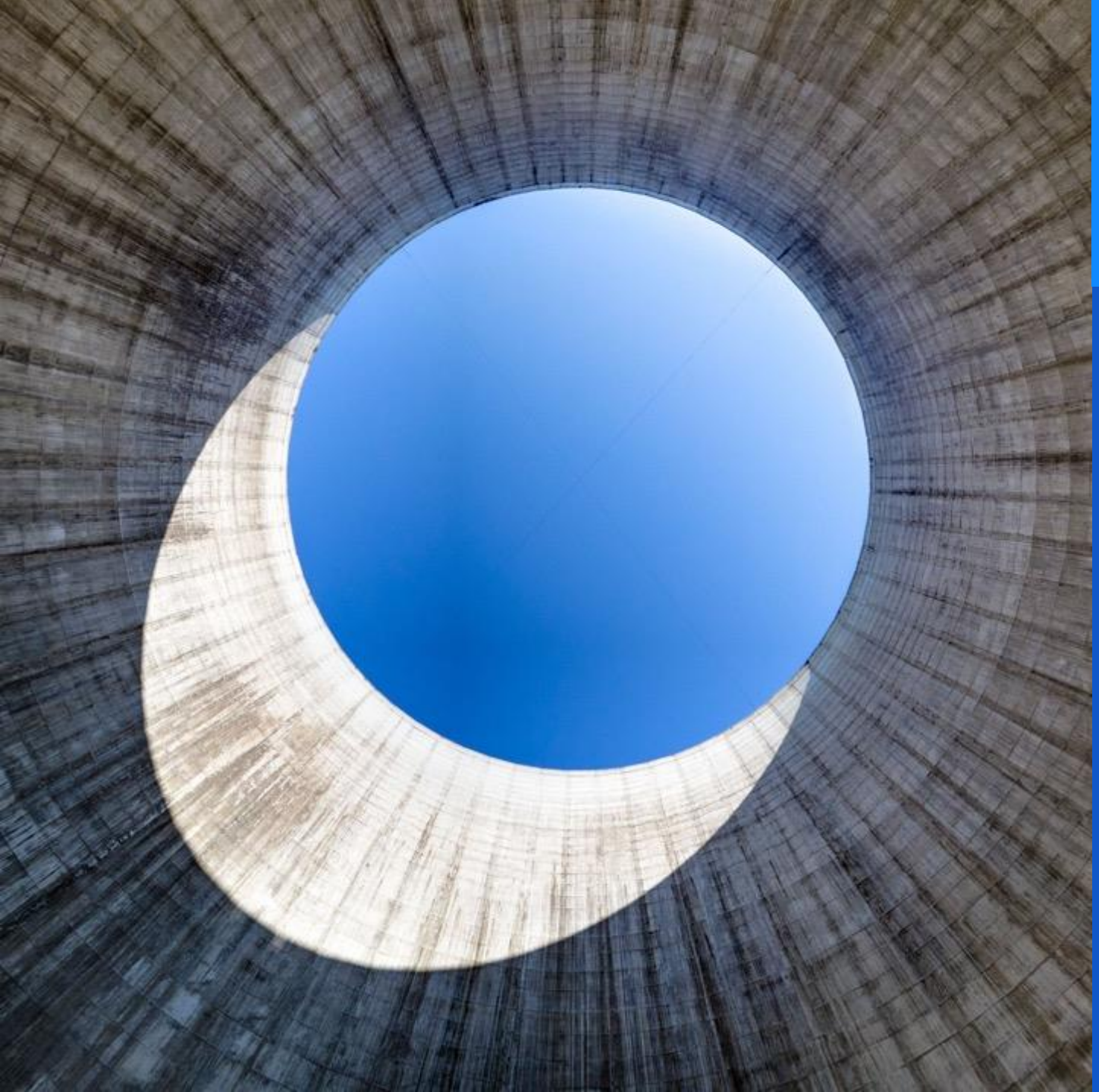


EDF Value Proposition for Nuclear New Build Projects

Antoine GUELFI
EDF – Director of Export Services

Bulenergo Conference
25-26 January 2024 – Sofia, Bulgaria

SUMMARY

SUMMARY

EDF, THE WORLD'S LEADING ELECTRICITY COMPANY

- Its business covers all electricity-related activities

Electricity generation — **Transmission and distribution** — **Energy supply** — **Optimisation and trading**

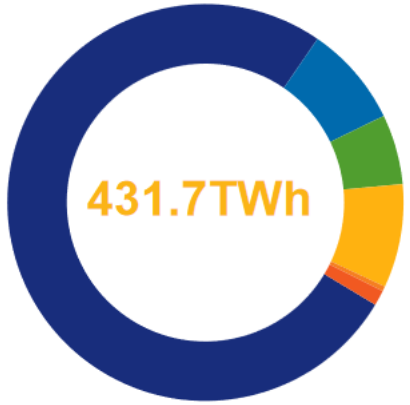
- Key figures in 2022

€143,5 Bn — sales

431,7 TWh — electricity generated worldwide

322 TWh — nuclear electricity generated worldwide

90% — carbon-free electricity



76%	Nuclear
8%	Hydropower(3)
6%	Other EnR
9%	Gas
0.4%	Coal
1%	Fuel Oil

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EDF, A MAJOR NUCLEAR OPERATOR IN EUROPE AND WORLDWIDE

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EDF, a major nuclear operator

56 reactors in operation
61,4 GWe
1 reactor in final commissioning

9 reactors in operation
5,9 GWe
2 reactors under construction
2 reactors under development

2 reactors in operation

67 reactors in operation

+ 2,000 reactor.year of experience

+ 50,000 EDF staff working in the nuclear field

+ 220,000 jobs in the nuclear industry in France

EDF manages the entire nuclear power plant lifecycle

- **DESIGN**
- **BUILD**
- **OPERATE**
- **DECOMMISSION**

EDF is fully engaged in nuclear new build activities and committed to supporting several countries in their nuclear programme development.

FLEXIBLE OPERATION

3 PILLARS FOR SUSTAINABLE FLEXIBLE OPERATION

DESIGN & TECHNOLOGY

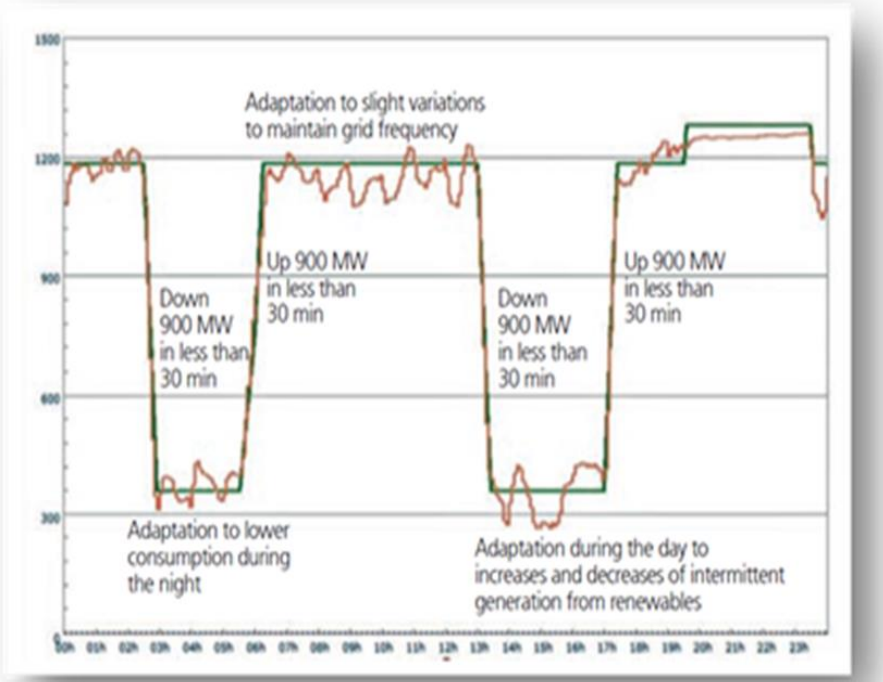
Specific and proven design features of nuclear power plants for flexible power generation

EXPERIENCE

Know-how, processes and methodology for flexible power production

INFRASTRUCTURE

Grid development & integration



- **Load following**
  Large load variation program agreed in advance with the grid operator, 2 large variations/day, [100%-30%], ramp up/tramp down 30 min.

- **Frequency control**
  Minor automatic load variations aimed at controlling grid frequency (primary 2% Pn in less than 30 s, secondary 5% Pn within 15 minutes)

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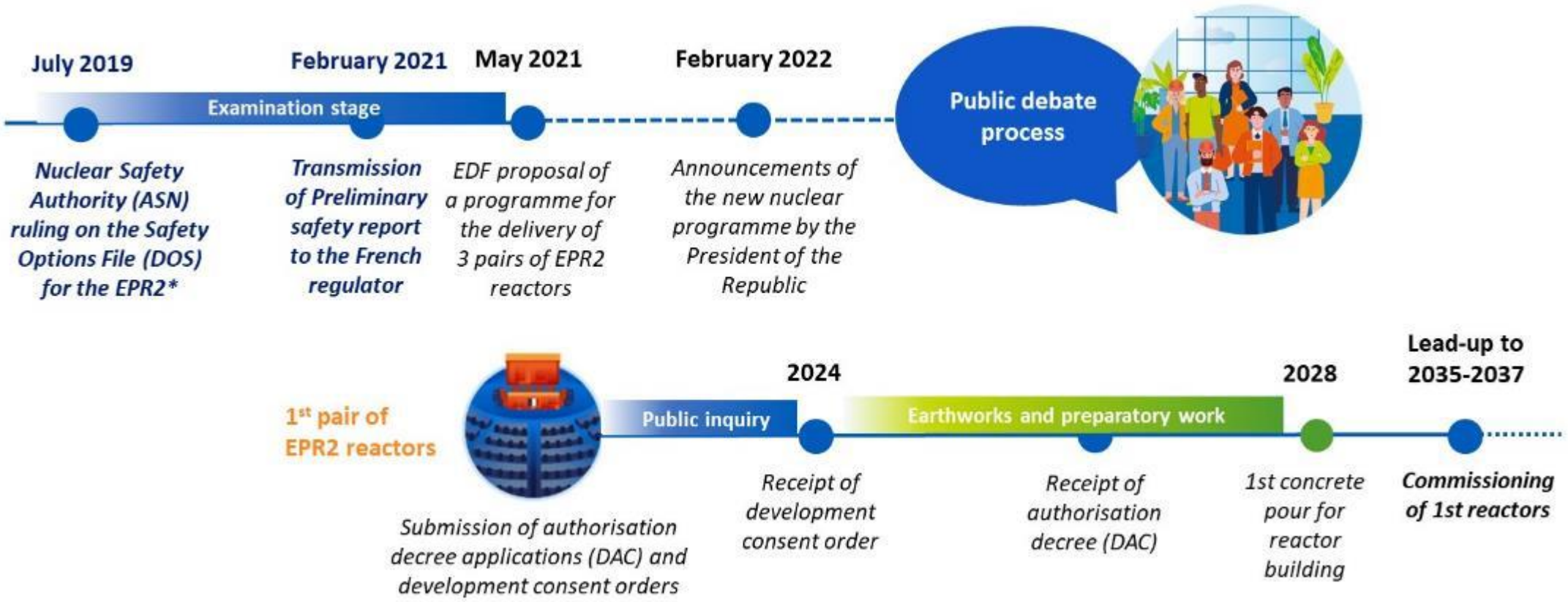
THE FRENCH FLEET RENEWAL: TOWARDS 6 + 8 EPR2



2nd and 3rd pair of EPR2 reactors

- **2024** resp. 2027**:** Consultation
- **2025** resp. 2028: Applications for authorisation decree (DAC) and development consent order
- **2026** resp. 2029: Receipt of development consent order and start of construction
- **By 2031** resp. 2035: 1st concrete pour for the unit n°1 reactor building
- **By 2038-2039** resp. 2042-2043: Commissioning of the 2 reactors

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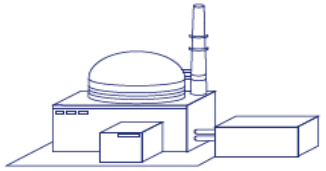
SUMMARY

A COMPREHENSIVE PORTFOLIO OF GEN III+ TECHNOLOGIES TO MEET OUR CLIENTS' NEEDS

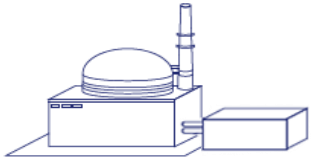


EPR

1,650 MWe

Large Size Reactor

- Most powerful reactor in the world
- The leading reference for very high energy demand
- High maneuverability

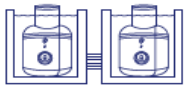


EPR1200

1,200 MWe

Mid-Size Reactor

- EPR adaptation to 1200 MWe
- Adapted to various site and grid conditions
- High maneuverability



nuward

340 MWe

SMR

- Adaptable to various environments
- Other low-carbon use: hydrogen, heat & electricity cogeneration, district heating, water desalinisation
- High maneuverability

EPR technology is proving its adaptability, robustness and efficiency in meeting New Nuclear market needs, allowing us to meet the challenges of today while driving innovation for tomorrow

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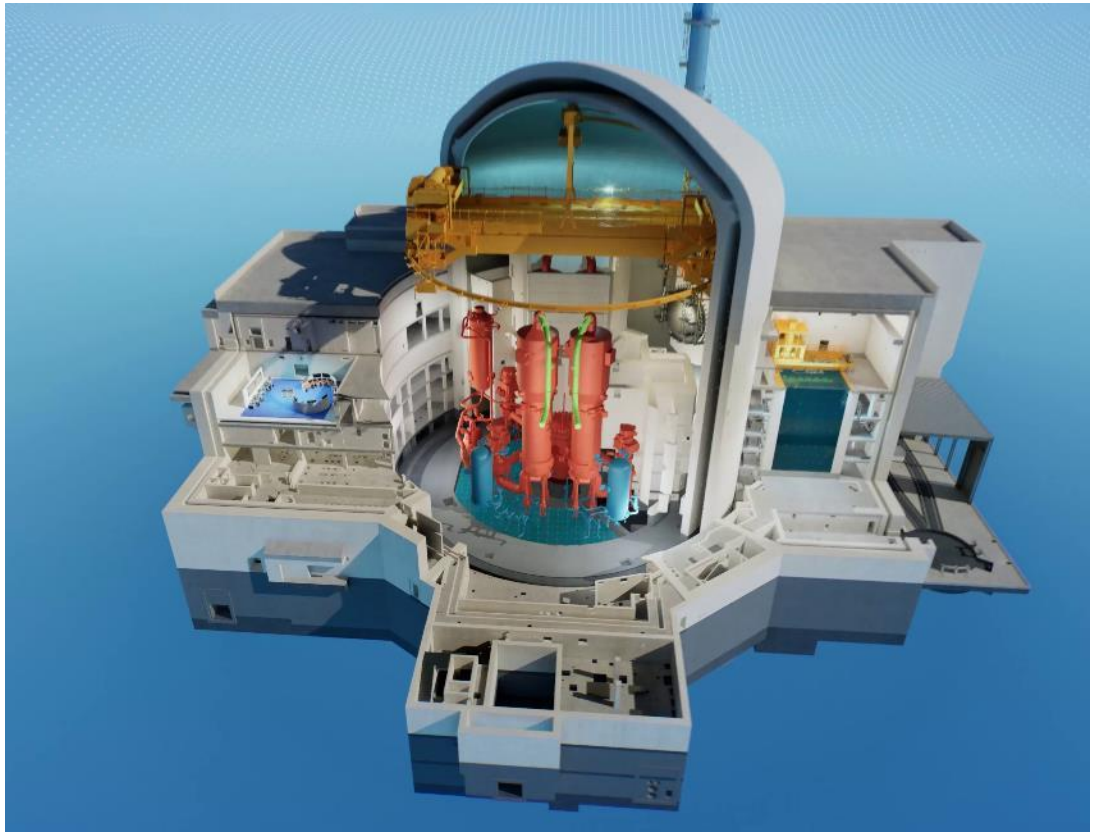
EPR REACTOR: THE MOST POWERFUL REACTOR WORLDWIDE

Electrical power output	**1650 MWe**
Thermal power	4590 MWth
Primary system	4-loop configuration
Plant design availability	≥ 90 %
Operation cycle length	12 to 24 months
Design service life	60 years
Instrumentation & Control	Fully digital
Fuel assemblies in core	241 with 17x17 AFA 3G design



A proven technology derived from decades of expertise and lessons learnt from past and on-going EPR projects

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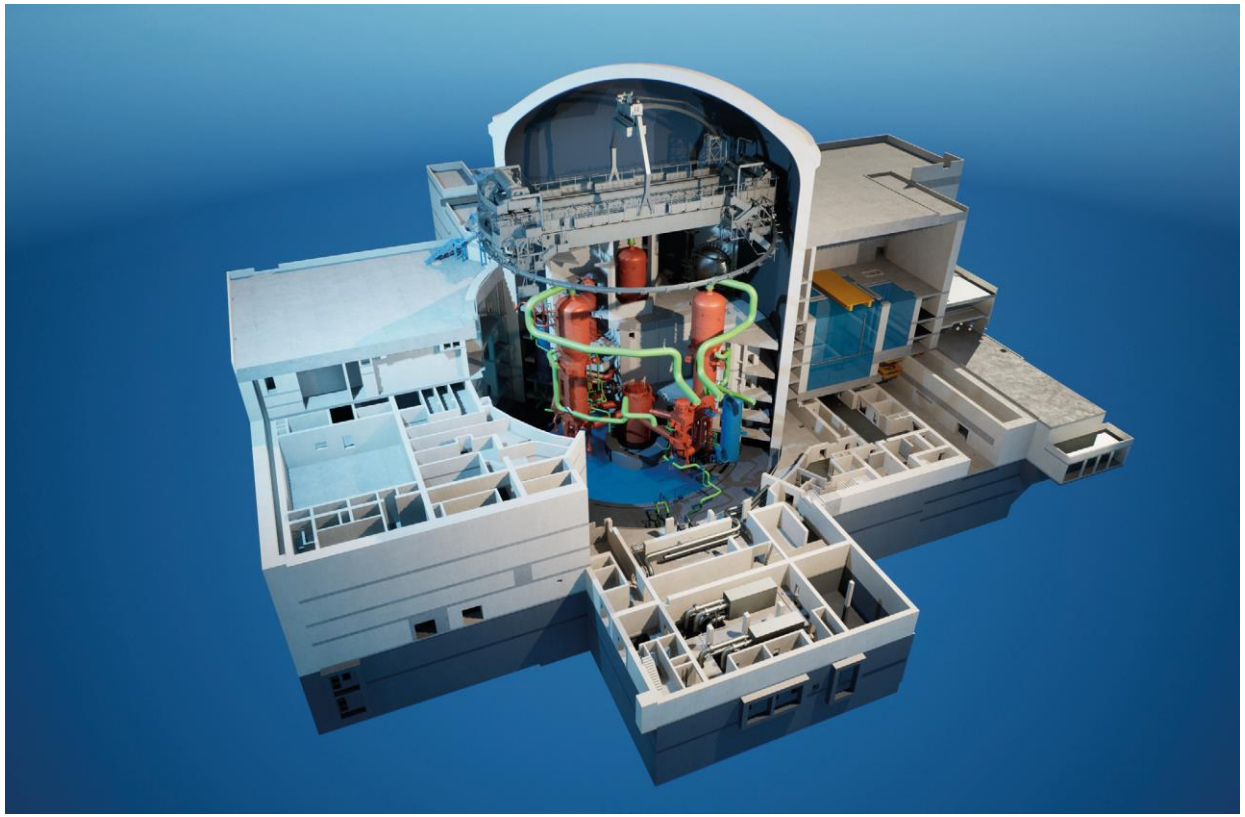
A STRONG GEN III+ PWR EXPERIENCE TO DEVELOP ADAPTED DESIGNS



EPR1200: mid-size reactor derived from the 1650 MWe EPR

- ➔ Recently proposed in Czech Republic, Slovenia and Slovakia

NUWARD SMR: 340 MWe plant – 2 x 170 MWe reactor

- ➔ Early discussion with several European countries
- ➔ Joint Early Review by 6 European safety authorities
- ➔ International Nuward Advisory Board including 2 Indian representatives (TCE and DAE)

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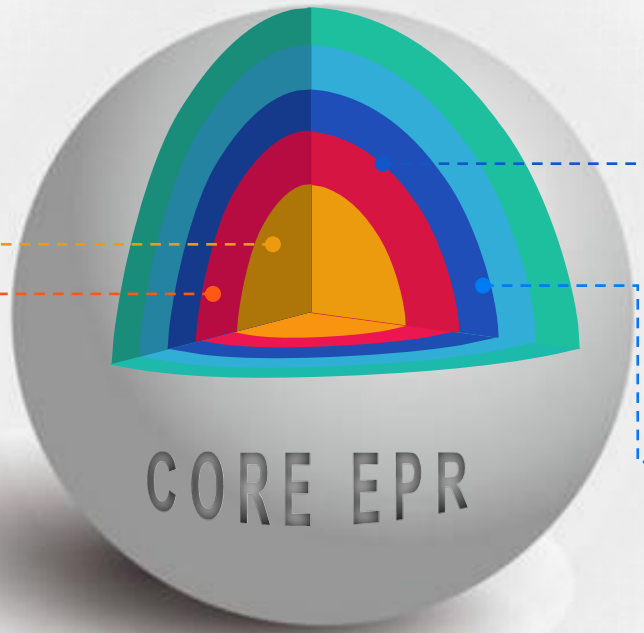
COMMITMENT TO THE HIGHEST SAFETY STANDARDS

SAFETY PRINCIPLES

- Safety Design
- Defense-in-depth
- Diversification and Redundancy
- Severe Accident Management

STANDARD EPR COMPONENTS & CATALOGUE

- Reactor Pressure Vessel
- Core instrumentation
- Steam Generators
- Pressurizer
- Primary Pumps



REACTOR SYSTEMS DESIGN

- Core design
- Safeguard systems architecture
- Support Systems architectures
- Heat Removal Systems
- Emergency Feedwater Systems
- Steam and Power Conversion System
- Severe accident mitigation devices
- I&C

CODES AND STANDARDS

afcen RCC-M

EUR

IAEA International Atomic Energy Agency

Western European WENRA Nuclear Regulators' Association

The Core EPR Technological Foundation: proven technology, reliable performance, accelerated deployment

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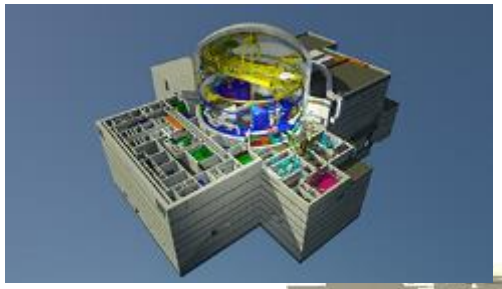
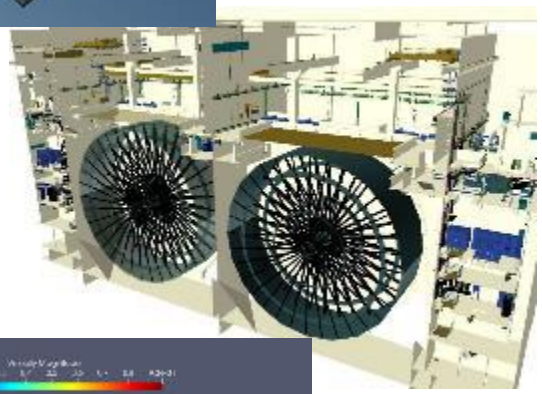
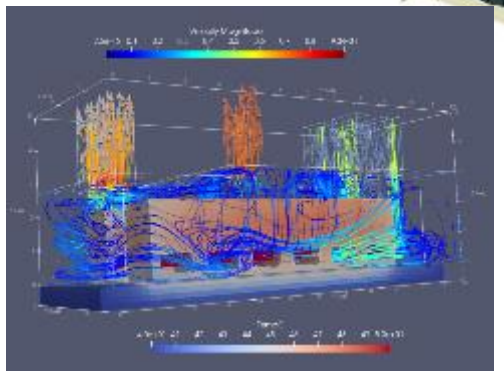
SUMMARY

INTEGRATED ENGINEERING & INDUSTRIAL CAPABILITIES TO DELIVER EDF'S AMBITIONS

EDF edvance GROUPE EDF framatome (GEAST)







Saint Marcel

Belfort

Le Creusot

Sanand, India

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INTEGRATED ENGINEERING & INDUSTRIAL CAPABILITIES TO DELIVER EDF'S AMBITIONS

- **The French nuclear industry,** ready to deliver new nuclear construction programmes
- **Mapping of the French nuclear industry**

970€ million of R&D investment

+ 200,000 employees

53,3% of the companies have export activities

+ 3,000 companies

+50% of the export sales realised outside of Europe

47.5 € billion sales

Source : CSFN study 2019 (Strategic Committee of the Nuclear Industry)

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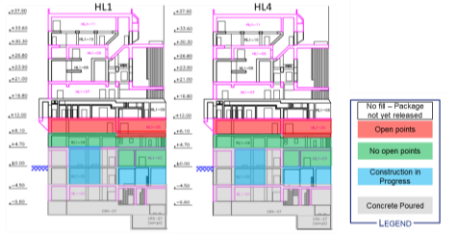
LARGE-SIZE NUCLEAR PROJECT MANAGEMENT

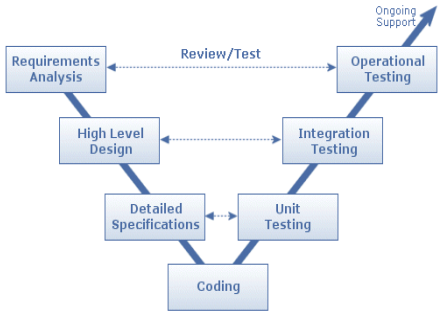
- **State-of-the-art Project Management practices**, compliant with international standards and adapted to nuclear activities
- Implementation of **relevant processes and KPI** to drive EPCC activities
- In-house **skills development programme**
- Internal large-scale **project management community**
- **Continuous improvement programme** covering project management and nuclear engineering processes, including **design integration**

Project Management Institute.

IPMA® international project management association



ISO IEC IEEE



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A WIDE RANGE OF HIGH VALUE-ADDED SERVICES IN SUPPORT OF THE EXISTING NUCLEAR OPERATOR

Load Following and Flexible Operation Expertise

- Renewables assets with flexible nuclear are partners for a low carbon electricity generation
- EDF and Framatome have decades of experience in design, operation and solutions for a flexible operation to increase its competitiveness

Long Term Operation Experience

- EDF has initiated a large-scale industrial programme for Long Term Operation relying on strong R&D and engineering studies
- The Long-Term Operation programme increases fleet competitiveness as well as it guarantees the best nuclear safety standards

Materials ageing, Physical and Chemistry analyses

- Analyses, investigations and measurements in materials and chemistry fields, combining engineering and testing resources to support the operational fleet, new nuclear projects, sites in decommissioning

E-monitoring assets with Metroscope software

- An industrialized product, simple and ergonomic, for operators and decision-makers, with (i) Automatic detection of energy losses, (ii) Automatic and live failure diagnostic, (iii) Objective quantification of the failure impact on the plant performance (in MWh & €uros)

Crisis management and Emergency preparedness

- Emergency planning ensures the capability to take actions that will effectively mitigate the consequences of an emergency

Dismantling and Waste management

- Assistance in nuclear decommissioning projects and management of radioactive waste, arising from operation and decommissioning: preliminary studies and decommissioning strategies, nuclear project and programme management, cost evaluation and optimization in decommissioning

EDF framatome cyclife GROUPE EDF metroscope Gifen I2EN International Institute of Nuclear Energy

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FRAMATOME GROWING PRESENCE IN CENTRAL & EASTERN EUROPE

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Trustful relationship & presence near 40 years

- Focused in supporting VVER operators in:
  - **Maintenance and modernization** of electrical and I&C systems
  - **Ageing management**
  - **Supply of spare parts and modernization packages**
  - **NEW: fuel supply** starting 2025
- **Subsidiaries in Czech Republic, Slovakia, Hungary, Bulgaria, Ukraine and Romania** bring our teams **closer to our customers**
- **Partnerships with local** engineering and installation companies with extensive plant experiences.

160 people over **10** sites

Backed by **100s** of experts and engineers in Germany with VVER technology knowledge

CYCLIFE'S INTEGRATED DECOMMISSIONING AND WASTE MANAGEMENT SERVICES PROVIDE TAILOR-MADE SOLUTIONS FOR CUSTOMERS

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Decommissioning and Dismantling Services

- Integrating Engineering
- Concept and Detailed Design Studies
- Digital Tools to Optimise Cost, Risk and Planning
- Innovative Remote Tool Development
- Consultancy and Project Management
- Strategy Development
- D&D Scenario Design Optimisation
- Decommissioning Project Support
- On-site Works Management

Waste Management Services

- Waste Size Reduction: Cutting, Melting, Incineration, Pyrolysis
- Material Recycling
- Consultancy and Integrated Services
- Cost, Risk and Planning Optimisation
- Waste Route Management
- Decontamination
- Large Component Management
- Waste Treatment Facilities
- On-site Mobile Units

TRAINING AND SKILLS DEVELOPMENT

In support to the technology offer, EDF also provides tailor-made training solutions for continuous skills development and knowledge sharing

UFPI

Through **UFPI**, EDF is offering :

- **customised training programs** for each profession involved on an EPR project
  - customised training is based on e-learning, off-site classroom training, on the job training, and full scope simulators exercises
- Supporting **advanced nuclear training** thanks to
  - 700 skilled and recognised professional instructors
  - Several training facilities in France and in the United Kingdom
  - cumulated expertise in designing tailor-made training and skills development programs

I2EN

International Institute of Nuclear Energy

(created by the French government in 2011)

The **I2EN** represents & coordinates the French offer in nuclear Human Capacity Building abroad in order to:

- propose the best **education** & **training solutions**
- share **best practices** in Human Capacity Building
- ensure France's capacity to **host international students and professionals**
- review the French **offer** in nuclear education & training
- **accredit** French nuclear degrees

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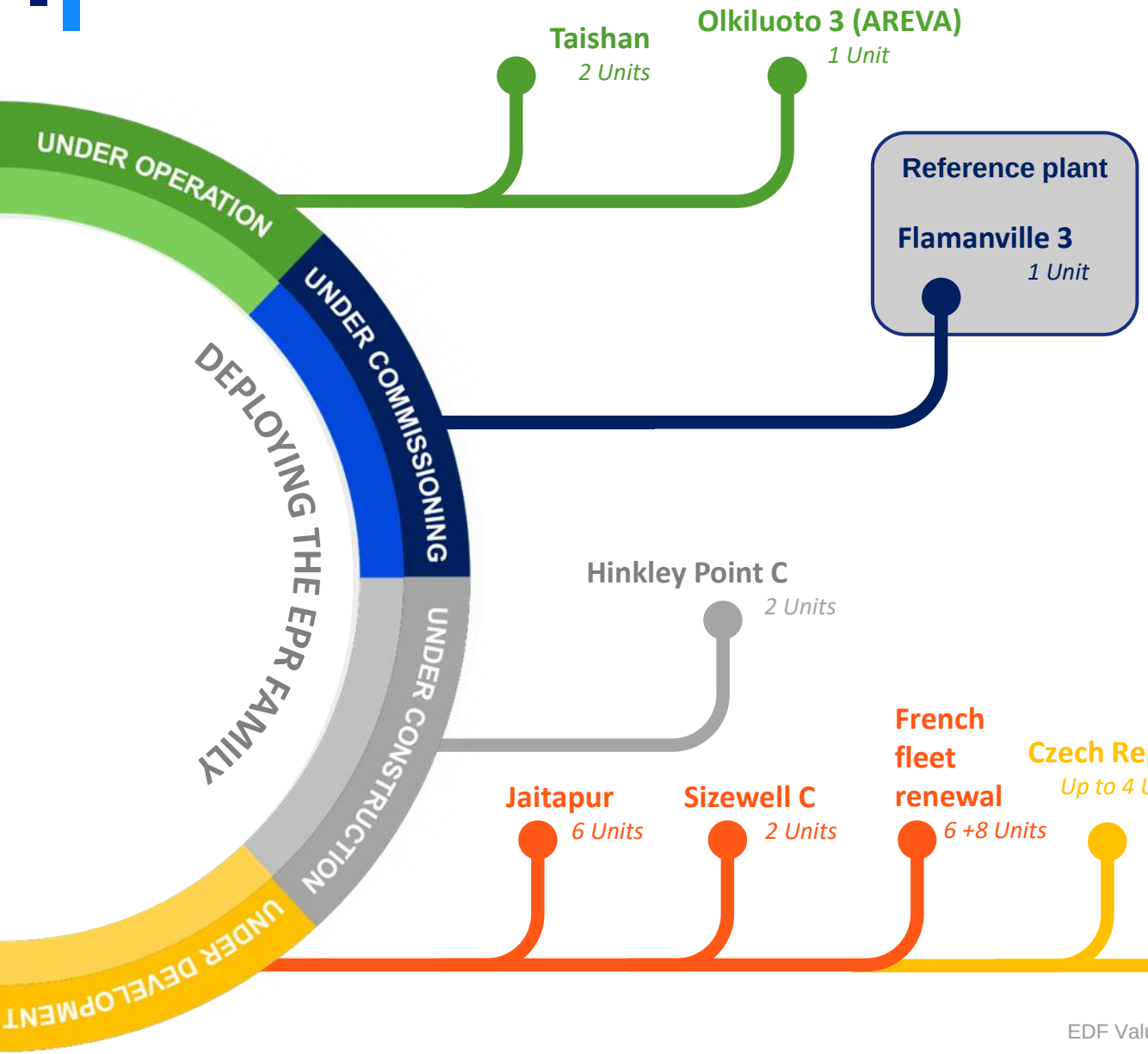
SUMMARY

NEW BUILD PROJECTS – EDF TRACK RECORD AND PERSPECTIVES



Taishan
2 Units

Olkiluoto 3 (AREVA)
1 Unit

Reference plant

Flamanville 3
1 Unit

Hinkley Point C
2 Units

Jaitapur
6 Units

Sizewell C
2 Units

French fleet renewal
6 +8 Units

Czech Republic
Up to 4 Units

Saudi Arabia
2 Units

Poland
Up to 6 Units

Kazakhstan
2 Units

Netherlands
2 units

Slovenia

Bulgaria

- EPR Technology guarantees all EPR configurations rely on robust safety features and proven systems
- Adaptable to a wide variety of regulatory and environmental conditions
- Full capitalization of previous projects lessons learned

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THE EUROPEAN CASE STUDY: ENHANCED PROJECT DELIVERY THROUGH PRACTICAL EXPERIENCE IN EUROPE

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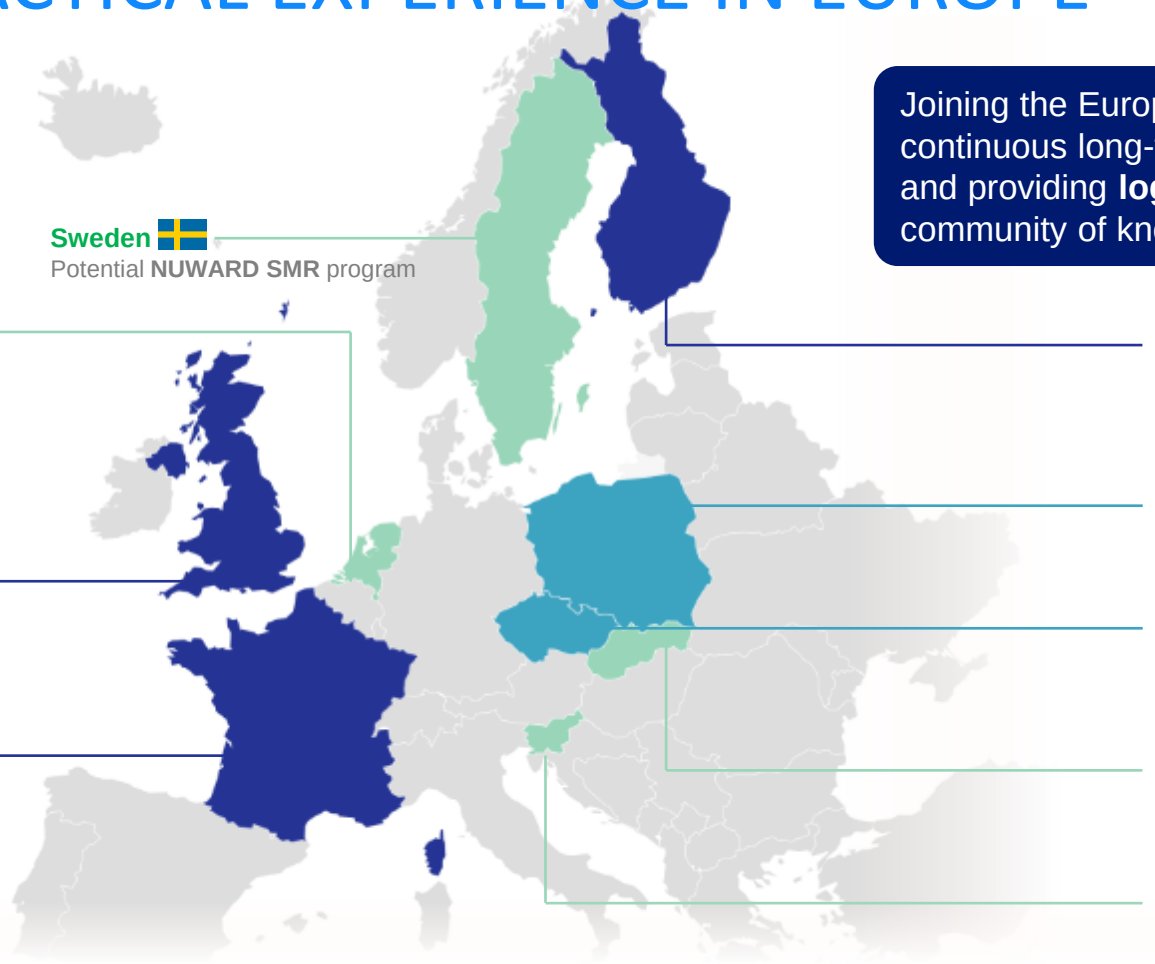
- Projects in operation or construction
- Prospects with submission of an offer
- Structured discussions about a potential project



Joining the European **EPR / NUWARD fleet** ensures continuous long-term synergies in sharing **lessons learned** and providing **logistical support** and **services** within a community of knowledgeable owners-operators.

Sweden
Potential **NUWARD SMR** program

The Netherlands
Potential of **2 EPR/EPR1200** and a **NUWARD SMR** program

United Kingdom
2 EPR under construction
2 EPR under development
Potential **NUWARD SMR** program

France
1 EPR under commissioning • **6 EPR** under development + **8 EPR** in option • First of a kind SMR program with **NUWARD SMR** under development

Finland
1 EPR in commercial operation
Potential of **2 EPR/EPR1200** and a **NUWARD SMR** program

Poland
Preliminary offer for up to **6 EPR** and a potential **NUWARD SMR** program

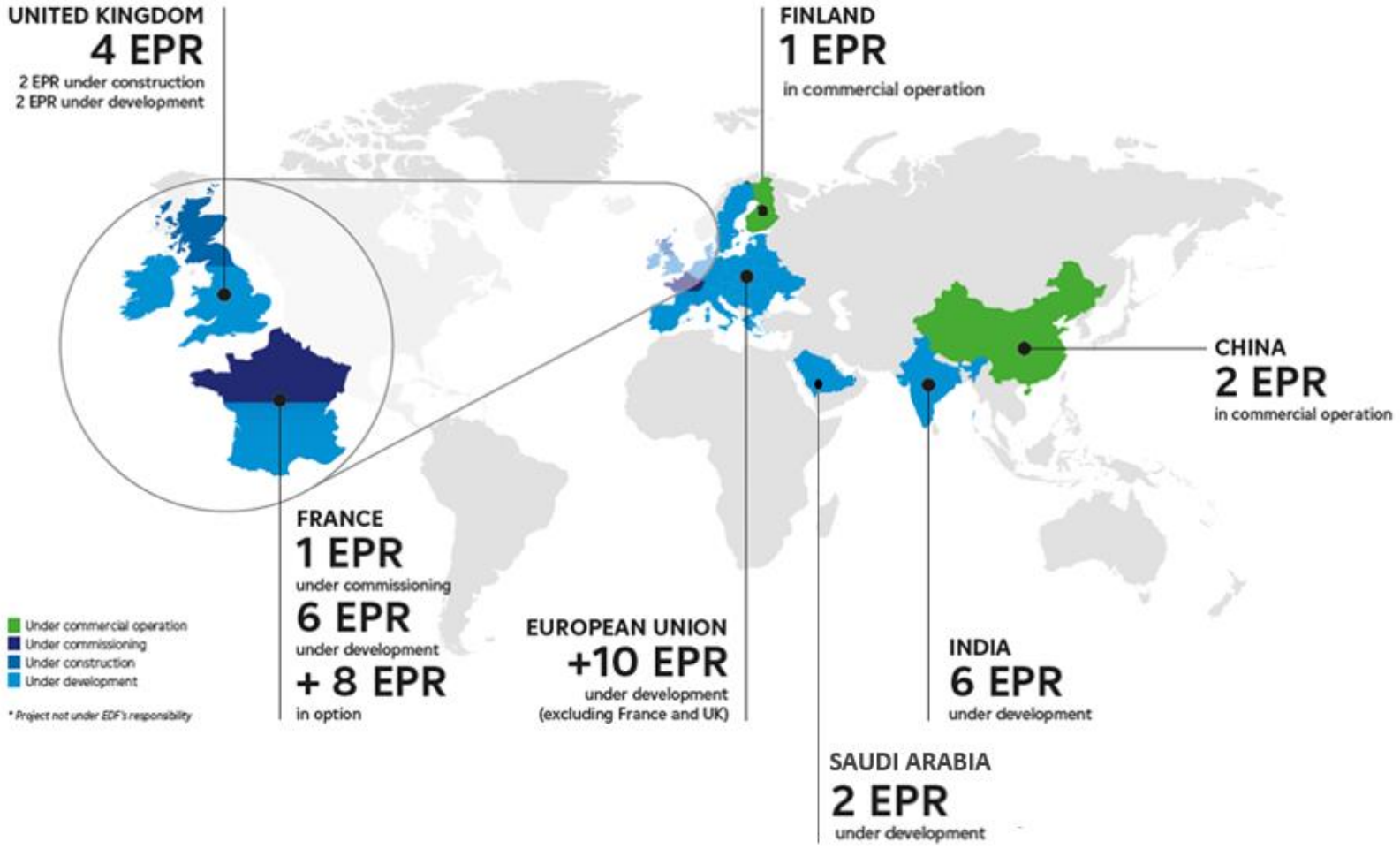
Czech Republic
Bid for **1 EPR1200**
Potential of **3 ERP1200** and a **NUWARD SMR** program

Slovakia
Potential of **1 EPR1200** and a **NUWARD SMR** program

Slovenia
Potential **EPR/EPR1200** program

Being part of the EPR fleet is being of a common industrial platform, enabling Europeans to work together to tackle the wall of projects up to 2035 and beyond.

A CONCRETE PERSPECTIVE FOR 30 EPR PROJECTS ACROSS THE WORLD



EDF is fully engaged in nuclear new build activities and is committed to supporting several countries in their nuclear program development with a focus on Europe and India

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INDUSTRIAL COOPERATION & LOCALISATION EXPERIENCE: BUSINESS CASES IN THE UK

Hinkley Point C represents a **multi-billion-pound opportunity** for British businesses and at the end of 2023, **around 22,000 people – across 3,800 British companies**.

From reinforced steel suppliers in South Wales, to advanced engineering firms in the North of England, **every region is benefitting from the project's economic opportunity**.

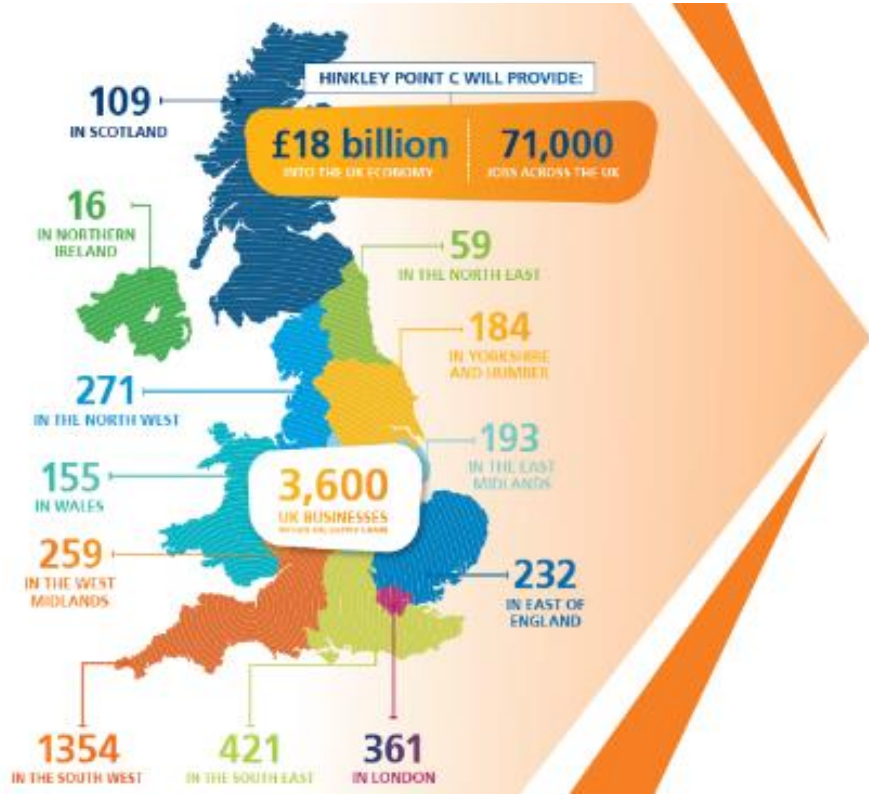
£18 Billion
The total projected economic value to the UK.

71,000
The total projected jobs to be supported by the project.

£3.2 Billion
spent with companies in the South West to date against a target of £1.5 billion during construction.

£140 Million
spent with companies in Wales to date.

64%
of the value of Hinkley Point C contracts have been awarded to UK-based companies to date against a target of 57%.



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BEYOND TECHNOLOGY:
EDF'S LONG-TERM PARTNERSHIP APPROACH

A GLOBAL FLEET APPROACH FOR ENHANCED DELIVERY AND OPERATION OF EPR

A ROBUST SUPPLY CHAIN TO SUPPORT THE SWIFT GROWTH OF GLOBAL NUCLEAR POWER

A LONG-TERM PARTNERSHIP, SHARING BEST PRACTICES AND FOSTERING COLLABORATION IN R&D, CAPACITY DEVELOPMENT AND FUEL SECURITY

LEADING THE ENERGY TRANSITION ON ALL ELECTRICITY-RELATED ACTIVITIES (SMR, HYDROGEN, GRID MANAGEMENT…)

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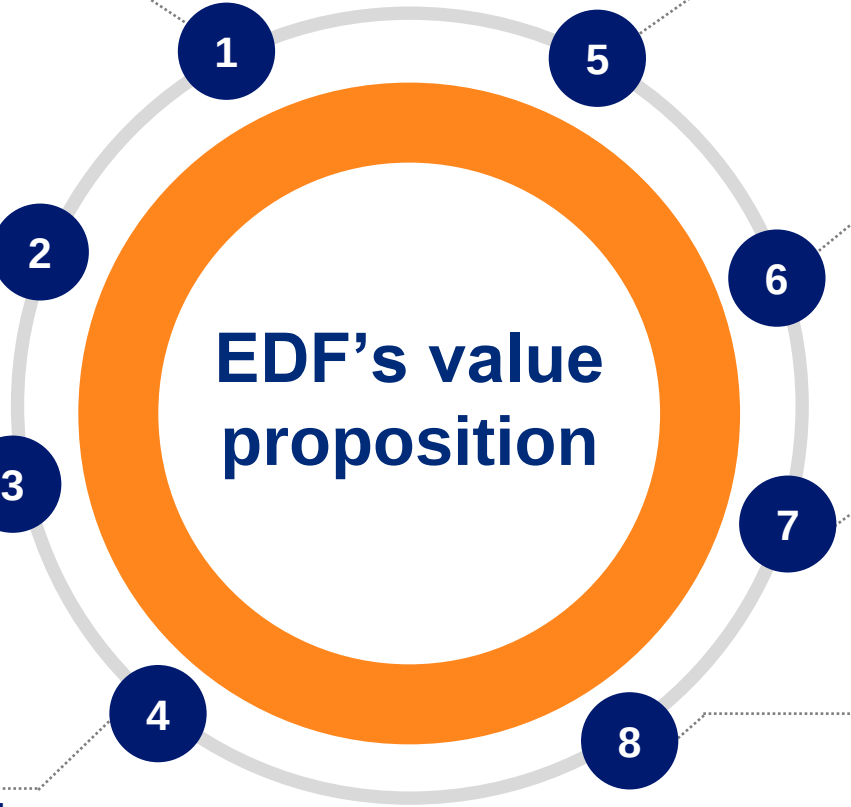
IN A NUTSHELL: EDF'S STRATEGIC VALUE PROPOSITION



1. **Best-in-class GEN 3+ reactors technologies**
2. **Commitment to the highest safety standards**
3. **Enhanced project delivery through practical experience in Europe**
4. **Support from the French Government**
5. **Integrated engineering & industrial capacities**
6. **Long-term partnership approach**
7. **Industrial cooperation & localisation**
8. **Training and Skills development**

EDF, as vendor-utility, offers an integrated and comprehensive solution for a long-term partnership supported by a robust experience in Europe.

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Thank You
БЛАГОДАРЯ
Merci

nucleardevelopment@edf.fr