EDF Energy – Nuclear R&D Programme

Current activities and future opportunities

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EDF - A Global Leader in Low-Carbon Electricity

- **€72.7 billion** in sales
- **39.3 million** customers
- **159,740 employees** worldwide
- **84.7% of generation does not emit CO₂**
EDF Energy in the UK

Generation

- **8** nuclear power stations (14 AGRs, 1 PWR)
- **31** wind farms (including 1 off-shore)
- **2 + 1** coal gas powered stations
- **2** EPRs in project at Hinkley Point

Sales & marketing

- **52.8 TWh** electricity sold
- **25.7 TWh** gas sold
- **5.8 million** customers

Generation 72.5 TWh

- **Nuclear** 77%
- **Coal** 22.5%
- **Combined cycle gas and cogeneration** 0.2%
- **Other renewables** 0.3%

Installed capacity 13 GWe

- **Nuclear** 67.6%
- **Gas** 0.7%
- **Coal** 31%
- **Other renewables** 0.7%
EDF Energy R&D in the UK

Local delivery of Global Value

100 people (FTE)
40 PhD
£40m of investment in R&D

Part of EDF Group International R&D Centres (500m€ investment per annum, 2100 people)
A 200m€ R&D programme to support performance of Group businesses and to anticipate and prepare for the future.

**R&D Roadmap Themes**

- Safety
- Performance
- Lifetime Extension
- Fuel and core
- New reactors
- Modelling and Simulation

**R&D programme supported by:**

- State-of-the-art experimental facilities
- Codes and modelling tools
- National and international collaborations

VERCORS mock-up: containment building at scale 1:3

Ultra-high resolution TITAN microscope
Nuclear R&D Programme in the UK – a changing context

• Mature AGR Fleet and one operational PWR where R&D is a key part of underpinning:
  • Safety of our Plant
  • Our Operational Performance Today
  • Our Plant Life Extension (PLEX) commitments

• Challenging generating market where achieving financial value in R&D is important

• Increasingly diverse R&D needs:
  • AGR Technology
  • Waste and Decommissioning challenges
  • New LWR Technology in various forms
  • Growing application and use of digital technology
A £30m R&D programme with a specific focus on Plant Life Extension for AGRs

R&D Roadmap Themes

- Improve Plant Performance
- Understand Plant Condition
- Improved Modelling
- Skills

R&D Scope

- Graphite (30% of the budget)
- High temperature Materials (25% of the budget)
- Chemistry
- Plant Engineering, nuclear technology, fuel handling
- Environment
**AGR Lifetime Challenges**

**Graphite core**

**Fundamental Requirements**
- Neutron moderator
- Mechanical stability (fuel configuration, control rods) and passage of primary coolant
- Thermal inertia (important aspect of reactor fault studies)

**PLEX Challenges**: ageing and degradation due to both temperature and irradiation effects (weight loss, shrinkage)

**Boilers**

**Fundamental Requirements**
- Provide the primary heat sink for cooling the reactor
- Allow steam production
- Part of confinement barrier

**PLEX Challenges**: gas-side oxidation and water/steam-side corrosion coupled with ageing and degradation

Replacement or repair of the graphite cores and boilers is not feasible

**R&D programme**

> Improve knowledge of actual state by **inspection and monitoring**.
> Improve understanding of ageing and **degradation mechanisms**:
> Assess and mitigate the impacts of ageing and degradation mechanisms
> Maintain key skills needed by the development of AGRs exclusively in the UK.
R&D Road Map – Overview

Themes:-
• Improve Plant Performance
• Understand Plant Condition
• Improved Modelling
• Skills

Annual independent challenge of the programme at the “Setting the Future R&D Direction” Meeting.

“Setting Future the R&D Direction”

“Setting the Future R&D Direction”

+7

+9

+6
Some illustrations

Shaking table experiment (Bristol) and quarter scale rig (AMEC) of the **graphite core** and modelling at different scales (Oxford, Glasgow, AMEC, Atkins...)

Evaluation of the impact of solar weather (BGS, National Physical Laboratory, University of Surrey)

Experimental analysis and modelling of fuel pins – **Modelling and Simulation Centre**

Creep cracking in carbonised 316H stainless steel – **High Temperature Centre**
Future opportunities

Life extension of AGRs and SZB
- Incremental Plant Life Extension Programme
- End-of-Life Value Optimisation

Decommissioning and Deconstruction
- Characterisation
- Materials and Waste Management
- Handling, Packaging and Storage
- Decontamination and Remediation

New Build
- Support to EPR projects (HPC, SZC)
- New reactors – including Small Modular Reactors
Thank You!