# The French nuclear experience in the Polish nuclear energy context

## The EPR reactor: safety, localization, construction, experience feedback

Patrick ZAK
Director Pre Development and Marketing
EDF New Nuclear Projects and Engineering

**Poznan– ExpoPower – 23 April 2018**

# CONTENT

# EDF GROUP
## KEY FIGURES OVERVIEW

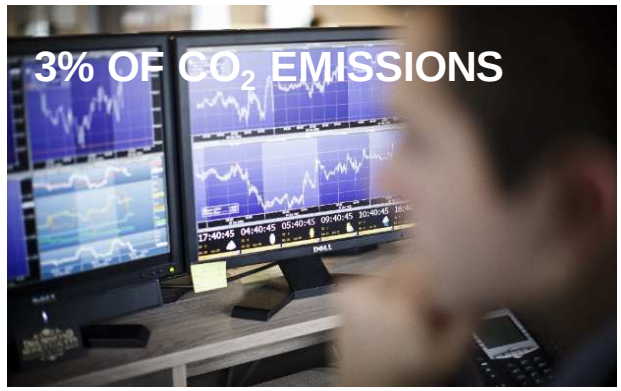

**EDF produces around 22% of the European Union's electricity, primarily from nuclear power**

# FRENCH NUCLEAR LANDSCAPE

## SOCIO ECONOMICAL BENEFITS





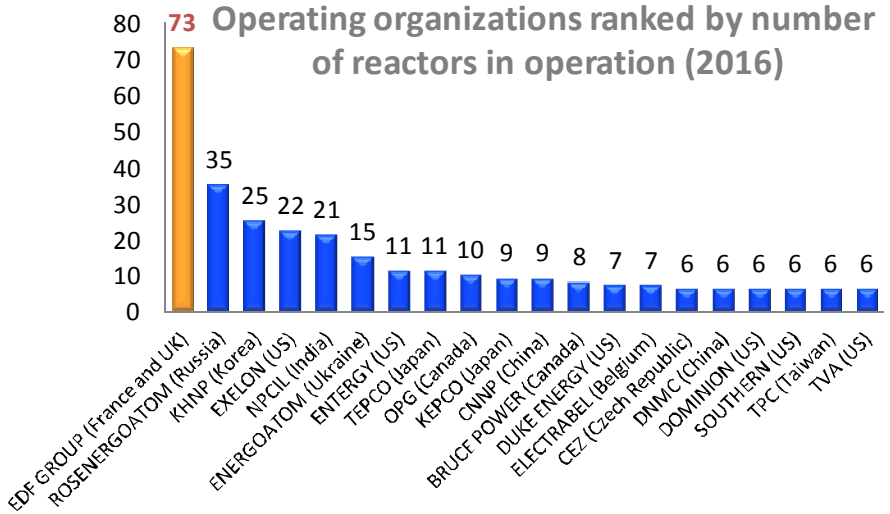



# DESIGNING, BUILDING, OPERATING AND MAINTAINING THE LARGEST FLEET WORLDWIDE

## 40 years of Operation and Maintenance

**EDF : World's leading nuclear power plant operator**

- **58 reactors in France (63 GWe)**
- **15 reactors in the UK (9GWe)**
- **~ 2000 reactor-years of experience operating the French fleet**




## EDF International experience on project delivery

**5 ongoing EPR Units**

*Flamanville 3*
*France*

*Taishan 1*
*China*

*Taishan 2*
*China*

*HPC 1&2*
*United Kingdom*

**An EPR Owners Operators Group : EDF, EDF Energy, TNPJVC, TVO**

# CONTENT

# THE EPR REACTOR

1,650 MWe PWR

- Generation III+ PWR
- High power output (1,650 MWe)
- Plant efficiency 36%
- Evolutionary design (Konvoi / N4)
- Low global power generation costs
  - Fuel consumption reduced by up to 15%
  - 60 years of operation
  - Availability factor 91%
  - Improved flexibility to reduce OPEX
- Load following capability
- Reduced number of welds
- Maximized benefit from size effect
- Minimal environmental impact
- MOX Fuel capability
- Reactor being designed in collaboration with utilities and safety authorities
- EUR criteria compliant
- An outstanding safety level…

# STATE OF THE ART IN TERMS OF SAFETY

**Reduce the probability of a severe accident with core meltdown**

Physical separation, diversity, and redundancy of critical components – 4 safety trains

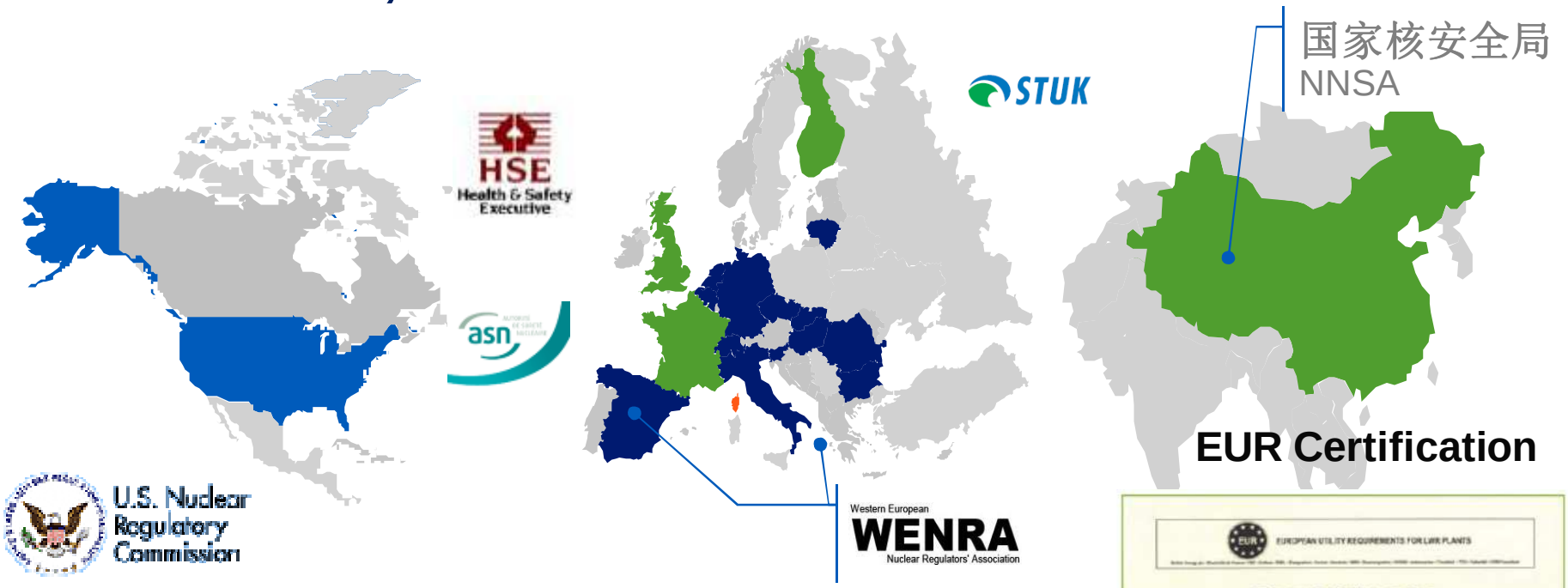

**Protect population and environment in case of severe accident**

Confined corium and radioactive products in the reactor (“core catcher”) – Deterministic approach

**Protect against malevolent act (e.g. airplane crash)**

High structural resistance – Double shell containment

# A DESIGN ALREADY ASSESSED AND LICENSED BY VARIOUS INDEPENDANT BODIES AND SAFETY AUTHORITIES, WORLDWIDE

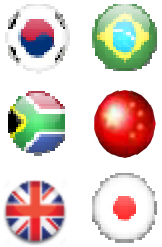



- Construction license granted in 4 countries
- Design license started
- In line with the safety objectives of the Western European Nuclear Regulators' Association (WENRA)

**EUR Certification**


**A smoother licensing phase supported by experienced team involved in numerous licensing contexts**

# 40 YEARS OF FRENCH KNOW HOW TRANSFER AND LOCAL INDUSTRY DEVELOPMENT

| Areas of support | Knowledge and learning sharing | | Examples |
|---|---|---|---|
| Skills development | 40+ | **years** of successful human capacity building guidance and cooperation with fellow countries since 1970's. |  |
| Localization | 45y | **years of local industries development**, both NPP (engineering, manufacturing, and construction ) and fuel cycle – through technology transfer and skills development, including R&D support, to create high quality jobs locally. |  |
| Education and training (all types) | 55+ | **partnerships** with top universities worldwide. set up of joint training centers. |  |
| NPP operation | 850+ | **trainees** from foreign operators trained over the last 30 years. |  |
| | 346 | **reactors** supported, out of the 435 in operation (i.e. 80% of nuclear global fleet), with products and services. |  |

# FLAMANVILLE 3: THE EPR REFERENCE PLANT

- EPR Reference Plant
- First EPR reactor in France
- Largest Project in Northern Europe
- Power output : 1,650 MWe
- EDF as Owner & Operator

**September 2015**
New schedule


**August 2017**
Cold Test
Nuclear circuit cleaning

**End 2018**
First fuel loading and start-up operations to begin

CURRENT STATUS | SCHEDULE

**March 2016**
Welding of 1st Primary Circuit

**End 2017**
Cold functional test

**July 2018**
Hot functional test

**2nd Quarter 2019**
Connection to the grid

# TAISHAN 1 & 2: ACCELERATION IN THE EPR LEARNING CURVE

- The first two EPR reactors in China
- Power Output : 1,750 MW each
- EDF as co-Owner-Operator with renewed partnership
- **Tropicalized to adapt to the country's climate**

**July 2017**
End of Hot Functional Tests

**Second half of 2018**
COD Unit #1

CURRENT STATUS | SCHEDULE

**April 2018**
First fuel loading

**Second half of 2019**
COD Unit #2

# CONTENT

# HINKLEY POINT C 1&2: CONFIRMING EPR AS THE REFERENCE IN EUROPE

- First nuclear construction project in the UK in 30 years
- GDA certification process
- Reference plant EPR Flamanville 3
- Contract For Difference guarantying a fixed price of electricity for 35 years
- Partnership with CGN as co-owner
- Power output : 1,638 MWe each

**September 2016**
Final contracts signed

**2019**
FCD Unit #1

**2026**
COD Unit #2

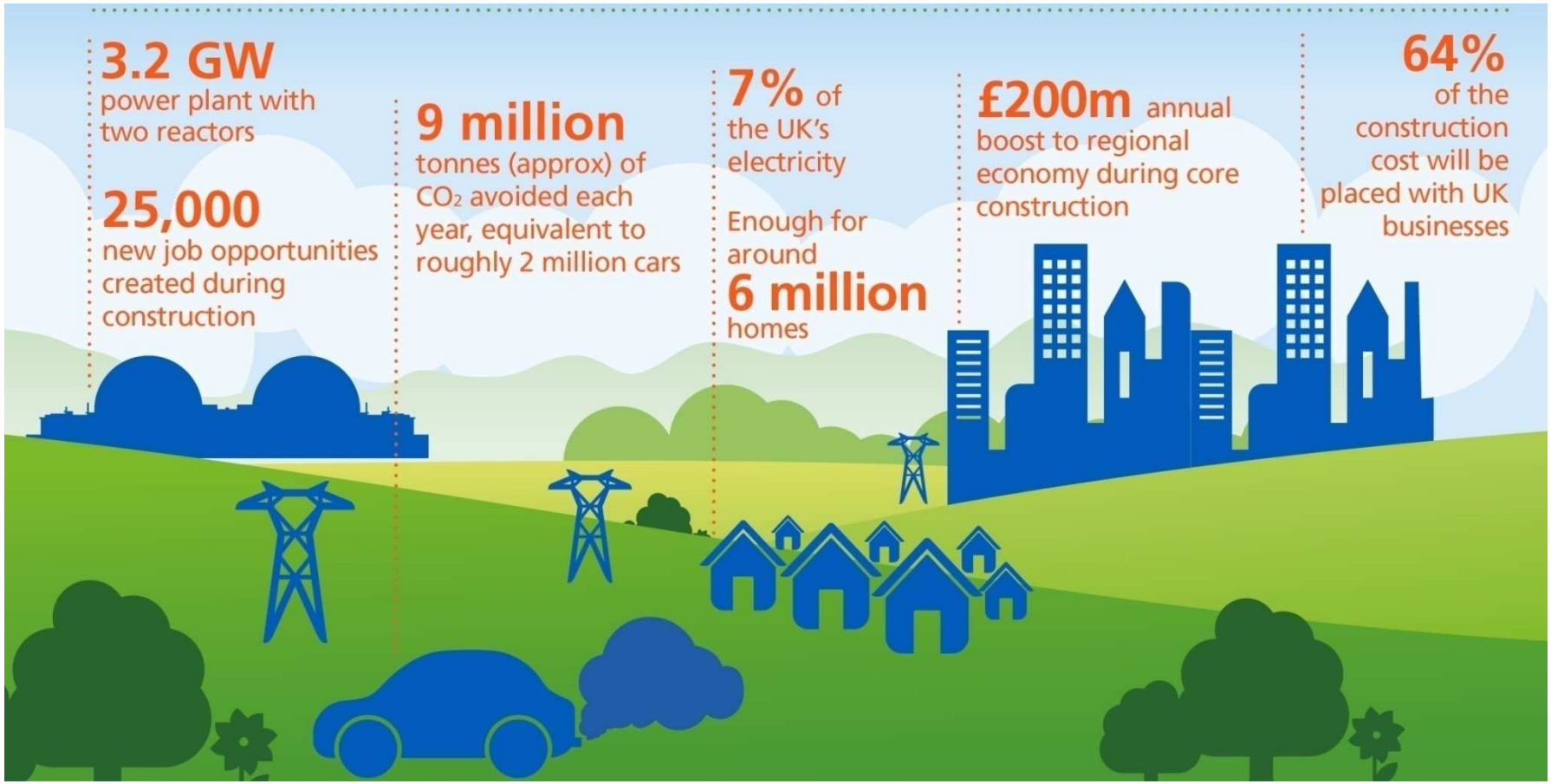
CURRENT STATUS | SCHEDULE

**October 2013**
UK Government agree Contracts For Difference for HPC

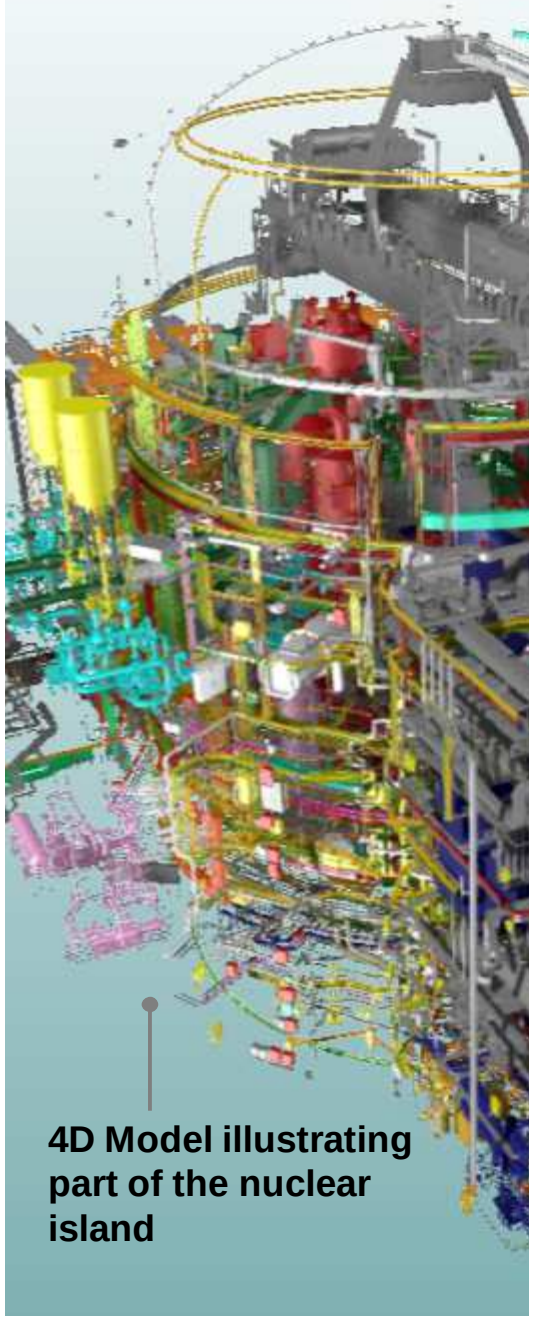
**March 2017**
First nuclear safety concrete successfully poured for power station galleries

**2025**
COD Unit #1

# HINKLEY POINT C
# Key figures



# HINKLEY POINT C - Scale of the Construction Site



**4D Model illustrating part of the nuclear island**

**3 Million**
Tonnes of Concrete

**5.6 Million**
$M^3$ of earth to be moved

**4000 km**
electrical cabling

**£40M** injected in local economy during operation

Over **£4 Billion** benefit to local economy during construction and operation

**30%**
Local workforce

# HPC INSPIRING INDUSTRIAL COLLABORATION

# CONTENT

# LESSONS IMPLEMENTED AT HPC

## Configuration

- End of construction topographical surveys with data compared with PDMS model and results made available to all parties

## Mechanical, Electrical and HVAC Erection

- Development of new contractual arrangements and collaborative one-team ways of working

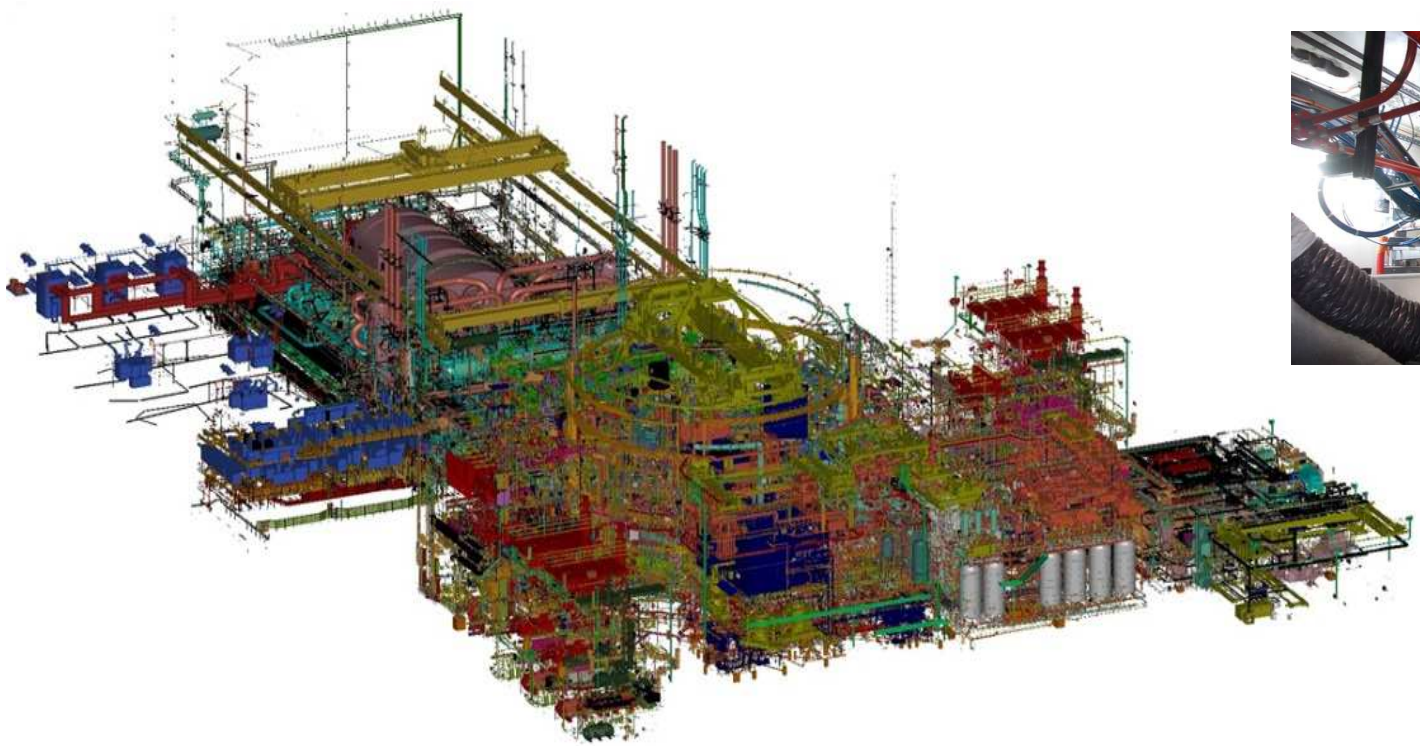
## Civil Construction

- 3D design of rebar and solving of embedment clashes before models frozen
- Use mock-ups to trial techniques, test arrangements and competencies, test interfaces
- Modular construction of rebar cages, floors, walls and pool liners

## Data-centric Approach

- Development of a central electronic depository for all project information to support commissioning and operation

# MEH INTEGRATION MODEL – THE CHALLENGE



Hinkley Point C:

- Construction schedule is challenging
- Scale and complexity is unique
- Delivery needs world-class productivity, room occupancy and daily progress rates
- Delivery needs a different way of working
  - New organisational and contractual arrangements
  - New methods, tools and systems being developed, including configuration capture by one consolidated 3D topographical survey

# CONCLUSION

- EDF is a strong player on the world's nuclear market – Operates the biggest fleet in the world
- The EPR is a robust design, EPR will keep the owner-operator on the safe side
- The EPR world wide fleet is being born
- Ongoing construction projects are getting to end, no project has been stopped
- EDF long standing experience as a nuclear operator guarantees that the phasing from construction to operation will be managed smoothly and efficiently (derisk of fuel loading clearance after construction)
- Improvement slope is a fact in all fields (engineering, fabrication, construction, PMO)
- Systematic lessons learned implementation in new project is industrialized – Implementation on the biggest construction site in Europe at Hinkley Point C
- The level of confidence regarding capability to deliver future projects on time and on budget is high
- Polish EPR will be the 7$^{th}$ and 8$^{th}$ a the EPR world series

# DZIĘKUJĘ

# PYTANIA?