# The role of nuclear and SMRs in the energy transition

**AFGC**
**03/10/2024**

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# The climate emergency requires a very strong and sustained growth in the production of decarbonised electricity

To stay below +2°C, we need to increase from 27,000 TWh in 2020 to 37,000 TWh in 2030 and 71,000 TWh in 2050, which is a +170% increase by 2050. This requires massive investments, far beyond what has been done in the last 20 years.

**Global CO2 emissions**
(WEO 2021 scenarios)


**Global electricity production**
(WEO 2021 scenarios)


## Three times horizons to meet our +1.5°/2°C ambitions

- A peak in emissions before 2030
- Towards carbon neutrality by 2050
- Negative emissions post-2050 (overshoot scenarios)

## Three driving forces behind this global growth

- Development and Demography
- Capacity Renewal
- Electrification of Uses

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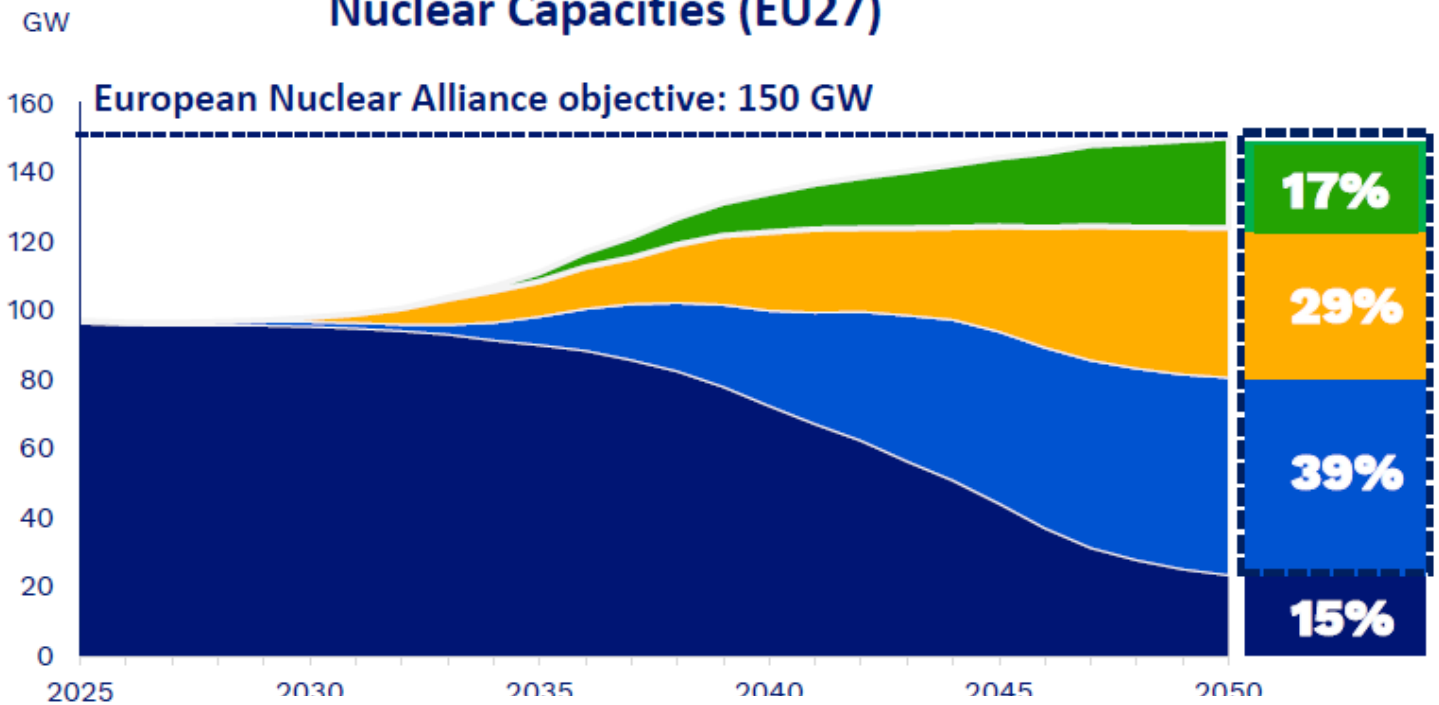
# EDF Net Zero Scenario, consistent with the commitment taken by 16 countries to increase nuclear capacities to 150 GW by 2050




By 2050, up to **85%** of nuclear capacity come from Long-Term Operations (LTO) or new build

**RECOMMENDED ADDITIONAL LEVERS**
- Long-Term Operations / New Nuclear

**EXPECTED ADDITIONAL LEVERS**
- Long-Term Operation of existing fleet over 60 years
- New nuclear programs: large units or SMR

**NEW NUCLEAR CAPACITIES** already announced
- Large Nuclear Units (> 1 GW)
- Small Modular Reactors (< 500 MW)

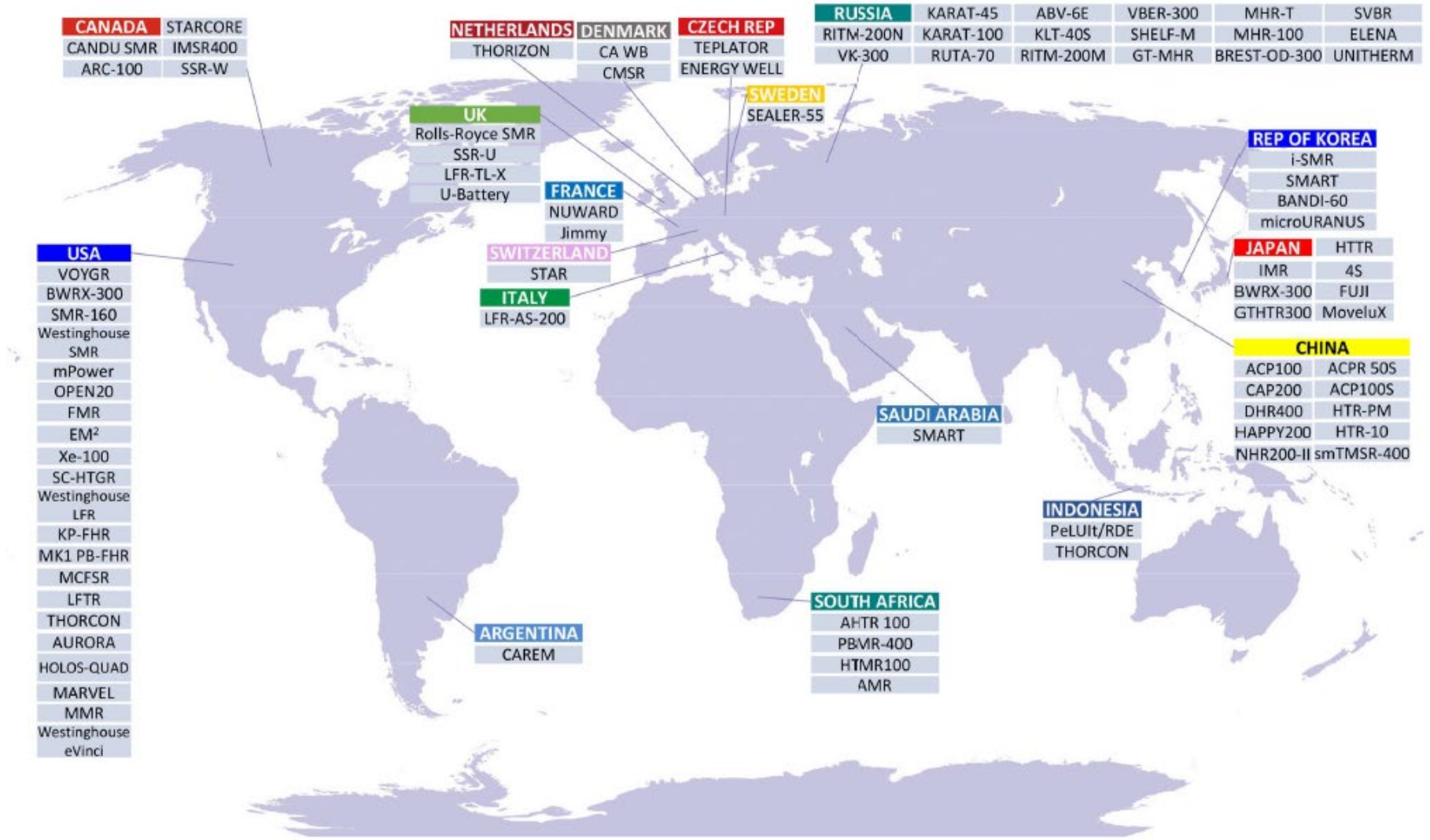
**EXISTING CAPACITIES** up to 60 years old

**Nuclear power makes a major contribution to EU decarbonization, as a decarbonized, energy-dense and dispatchable technology.**
**Nuclear New Build and LTO will represent 85% of 2050's nuclear capacity and should be an industrial priority.**

01

# SMR: what are we talking about?

# More than 80 Small Modular Reactor designs around the world




*Global Map of SMR Technology Development, AIEA (2022)*

# En France (source site ASN)

## Réacteurs à eau légère

**NUWARD**
Prototype industriel
540 MWth

**CALOGENA**
Prototype industriel
30 MWth

## Réacteurs à caloporteur sodium

**OTRERA**
Prototype industriel
300 MWth

**HEXANA**
Prototype industriel
400 MWth

## Réacteurs à haute température

**JIMMY**
Prototype industriel
10 à 20 MWth

**BLUE CAPSULE**
Prototype industriel
150 MWth

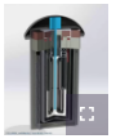
## Réacteur à caloporteur plomb

**NEWCLEO**
Réacteur expérimental
80 MWth
(à terme 450 MWth)

## Réacteurs à sels fondus

**NAAREA**
Réacteur expérimental
80 MWth

**STELLARIA**
Réacteur expérimental
250 MWth



**THORIZON**
Réacteur expérimental
250 MWth

## PHASE PRÉPARATOIRE

### Étape 1 : Suivi prospectif

- BLUE CAPSULE
- HEXANA
- OTRERA
- STELLARIA

### Étape 2 : Revue préparatoire

- **NEWCLEO**
  Cycle de réunions thématiques terminé
- **NAAREA**
  Cycle de réunions thématiques en cours
- **CALOGENA**
  Lancement de la revue préparatoire
- **THORIZON**
  Lancement de la revue préparatoire

## PHASE RÉGLEMENTAIRE

### Étape 3 : Pre-instruction (options de sûreté)

- **NUWARD**
  *Le 19 juillet 2023, EDF a demandé à l'ASN, un avis sur les principales options de sûreté retenues pour son projet de petit réacteur modulaire NUWARD SMR.*

### Étape 4 : Instruction de la demande d'autorisation de création (DAC)

- **JIMMY**
  *Dépôt d'une demande de DAC le 3 mai 2024 pour la construction d'un réacteur destiné à fournir de la chaleur industrielle à une usine du Groupe Cristal Union située sur le site de Bazancourt (51). L'analyse de recevabilité du dossier est en cours par l'ASN depuis le 6 mai 2024.*

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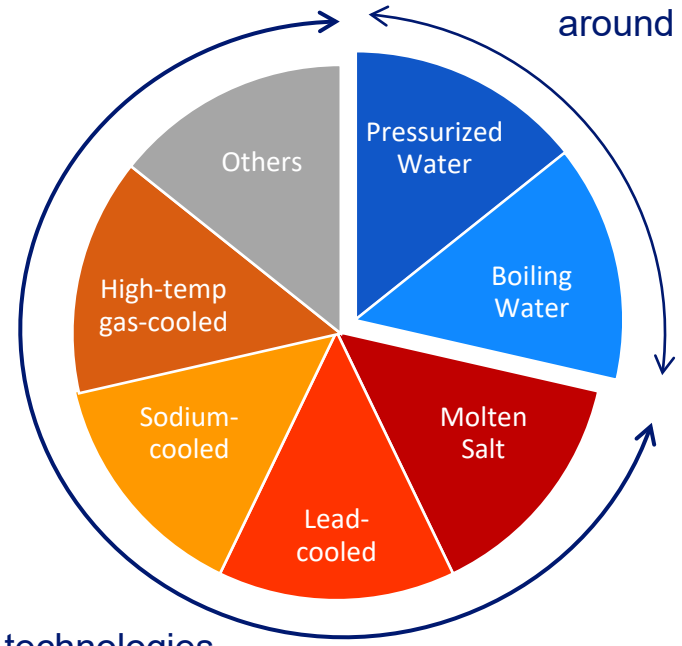
# SMRs/AMRs can be differentiated by their technology and power range

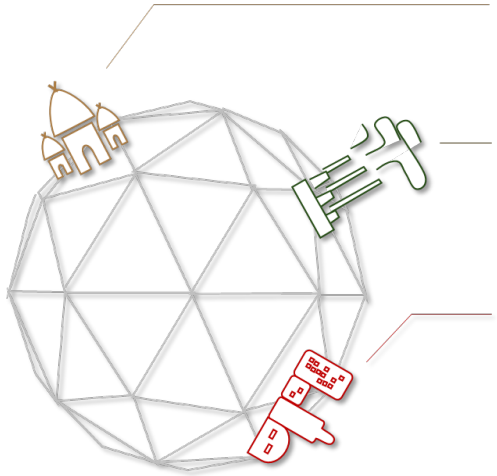
## All kinds of nuclear fission technologies

Gen 3 technologies
Racing for first plant around 2030




Gen 4 technologies
Ambitious targets but more likely to be ready between 2040 and 2050

## All scales for several uses and markets



5 to 15 MWe for electricity needs disconnected from the grid such as remote communities or military bases.

15 to 200 MWe for heat or electricity generation for large industrial sites such as mines or gas extraction or Hydrogen production.

~ 200 to 400 MWe for electricity generation connected to the grid

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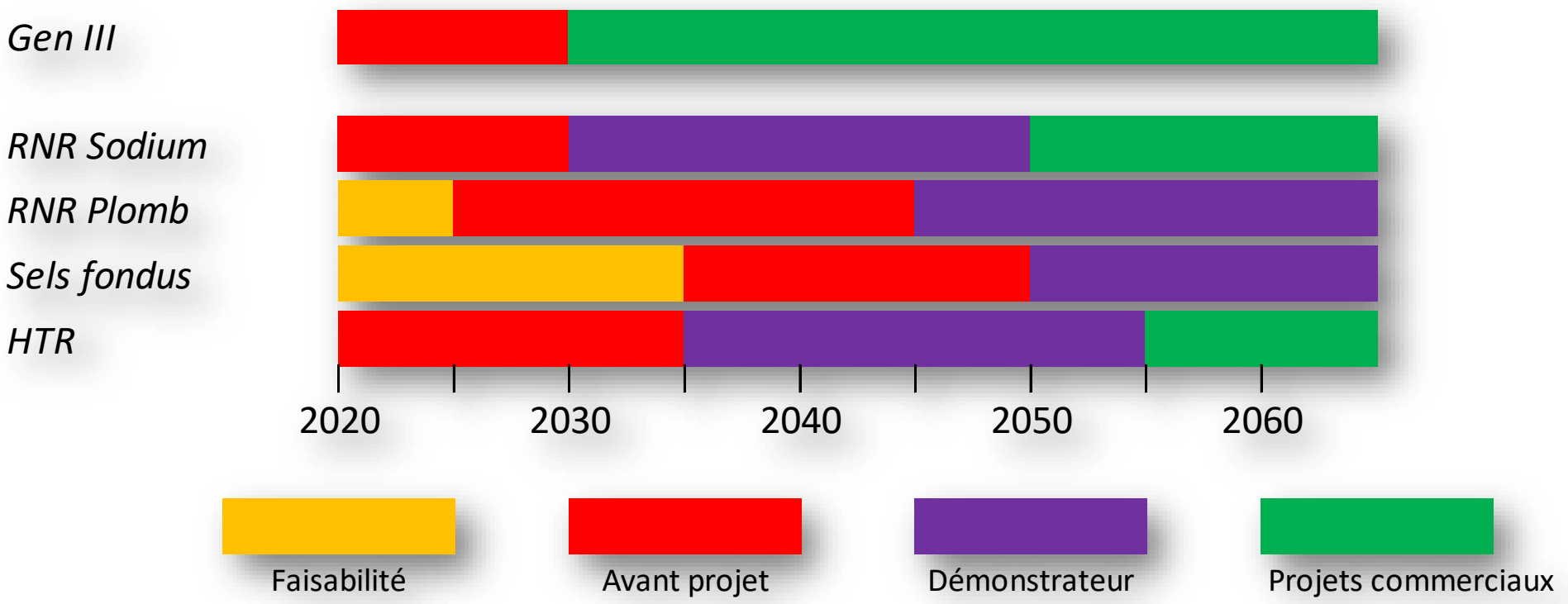
# À l'horizon 2030, seuls des modèles de 3ème génération seront matures industriellement




- Pour tous les concepts Gen 3, un délai de développement - du concept à l'industrialisation - de 10 à 20 ans
- Pour tous les concepts avancés / Gen 4, un délai nettement plus long avec (i) des verrous technologiques, (ii) des cycles du combustible à développer, (iii) un licensing nouveau complet à développer.

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# Key conditions for successful deployment of SMRs

**MODULARISATION & FACTORY BUILD:** Modular design and manufacturing (construction cost decrease, shortened on-site construction duration)

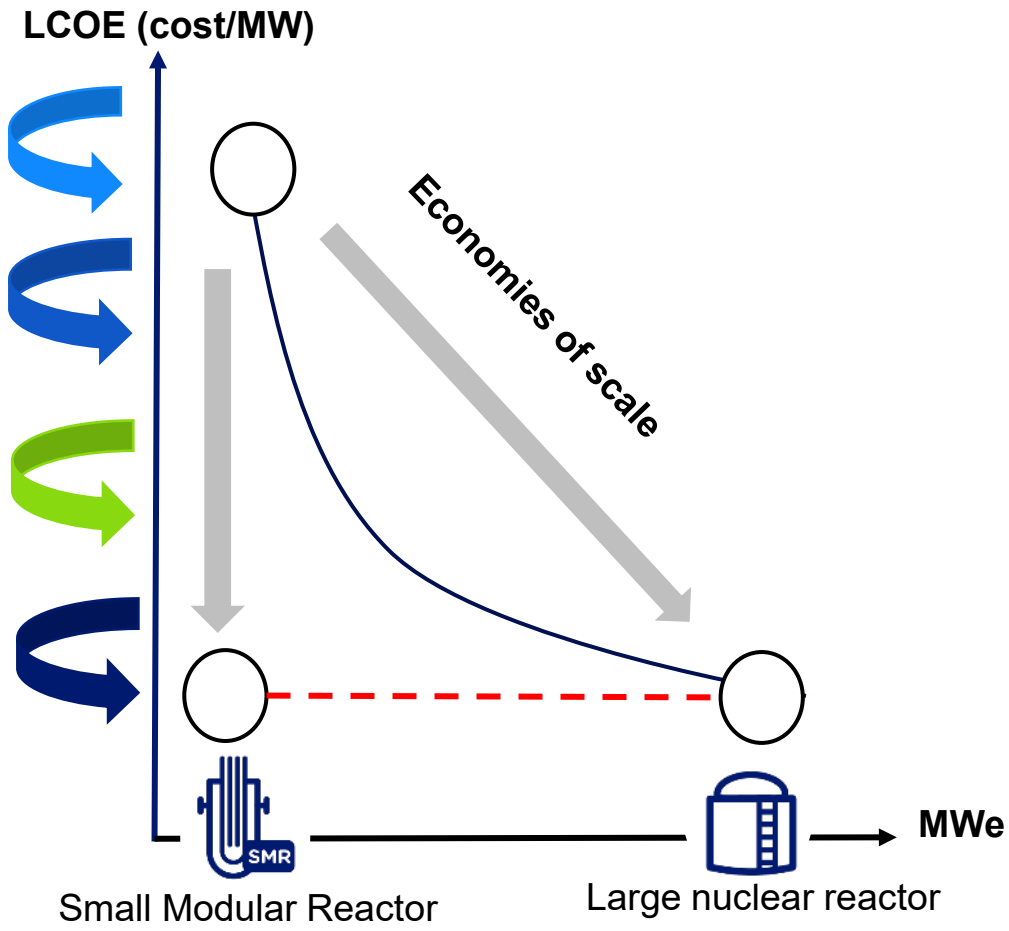
**SIMPLIFICATION:** Simplification of design (architecture, components, civil structure, easy and quick to build)

**STANDARDISATION & SERIES EFFECT:** Standard design and series effect (production of components in series, standardisation, large new build programme, etc.)

**HARMONISATION:** Harmonised and adapted design for worldwide deployment: regulatory requirements, in-factory certification, passive system qualification

**FINANCING:** Revenue guarantee, manageable construction risk profile, adapted regulatory framework

**INTERNATIONAL MARKET:** Access to worldwide market




*Source: NEA 2020*

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# NUWARD's European SMR

# NUWARD, together with the EDF Group, are committed to develop a Generation 3 SMR to meet the demand of electric utilities and energy-intensive industries

The NUWARD SMR project has reached the **basic design phase**.

Considering **the evolving SMR market dynamics** and the learning drawn from the development of NUWARD SMR, NUWARD has decided in June 2024 **to pivot its SMR product strategy** and to take a new path.

To address the needs expressed by **the market timely and competitively**, NUWARD is shifting its product strategy towards the development of a **design based on proven technology bricks only**.

NUWARD is now preparing the conditions for a product development **leveraging the extensive technical, industrial and commercial experience cumulated** so far, with the goal to **offer a competitive solution** fit foe the European market and beyond.

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# Our SMR: a solution complementing large scale power plants and renewable energies to fight climate change

## The NUWARD's SMR is developed to meet three main market segments:

**Replacing fossil-fueled power plants in the 300-400 MWe range,**

**Powering energy-intensive industrial sites in electricity and/or heat,**

**Powering grids with limited capacity or demanding small incremental power build-up**

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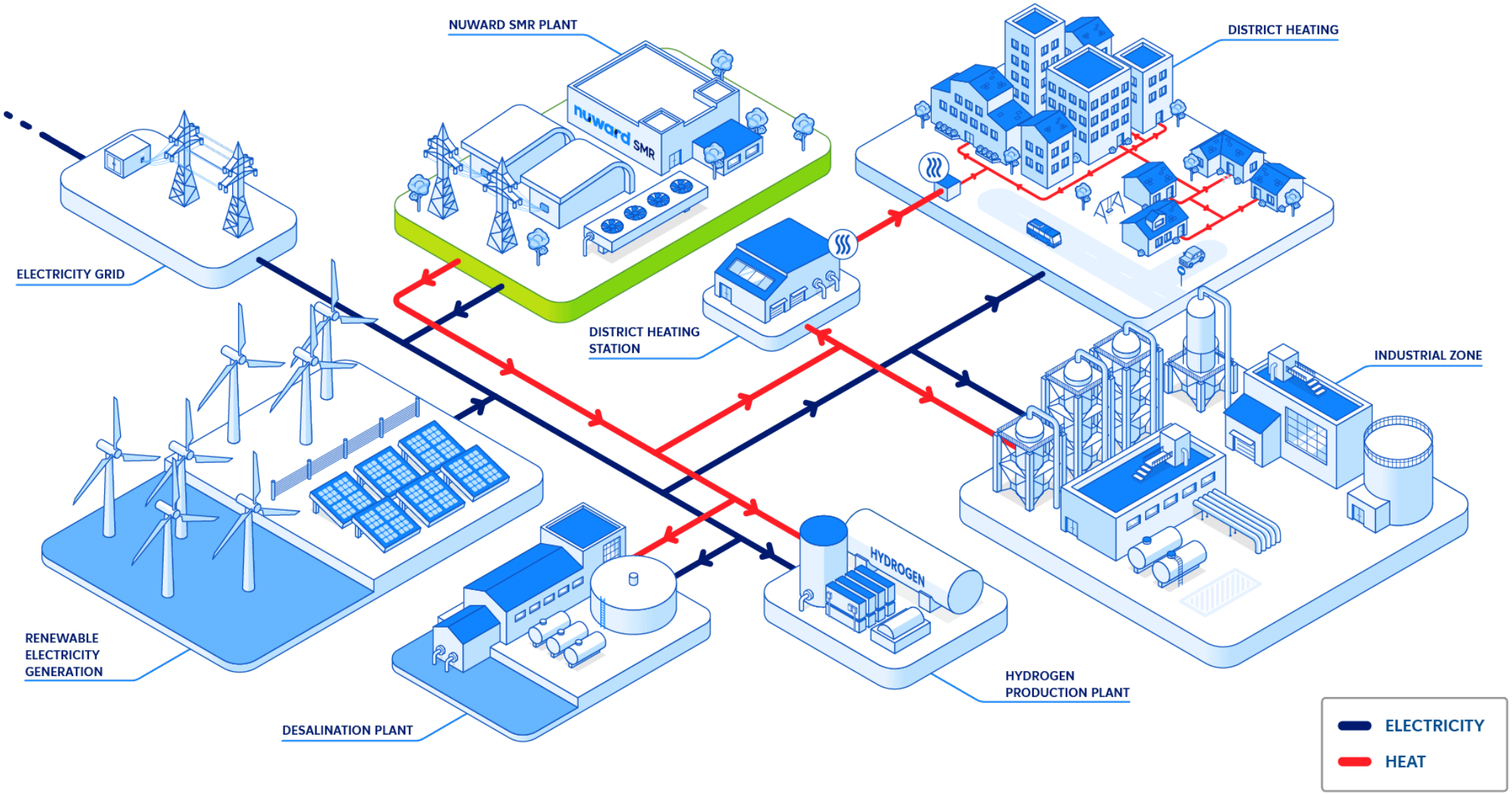
# The usages of the NUWARD's SMR power plant



# European by design

- Unparalleled design construction and operation **experience and expertise based in EU**
- Fully owned **EU Intellectual Property**
- Fully delivered by **EU Supply Chain**
- Working towards **EU licensing**
- Adapted to **EU market needs**

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# NUWARD: the EDF Group's subsidiary 100% dedicated to SMR

| Creation date | Staff | Shareholder | Countries with cooperation in place |
|---|---|---|---|
| 2023 | 110<br>In Sept 2024 | EDF | 10+ |

**Benefits of the NUWARD company creation:**

A **subsidiary dedicated** to the development of the NUWARD SMR product

**Simplified decision-making processes**, aimed at increasing our responsiveness to meet ambitious milestones

Fostering **agility** and **continuous improvement**

An organisation **that simplifies** the signing and management of new partnerships

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FRANCE 2030

# NUWARD confirms its intent to market a Gen 3 SMR to meet the demand of electric utilities and energy-intensive industries

## Lessons learned from the market

**Strong market pull for SMRs**, starting in Canada then the EU

1. From electric utilities, favouring
   - low risk concepts to control quality, schedule and cost
   - easy to maintain and operate,
   - to deliver reliable and competitive electricity in the early 2030's.
2. From energy-intensive industrial players to deliver competitive electricity and heat, in a 2nd stage

**The size and maturity of the market remain highly uncertain**

A number of conditions still to be gathered for series to be built:

- clear energy policies & nuclear new build strategies (roadmaps, programme approach),
- Clear siting strategies,
- clear financing tools,
- Licensing harmonisation…

**A chicken and egg trap!**

FOAK plant is necessarily costly, a steep cost decrease via the series effect is required

## Lessons learned from NUWARD SMR until June 2024

The **integrated reactor presented intrinsic safety features** that could be a differentiator on the market…

but it still required **excessive lead times** to develop corresponding innovations, reach industrial maturity and achieve licensing.

**NUWARD confirms the relevance of the key product specifications adopted for a Gen 3 SMR**

- Power in the range approx. 200-400 MWe
- Multipurpose
- Firmly rooted in Europe, active member of the European Industrial Alliance on SMRs

**NUWARD design will be based on proven technology bricks**

# NUWARD will leverage the extensive technical, industrial and commercial experience cumulated to develop a competitive SMR

## Lessons learned on key levers to reach competitiveness

**Modularity** is crucial for NOAK SMRs to be competitive and must be integrated into engineering work sequences, but:

- It tends to increase the FOAK costs;
- Series effect depends also on countries roadmaps and commitments.

**Industrialisation**: Involving key equipment suppliers early in the design process can reduce costs and speed up market entry, but it is often overlooked by technology developers.

**Simplicity**: Passive safety yields architecture simplification and may drive cost down, under specific conditions.

**Standardisation** of the design is essential for achieving at least 30% cost reduction through the series effect. It requires licensing harmonisation. The Joint Early Review's bottom-up approach is a significant step forward.

## NUWARD roadmap for a safe, simple and competitive SMR includes:

- **Modular** design
- Integrating **design-to-manufacturing** approach
- In depth analysis of **passive safety** options
- Fostering **licensing harmonisation** with the Joint Early Review

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# NUWARD: pioneer in European licensing and harmonisation

## A unique initiative with the Joint Early Review Process

**Phase 1 completed with three European nuclear safety authorities**

New kind of discussion between Nuclear Regulators with a technology developer

First early feedback benefiting Basic Design studies

Anticipating the challenges of international licensing

**Phase 2 launched in December 2023 with three more European nuclear safety authorities**


The new design of our SMR will benefit from the feedback and work carried out during the JER.

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# Market & product appraisal: INAB

## International NUWARD Advisory Board

By providing valuable insights from across the world, the INAB is fine-tuning NUWARD SMR's product development **to align precisely with market demands.**

This ensures that **NUWARD SMR is a solution tailored to the real-world energy needs**, leading the way in next-generation nuclear technology.

# Based on the past experience, key success factors for SMRs to contribute to the fight against climate change and to energy security

## DEVELOP THE TECHNOLOGY

- Deliver innovations, tests, qualification, safety demonstration
- International design
- Prepare the **supply chain** and the construction

- Public support
- Level playing field
- International cooperation on licensing

## BUILD THE FIRST PLANT

- Prepare the **territory project**
- Anticipate construction
- Secure the **funding**

- Regulations
- Funding

## CLIMB THE LEARNING CURVE AND SCALE-UP

- Develop projects in **several countries**
- Demonstrate the **series effect**
- Anticipate the series with the supply chain

- Long-term visibility
- National / regional roadmaps
- Partnerships

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# Join NUWARD industrial database

Our Supplier Database will be used to get in touch with Suppliers, including calls for tender, price inquiries, market surveys, etc..

scan the QR code or visit:
https://www.nuward.com/en/supplier-contact-form
to complete the questionnaire

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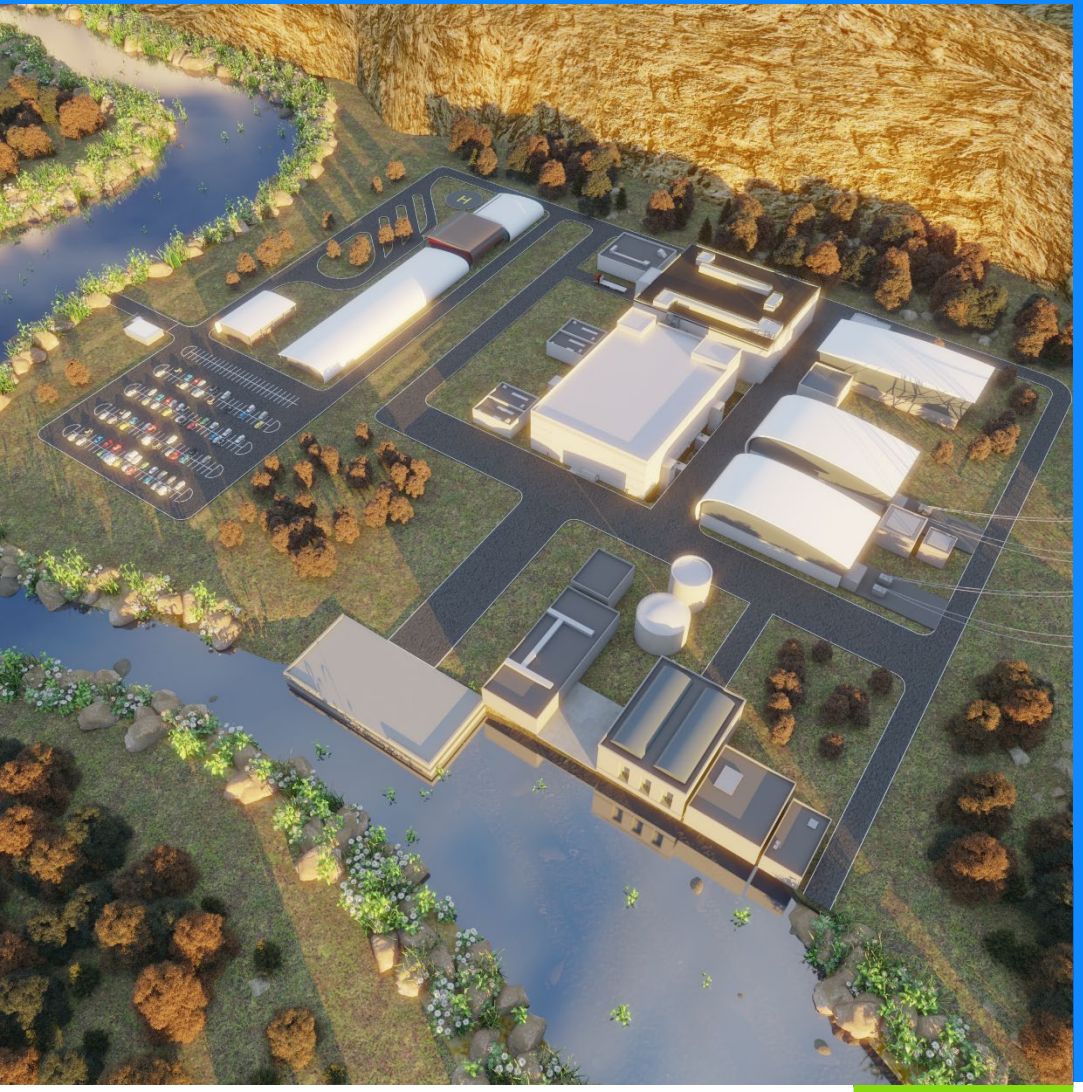

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