Benefiting from EDF EPR projects

JADERNÉ DNY 2020 na ZČU v Plzni

New Nuclear Source for the Czech Republic
State of preparation in 2020

September 23, 2020
AGENDA

- EDF company profile
- Reference projects and construction experience
- EDF Technology Portfolio
- New projects
- EDF value proposition for Czech Republic nuclear new build program
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EDF GROUP AT A GLANCE

EDF produces around 22% of the European Union’s electricity, primarily from nuclear power.
EDF GROUP
A unique expertise and know-how in the nuclear industry

EDF, the world’s leading nuclear operator

- 56 reactors
- 1 Reactor under construction in France/63.1GW
- 15 Reactors under construction in UK/8.9GW
- 2 Reactors in commercial operation in China/Taishan

- Operate the existing nuclear fleet beyond 40 years for a competitive energy mix

EDF, a global expertise

EDF manages the entire lifecycle of nuclear generation facilities

- COMMISSIONING
- OPERATING
- DESIGN
- DECOMMISSIONING AND DISMANTLING

EDF, the world’s leading nuclear operator manages the entire lifecycle of nuclear generation facilities.
Build a net zero energy future with electricity and innovative solutions and services, to help save the planet and drive wellbeing and economic development.
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EPR FLAMANVILLE 3: Reference Plant

GENERAL INFORMATION
- First EPR reactor in France
- Power output: 1,650 MW
- EDF combining its skills and responsibilities of Owner & Operator and Architect Engineer: 100% EDF ownership

CURRENT STATUS
- March 2016: Welding of 1st Primary Circuit
- January 2018: Cold tests carried out
- August 2017: Nuclear circuit cleaning
- August 2018: Functional tests vessel open successfully completed
- March 2019: End of 1st phase hot functional tests: > 95% of the test criteria testing compliant
- Ongoing: Welding repairs
- February 2020: End of 2nd phase of the hot functional test

NEXT
- End 2022: Fuel loading
EPR TAISHAN 1 & 2: first EPR units in operation

GENERAL INFORMATION

- The first two EPR reactors in China
- Power Output: 1,750 MW each
- EDF as co-owner and co-operator: 30% EDF ownership
- Design adaptation to country's tropical climate
- Worldwide annual record per unit

CURRENT STATUS

- July 2017: End of hot functional tests
- 29 June 2018: Unit #1 grid connection
- 13 December 2018: Unit #1 in Commercial Operation
- July 2020: Unit #1 first outage refueling
- September 2015: Vessel Flushing Operations
- 6 June 2018: Unit #1: 1st criticality
- 10 December 2018: Unit #2: Start of hot functional tests
- 7 September 2019: Unit #2 in Commercial Operation

24+ TWh generated per year
EPR HINKLEY POINT C: a new business model

GENERAL INFORMATION

- First nuclear construction in the UK in 30 years
- Power output: 2 x 1,638 MW
- Certification process: Generic Design Assessment (GDA)
- Contract For Difference (CFD) guarantying a fixed price of electricity for 35 years
- 66.5% EDF ownership

CURRENT STATUS

- October 2013
  UK Governments agrees Contracts for Difference

- March 2017
  First concrete successfully poured for power station galleries

- June 2019
  Unit #1: Completion of the common raft, 1st nuclear concrete

- September 2016
  Final contracts signed

NEXT

- June 2020
  Unit #2: Completion of the common raft, 1st nuclear concrete

- End 2021
  Unit #1: Dome lifting

- 2025
  COD Unit #1

- 2026
  COD Unit #2
Securing the future project’s progress

- **Safety culture** development
- **Definition of** an efficient and relevant project organisation
- Reference frames and regulatory requirements
- Reliability of the basic design configuration
- Project and detailed design **software**
- Mature design at contract signature
- **Clear boundaries** between engineering, qualification and procurement contracts and construction and erection contracts
- Scheduling of **Suppliers’** studies with above milestones and Supply chain assessment
- Sites activities steering

**CAPITALISED LESSONS LEARNED**

Benefiting all future projects
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EDF Technology Portfolio

**Large Size Reactors**
(> 1,400 MWe)
Optimizing the power capacity per nuclear site
Proven technology

**Mid Size Reactors**
(900 MWe up to 1,400 MWe)
Integration in the power network
Proven EPR based design

**Small Size Reactors**
(< 500 MWe)
Affordable and flexible nuclear for power generation
Under development
### EPR reactor main characteristics

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thermal Power</strong></td>
<td>4,300 MWth – 4,590 MWth</td>
</tr>
<tr>
<td><strong>Electrical power output</strong></td>
<td>1,650 MWe – 1770 MWe</td>
</tr>
<tr>
<td><strong>Thermal efficiency</strong></td>
<td>37 %</td>
</tr>
<tr>
<td><strong>Plant design availability</strong></td>
<td>91 %</td>
</tr>
<tr>
<td><strong>Primary system</strong></td>
<td>4-loop configuration</td>
</tr>
<tr>
<td><strong>Operation cycle length</strong></td>
<td>Up to 24 months</td>
</tr>
<tr>
<td><strong>Design service life</strong></td>
<td>60 years</td>
</tr>
<tr>
<td><strong>Instrumentation &amp; Control</strong></td>
<td>Fully digital</td>
</tr>
<tr>
<td><strong>Fuel assemblies in core</strong></td>
<td>241 with 17x17 arrangement</td>
</tr>
<tr>
<td><strong>Radiation Protection</strong></td>
<td>collective dose &lt; 0.5 man.Sv/y</td>
</tr>
</tbody>
</table>

EPR design fully experienced from licensing to operation.
EPR SAFETY FEATURES

MAIN SAFETY PRINCIPLES...

- REDUNDANCY: To reduce single failure
- DIVERSITY: To reduce common cause failures
- COMPLEMENTARITY: Between active and passive systems
- PREVENTION OF ENVIRONMENTAL DAMAGE
- RESISTANCE TO EXTREME HAZARDS
- ROBUSTNESS OF COOLING CAPABILITY

...TO ACHIEVE ESSENTIAL SAFETY FUNCTIONS

- FULLY COMPLIANT WITH EUROPEAN UTILITY REQUIREMENTS (EUR)
- LICENCED IN 4 COUNTRIES: CHINA, FINLAND, FRANCE AND THE UNITED KINGDOM
- OUTPERFORMED THE EUROPEAN POST-FUKUSHIMA STRESS TEST

1. Four redundant independent safety-systems
2. Reinforced concrete shell
3. Core catcher
EPR performances

13 TWh of low carbon electricity generation per year, avoiding 10.5 millions t eq CO² emissions

Enhanced grid base-load and load-following manoeuvrability: 80% variation in 30 minutes

Biodiversity preservation with limited ecological and land footprint thanks to a compact and optimized design

30% reduction of liquid discharges

An improved efficiency in fuel design and management reducing uranium consumption by 20%

Design for 91% availability
**EPR 1200**

<table>
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<tr>
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<th>3,300 MWth</th>
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</thead>
<tbody>
<tr>
<td><strong>Electrical power output</strong></td>
<td>1,200 MWe</td>
</tr>
<tr>
<td><strong>Thermal efficiency</strong></td>
<td>36 %</td>
</tr>
<tr>
<td><strong>Plant design availability</strong></td>
<td>≥ 91 %</td>
</tr>
<tr>
<td><strong>Primary system</strong></td>
<td>3-loop configuration</td>
</tr>
<tr>
<td><strong>Operation cycle length</strong></td>
<td>Up to 24 months</td>
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<td><strong>Design service life</strong></td>
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**EPR technology philosophy:**
- Safety (GEN III+, defence-in-depth, 3 trains, core catcher, APC)
- Maintenance and operation (including load-following)
- Radioprotection
- Environmental protection

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**EPR / EPR 1200 main technological differences**
- Number of loops and vessel configuration
- Reactor building interior layout

**Main safety related components identical to EPR**

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**PROVEN EPR BASED DESIGN: MODIFICATIONS LIMITED TO 3-LOOP CONFIGURATION FULLY BENEFITS FROM EPR EXPERIENCE**
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NEW PROJECTS

UNITED KINGDOM
- Hinkley Point C: 2 EPR
- Sizewell C: 2 EPR
- Bradwell B: 2 UK HUALONG

POLAND
- 6 EPR

CZECH REPUBLIC
- 1 EPR 1200 Dukovany
- 2 sites identified (Dukovany or Temelin)
- 1 to 4 units

KAZAKHSTAN
- 2 EPR 1200 or SMR

CANADA
- SMR 300-400 MW Darlington

BRAZIL
- ANGRA 3 to be completed
- EPR 1200

SOUTH AFRICA
- RFI in september 2020: EPR / SMR

SAUDI ARABIA
- RFI Answer in 2017-2018
- FEED-B Phase in 2019
- 2 EPR

INDIA
- JAITAPUR: 6 EPR

CHINA
- 4 EPR
  - Taishan 1 and 2 in operation
  - Taishan 3 & 4

INDONESIA
- EPR 1200 or SMR

POLAND
- 6 EPR

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SIX DIMENSIONS OF EDF VALUE PROPOSITION FOR CZECH REPUBLIC NUCLEAR NEW BUILD PROGRAM

- EPR 1200 reactor: high performance and highest standard in Safety
- Long term partnership across the lifetime of the project
- Extended Know How transfer to the Owner-Operator
- Proven localisation approach leveraging Czech industry capabilities
- Education & Science collaboration
- A cultural and geographical valuable proximity
Thank you for your attention

"In view of the urgency of climate change, the low-carbon electricity produced by EDF is clearly the energy that changes everything. It makes growth and the well-being of citizens sustainable and possible."

Jean-Bernard Lévy, CEO of EDF

Děkuji