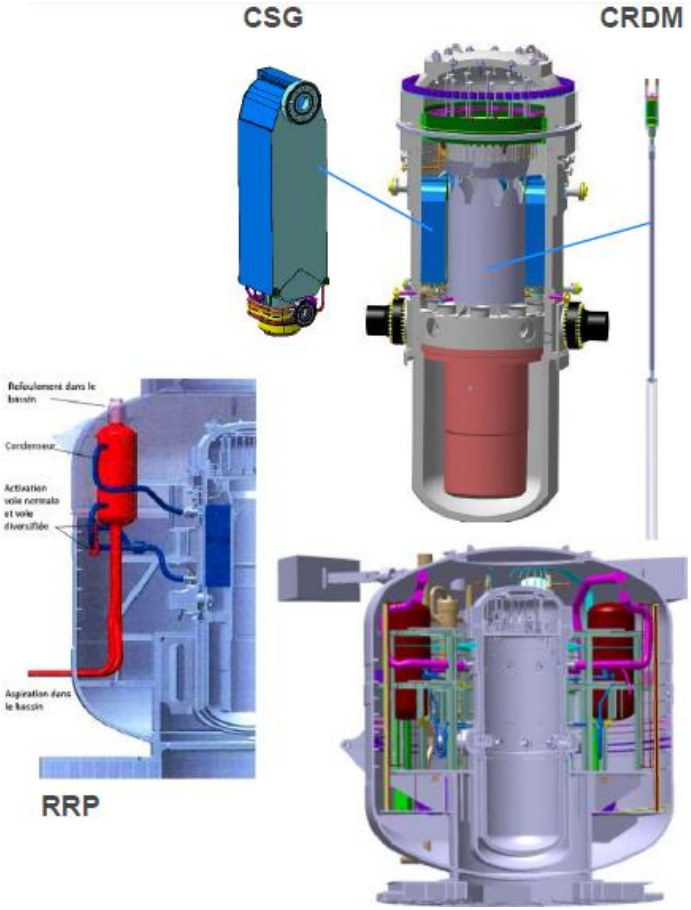
A compact reactor…

… integrated in a metallic containment immerged in a water basin





NUWARD™ design: technological novelties under development providing significant improvements

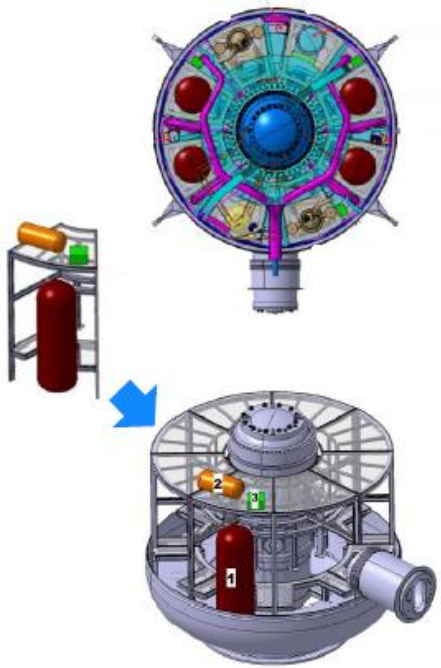


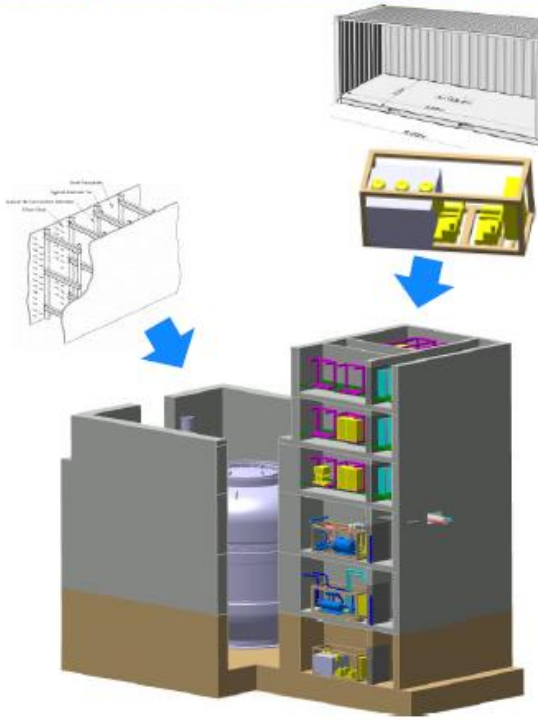
INNOVATION	IMPACT
Integrated architecture	Primary cooling system inside RPV Reduced LOCA
Plate Steam Generators (CSG)	Compactness
Immerged Control Mechanisms (CRDM)	Elimination of rod ejection risk
Passive Core Cooling (RRP with S-CSG)	Passive residual heat removal
Boron Free Core	No clear water plug Simplified effluent treatment
Metallic containment	Tightness + immersion in water wall
Semi Buried NI Building	Protection against external hazards

2. NUWARD™: STANDARDIZATION & MODULARITY

NUWARD™ integrated standardization and modularity at the early pre-conceptual design phase

Principles





containment & vessel
on-site assembly
non standard transport

8 modules in containment
factory-tested
category-2 transport

modules for NI, CI & BoP
factory-tested
20' skids standard transport

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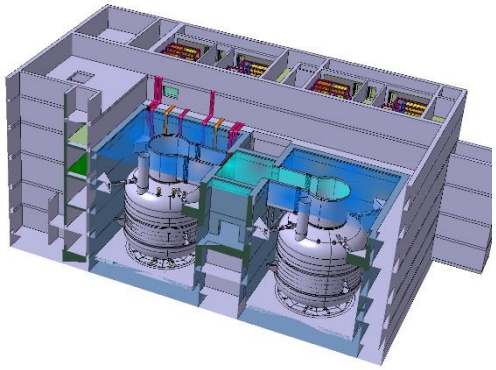
3. NUWARD™: ROADMAP OF DEVELOPMENT



Study of feasibility 2012-2015

Pre-Conceptual Design 2017-2019

Conceptual Design 2019-2022

Basic Design + pre-licencing

Detailed Design + licensing

- **50M€ budget** has been allocated to NUWARD™ last September 2020 as part of the **French Recovery Plan**,
- **French President Macron reiterated** during his speech at Le Creusot factory last 8 December 2020, **the importance of nuclear energy to achieve carbon neutrality and his willingness to position France as a key player of the SMR market segment**
- **NUWARD™** will be available to **meet market needs in the next decade (2030s)**

3. NUWARD™: KEY PARTNERS & INTERNATIONAL COOPERATION

NUWARD™ was presented to the market at the IAEA General Conference in Sept. 2019 by EDF and its strategic partners CEA, Naval Group and TechnicAtome

- Through international cooperation EDF's objective is to
  - **access the largest possible market**
  - **accelerate the commercialization of the product**
  - **benefit from licensing experience in other countries**.

- A cooperation between an international nuclear champion such as **Westinghouse (WEC)** and the flagship of the French nuclear industry has the potential to create the conditions **for a world-class team, able to develop, license, deploy and support operation of the SMR on the wide international market.**

Framework agreement signature in Sept. 2019 between Westinghouse, EDF & CEA to explore potential cooperation on SMR development

SMR: AN OPPORTUNITY FOR THE FUTURE

- **SMR market** should develop by **2035-2040** to address new needs and broaden the decarbonized energy offer
- **Many countries** are actively considering SMR deployment and technology providing countries are **already proposing their products**
- **NUWARD™** is being developed to be **present on time** on the market with a **high expectation product, high safety level, simple and easy to build** and thus **economically competitive**
- With NUWARD™, **France** is developing a LW-SMR benefiting from its **important know-how**