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.**
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 400 MWe** 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
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
1. SMR: a new paradigm

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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 immersed in a water basin
NUWARD™ design: technological novelties under development providing significant improvements

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