



Round table Energetické Třebíčsko

EDF proposal for nuclear new build program in Czech Republic

Třebíč – December 4th 2018



AGENDA

1. EDF / MHI proposal for EPR and ATMEA1 proposal in Czech Republic
2. EDF group presentation
3. EPR technology presentation
4. EDF localization strategy
5. Hinkley Point C experience with surrounding communities during the preparation, construction and operation phases
6. Conclusion



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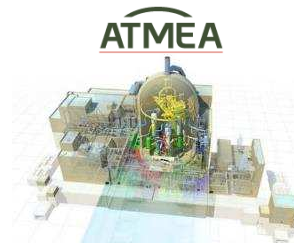


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EDF / MHI PROPOSAL FOR EPR AND ATMEA1 PROPOSAL IN CZECH REPUBLIC

- **EPR & ATMEA1: flexible power solution**
 - Middle range power: ATMEA1
 - Large size reactor: EPR
 - Similarities between the 2 design allows series effect and operation synergies
- **EPR proposal**
 - EDF proposal, with MHI support
- **ATMEA1 proposal**
 - Lead EDF
 - in cooperation with MHI
 - ATMEA provides technical support to EDF and MHI



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EDF GROUP

WORLD'S NO. 1 ELECTRICITY COMPANY

- Well established in Europe, especially France, the United Kingdom, Italy and Belgium.
- Diversified low-carbon energy mix founded on nuclear power capacity.

EDF COVERS ALL ELECTRICITY- RELATED ACTIVITIES

- Generation
- Transmission, distribution
- Trading, supply
- Energy services

LEADER IN LOW-CARBON POWER GENERATION

- No. 1 in the world for nuclear power generation.
- No. 1 in Europe for renewable energy generation.
- No. 3 in Europe for energy services.



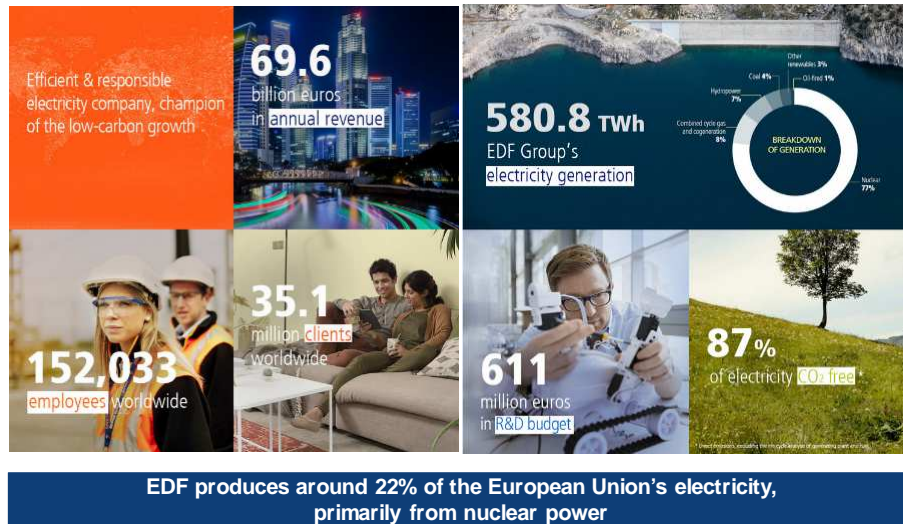
an efficient, responsible electricity company that champions low-carbon growth



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EDF GROUP: KEY FIGURES

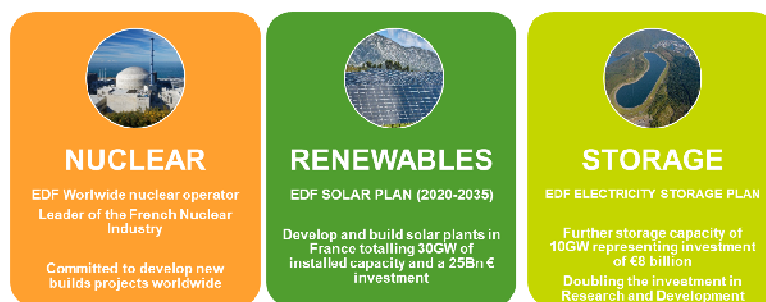


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EDF GROUP: LOW CARBON STRATEGY

To ensure a low carbon future, electricity production mix is based on:



EDF is engaged in the energy transition and promotes the complementarity of nuclear and renewables energies in tomorrow's energy mix



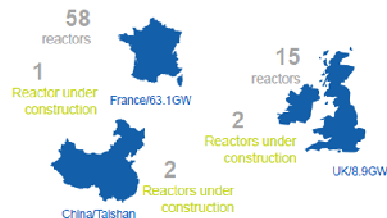
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EDF GROUP: FOCUS ON NUCLEAR OPERATION

A unique expertise and know-how in THE NUCLEAR INDUSTRY

EDF, the world's leading nuclear operator



EDF, a global expertise

EDF manages the entire lifecycle of nuclear generation facilities :

- ▣ design
- ▣ operation
- ▣ decommissioning

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



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EDF GROUP: BENEFITS OF NUCLEAR ENERGY

Impact on Local and National Economy

- ▣ The industry is exporting
- ▣ The local economy around our 19 sites is blooming

Creation of Industrial Sector

Nuclear Industry is the 3rd industrial sector in France employing around 220.000 persons in 2500 companies

Price of Electricity

French household electricity prices among the lowest of Europe

Low carbon energy

CO2 emission at the level of hydro or renewables

Nuclear Benefits

Independency

France benefits from one of the highest rate of energy independency



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EDF GROUP: BENEFITS OF NUCLEAR ENERGY


IMPACT ON LOCAL AND NATIONAL ECONOMY

National Impact in France

- 220 000 permanent jobs in the French Nuclear Industry
- More than 400 000 jobs in total
- 2 500 companies involved
- 3rd country industrial sector



FLAMANVILLE 3




- 4,400 people working on site and 55% hired locally
- Over 150 contracts signed
- 700,000 hours of training
- 123 M€ spent on outdoor infrastructure

HINKLEY POINT C


- 25,000 employment opportunities created over the construction period
- 5,600 people employed at peak
- £ 85M in orders placed with local companies
- Investment in community wellbeing

AROUND 5,600 PEOPLE



WILL BE EMPLOYED ON SITE AT PEAK

Benefiting from operation of existing reactors, sites in France are candidates for New Build



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EDF GROUP: BENEFITS OF NUCLEAR ENERGY

CREATION OF INDUSTRIAL SECTOR

€ 6 Bn


export of goods and service

1st

France is recognized as a world leader in terms of **quality, availability and access** to its electricity, which is an important asset for industrial investors.

The French nuclear industry:

- exports 10% of its electricity produced to its neighbors for € 2 bn per year
- € 1 invested in nuclear power creates 3 times more jobs than in other electricity production sector




TOTAL DES ÉCHANGES

EXPORTS: 6072 MW

IMPORTS: 1471 MW

Exports balance of electricity for the nuclear sector (october 2018)

Nuclear industry is the 3rd industrial sector in France after aeronautics and car industry



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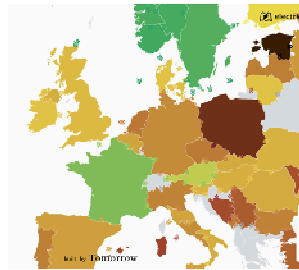
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LOW CARBON



80 g

is the production of CO₂/kWh in France for 2017.



	POWER GENERATION	ENERGY MIX		CO ₂ EMISSIONS
		NUCLEAR	RENEWABLES	
	531 TWh	77%	17%	40 million tonnes
	546 TWh	15%	25%	330 million tonnes

94%

of electricity production in France is carbon-free.

Source: « Electricity map » app

Nuclear, free carbon emission, drastically reduces EDF and France carbon factor

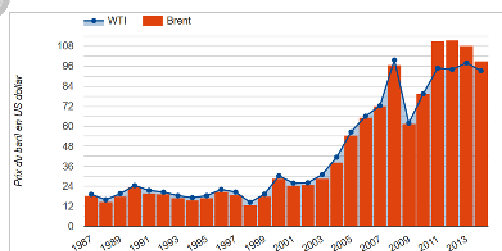


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EDF GROUP: BENEFITS OF NUCLEAR ENERGY

INDEPENDENCY



Evolution of barrel price in US dollar since 1987

56%

France's energy independence rate is one of the highest in the EU.

Nuclear energy has enabled France to **protect itself** from the **hazards** of global **energy markets** and the associated geopolitical risks.

Following the oil choc in 1973, the nuclear programme is launched to assure French energy independency

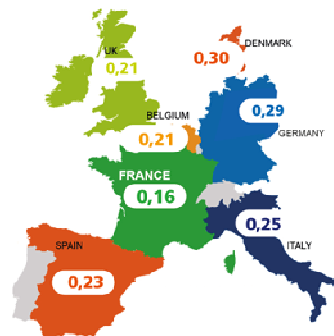
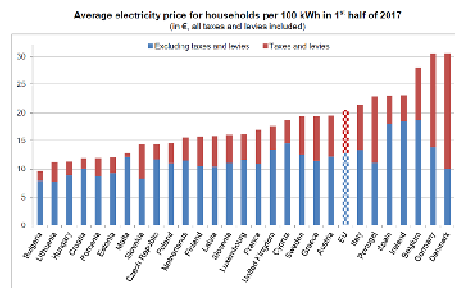


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EDF GROUP: BENEFITS OF NUCLEAR ENERGY

PRICE OF ELECTRICITY



A German household pays its electricity
ALMOST 2 TIME MORE
than a French one.

Electricity price (€/kWh) paid by individuals in Europe (2015)

French household electricity prices among the lowest of Western Europe



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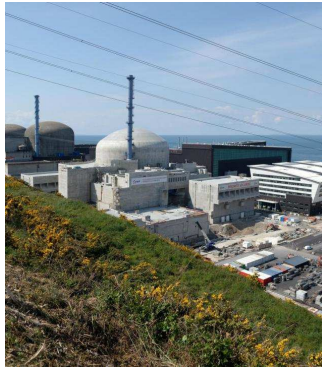
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EPR REACTOR



- EPR reactor benefits from all the experience acquired over more than 30 years by French and German nuclear industry: EPR is an extension of existing technologies
 - French N4 reactors (Chooz and Civaux)
 - German KONVOI reactors
- **3 AIMS**
 - + **Strengthening nuclear safety**
 - Reduction by design the probability of core meltdown
 - Factoring in protection against external hazards (airplane crash shell)
 - + **Preserving the environment and protecting the operator**
 - Reduction of 30% in liquid and gaseous release
 - Reduction by half of exposure to radiation during maintenance
 - + **Improving unit performance**
 - Optimization of the electricity production per site
 - 1650 MWe with availability factor of 91%
 - Designed for operating lifetime of at least 60 years
 - Cost effective thanks to the size effect



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EPR REACTOR MAIN DESIGN CHARACTERISTICS



- **Power:**
 - Core Thermal Power: 4590 MWth
 - Generated Electrical Power: > 1600 MWe
- **Availability:** > 91 %
- **Radiation Protection:** collective dose < 0.5 man.Sv/y
- **241 Fuel assemblies in core**
- **Fuel cycle length:** up to 24 months
- **Design service life:** 60 years
- **Ready for power maneuvering**

Designed for sustainably reducing O&M costs




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EPR REACTOR


LARGE COMPONENTS




Steam generator




Neutron reflector
Pressurizer



Fuel handling

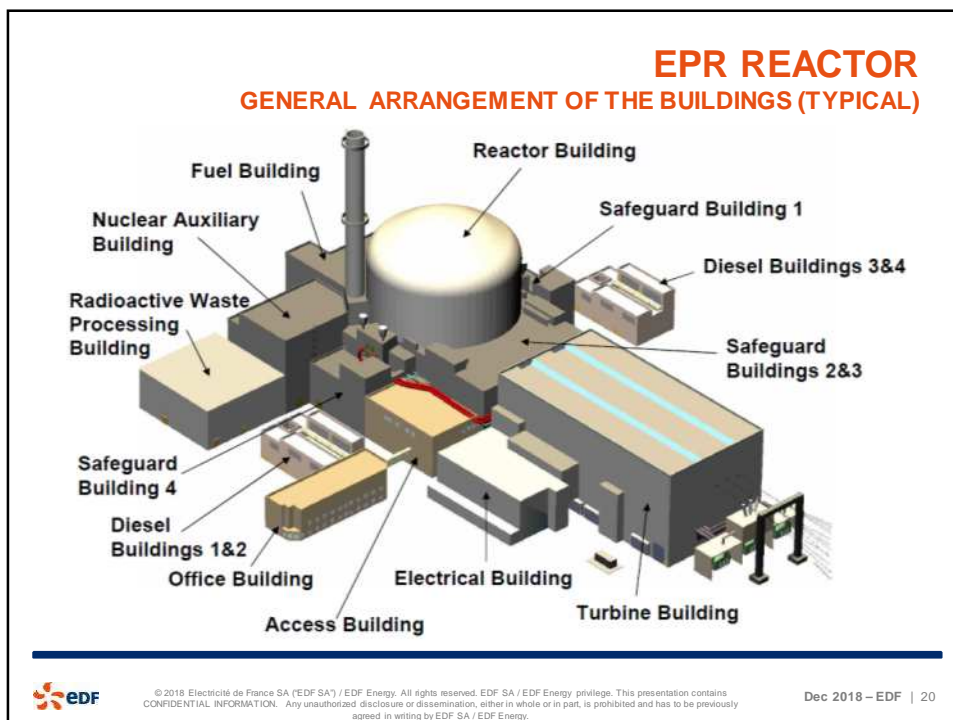


Pressure vessel



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EPR REACTOR SAFE TECHNOLOGICAL IMPROVEMENTS



Double-wall containment building with a shell able to resist to an airplane crash



4 independent safeguard systems



Core catcher in case of an accident



■ Safety

- Accident probability reduction (factor 10)
- External hazard protection (shell able to resist an airplane crash)
- Evolutionary design (core catcher)

■ Performance

- Annual generation boosted of 36%
- Efficiency improvement (+3pts)
- Increased availability (91%)

■ Radioprotection

- At least 40% cut in collective annual exposure

■ Environment

- Very important reduction in radioactive waste and gaseous and liquid discharges

A PROVEN REACTOR DESIGN – A REFERENCE FOR THE SAFETY

- Fully compliant with the European Utility Requirements (EUR)
- Strong resistance confirmed by the European Post-Fukushima stress tests

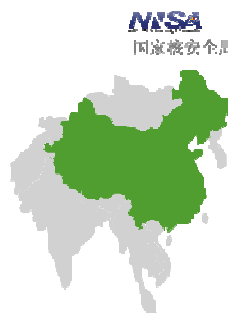
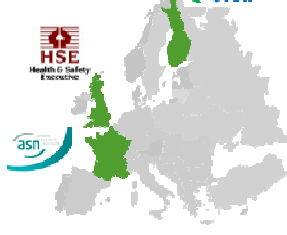
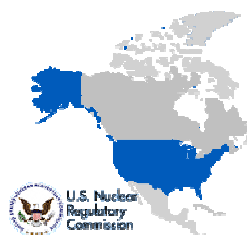


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EPR REACTOR A PROVEN LICENSEABILITY

- Construction license granted
- Design license started



EUR Certification

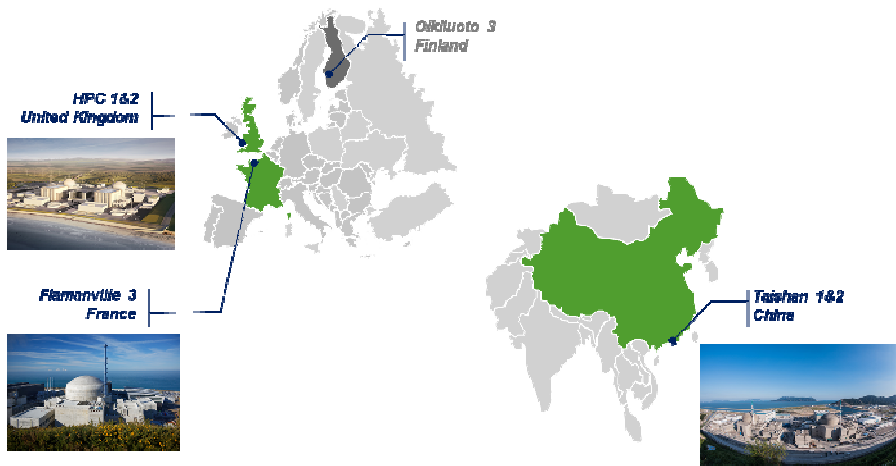
LICENSED IN 4 COUNTRIES



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EPR ONGOING PROJECTS



WITHIN 2 YEARS, 4 UNITS WILL BE IN COMMERCIAL OPERATION



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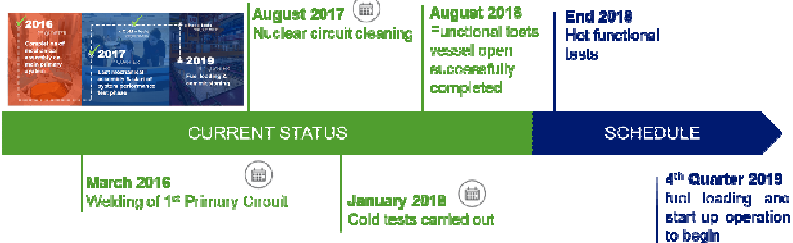
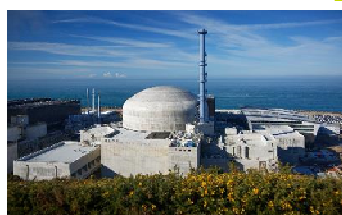
EPR ONGOING PROJECTS

EPR FLAMANVILLE 3 : THE REFERENCE PLANT



GENERAL INFORMATION

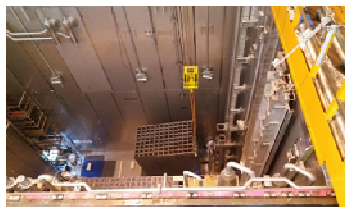
- EPR Reference Plant
- First EPR reactor in France
- Power output: 1,650 MW
- EDF as owner & operator



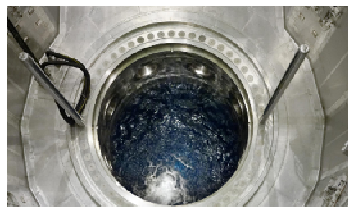
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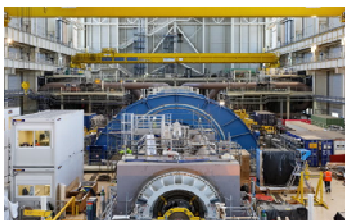
EPR FLAMANVILLE 3 : EPR ONGOING PROJECTS



Fuel rack installation within the pool



Reactor pressure vessel (RPV) cleaning



Turbine and alternator in rotation



Pump station for brine 1&2 transferred to the operating team



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EPR TAISHAN 1 & 2: ACCELERATION IN THE LEARNING CURVE

GENERAL INFORMATION

- The first two EPR reactors in China
- Power Output : 1,750 MW each
- EDF as co-owner and co-operator
- The project had to be tropicalized to adapt to the country's climate



July 2017
End of hot functional tests

6 June 2018
1st criticality

Q4 2018 COD Unit #1

CURRENT STATUS

September 2016
Vessel Flushing Operations

April 2018
First fuel loading

29 June 2018
Connection to the grid

SCHEDULE

Second half of 2018
COD Unit #2



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EPR ONGOING PROJECTS

EPR HINKLEY POINT C: A NEW BUSINESS MODEL FOR NEW NUCLEAR THAT INSPIRES OTHER COUNTRIES

GENERAL INFORMATION

- First nuclear construction project in the UK in 30 years
- A certification process: GDA requirements for reference plant EPR Flamanville 3 adaptations
- Contract For Difference guaranteeing a fixed price of electricity for 35 years
- Chinese partnership - EDF as co-owner and operator
- Power output : 1,638 MW each



September 2016
Final contracts signed

Mid-2019 :
1st concrete

2026 :
COD Unit #2

CURRENT STATUS

October 2013
UK Government
agrees Contracts For
Difference for HPC

March 2017
First concrete successfully
poured for power station
gallantry

SCHEDULE

2025 :
COD Unit #1



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SHARING MORE THAN A TECHNOLOGY EPR OWNERS OPERATORS GROUP



- EPROOG, a structured mutual support between Owners and Operators of EPRs to support their project and achieve the best performance of EPR units from Construction to Operation
- 4 AIMS
 - + Sharing all safety matters: an overriding priority
 - + Sharing good practices and lessons learned during all phases : engineering, construction, commissioning, pre-operation and operation
 - + Ensuring easy and smooth communication between the EPR Owner-Operators
 - + Develop mutual support to meet current and future Owner-Operator's needs



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SHARING MORE THAN A TECHNOLOGY

EPR OWNERS OPERATORS GROUP

EPROOG provides to its members ambitions and working program



Pre-Operation & Operation

- **Spare Parts sharing:** contractual sharing and/or joint purchasing
- **Operational Experience Sharing:** workshop to exchange on OE, events, technical issues
- **I&C Network:** workshop between I&C peers
- **Chemistry Working Group**
- **Cable Ageing Working Group Strategic Committee**

Project's & Engineering

- **Commissioning's feedback** cross-secondments during critical start-up phases
- **Material Preservation:** corrosion events, preservation practices
- **Licensing:** sharing of elements and best practices



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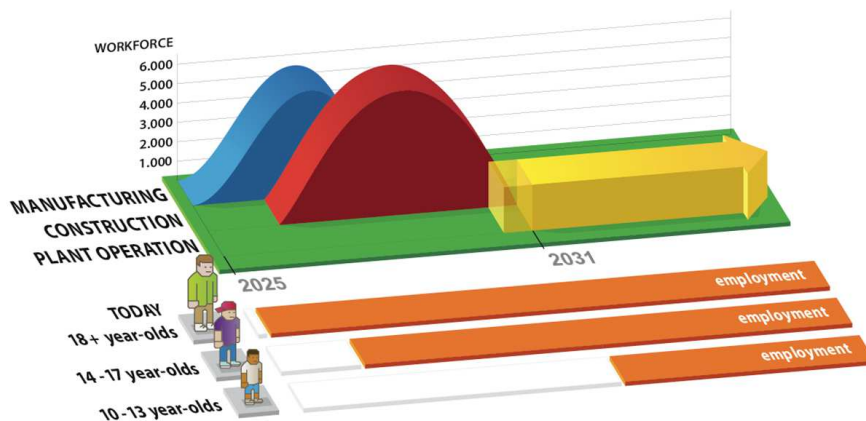


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NEW BUILD OPPORTUNITY UP TO 70% OF LOCALIZATION WITH OPPORTUNITIES OF JOB CREATIONS

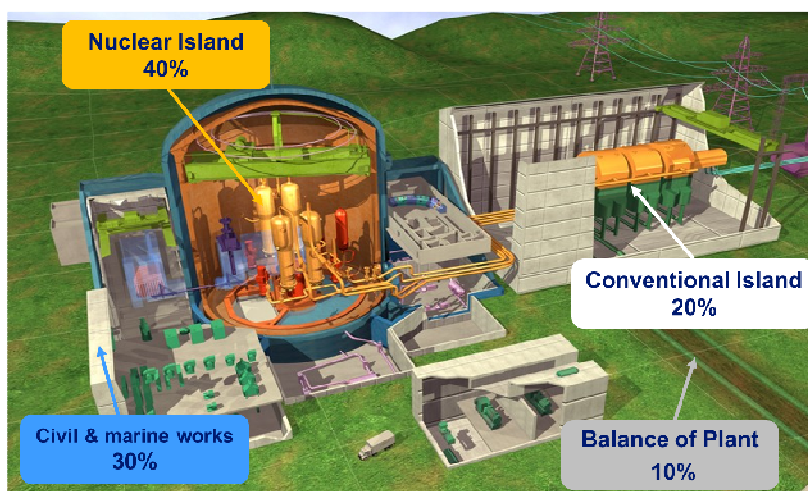
EMPLOYMENT OPPORTUNITIES IN NUCLEAR NEW BUILD FOR AN EPR TWIN UNIT PLANT



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EPR REACTOR: THE FULL SCOPE OF SUPPLY

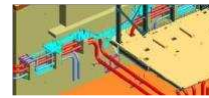


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A WIDE RANGE OF OPPORTUNITIES... ENGINEERING ACTIVITIES IN ALL BUILDINGS

- Nuclear plant project is organized as a standard large engineering project
 - **Civil engineering**
 - Design and calculation of buildings
 - Construction and civil interface drawings
 - **Piping : design and calculation**
 - Pipe routing & Support design
 - Pipe stress calculation
 - **Electrical**
 - Cable tray, cable routing & connection diagrams
 - MV - LV electrical distribution
 - Process instrumentation
 - **HVAC – Ancillary systems**
 - System specification and equipment sizing
 - Layout studies (air duct planning)
 - **System and process design**
 - Specification for I&C



Detailed Design Phase is usually localized as “Work Packages”



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A WIDE RANGE OF OPPORTUNITIES... NUCLEAR ISLAND (NI)

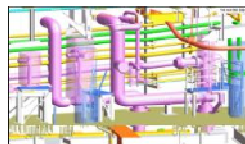
Mechanical Equipment

- 150 Heat exchangers
- 180 pressure vessels & tanks
- 500 pumps/compressors/filters
- 12 000 valves
- 1800 t of Large & Small bore piping with associated supports (1000t)



Electrical Equipment

- Cable trays
- 3000km of cables
- LV/HV switchboards
- Transformers
- 6 Emergency Diesels Generators



HVAC Equipments

- Total need of 880 000 m³/h
- Ductwork
- Air handling units
- Chillers
- Fan, Damper, filters, coils....

Handling Equipments

- Monorails, slewing cranes 2 to 20 T
- 1 Polar crane & 2 Gantry cranes



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WIDE SCOPE OF OPPORTUNITIES... CI -TURBINE HALL

The TURBINE HALL is composed of :

- ▢ The Turbo-Generator set and its auxiliary systems,
- ▢ The feedwater systems and components : condenser, heaters, feedwater tank, pumping systems...

Building description

- Steel structure : 7 300 t
- Concrete : 26 000 m³
- Reinforcement : 3 600 t



Mechanical Equipment

- 130 heat exchangers,
- 100 pumps, from 10 L/h to 3 500 m³/h
- 2 250 t of pipes, from DN 8 to 1 400mm
- 2 500 valves
- 70 tanks, from 0,06 to 750 m³
- 3 handling cranes (from 20 to 300 t),
- 380 hoists/trolleys (from 0,1 to 12,5 t).

Electrical Equipment

- About 180 km of cables
- 6 300 sensors



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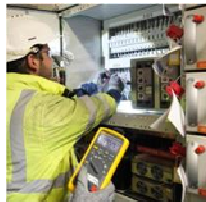
A WIDE SCOPE OF OPPORTUNITIES... CI - ELECTRICAL DISTRIBUTION BUILDING

Dedicated building for all non classified electrical equipment of the NI, CI & BOP, housing:

- ▢ The electricity supply systems as batteries, switchboards, inverters...,
- ▢ The CI's instrumentation-control,
- ▢ The systems specific to the building.

Building description

- ◆ Concrete structure : 4 300 m³
- ◆ Reinforcement : 500 t



Electrical & Mechanical Equipment

- ◆ 18 LV Switchboards (880V, 400V, 220V)
- ◆ 8 HV Switchboards (10kV)
- ◆ 14 Power transformers (880V/400V, 10kV/400V and 10kV/690V)

- Some mechanical equipment:
- ◆ 4 km of pipes (from DN 8 to DN 150)
 - ◆ 150 Valves



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A WIDE SCOPE OF OPPORTUNITIES... BOP - THE PUMPING STATION

Two main functions:

- ▢ Filter the sea water through trash racks, drum screens and band screens,
- ▢ Pump the filtered sea water to feed the cooling circuits of the Nuclear Power Plant

Building description	Mechanical Equipment	Electrical Equipment
<ul style="list-style-type: none"> ▪ Concrete: 63 000 m³ ▪ Reinforcement: 11 900 t ▪ Secondary Steelwork: 67 t 	<ul style="list-style-type: none"> ▪ 2 classified drum screens (Dia = 24 m) ▪ 46 pumps (1 m³/h to 30 m³/s) ▪ About 14 km of pipes (DN 8 to 900) ▪ About 720 Valves ▪ 8 handling cranes (10 t and 80 t) 	<ul style="list-style-type: none"> ▪ About 13km of cables ▪ 990 sensors

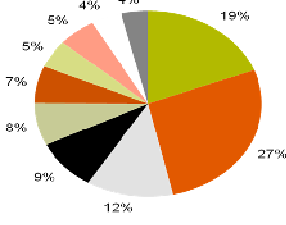




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MAJOR JOB OPPORTUNITIES DURING PLANT OPERATION

Example for 2 EPR units: 700 people for operation and maintenance



- operation
- maintenance
- support
- security
- indus safety
- engineering
- I&C
- Safety, excellence chemistry
- other


Subcontractors for Operation & Maintenance

- 600 to 2,000 contractors for maintenance during 1 plant outage (per reactor)

Sub-contracted competencies

- Electrics/I&C
- Transformer poles replacement
- Piping, welding
- Heat insulation
- Valves, Pump maintenance
- Turbo generator maintenance

Localization during construction creates direct business opportunities for maintenance over 60 years

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MANY INDUCED JOBS WILL BE CREATED

The welding trade is a key to the construction of the nuclear fleet as well as other projects including the Oil & Gas and Chemical Industries.



This trade provides an example of jobs created in addition to the welder himself. These induced expenditures directly translate into additional manufacturing jobs in the country

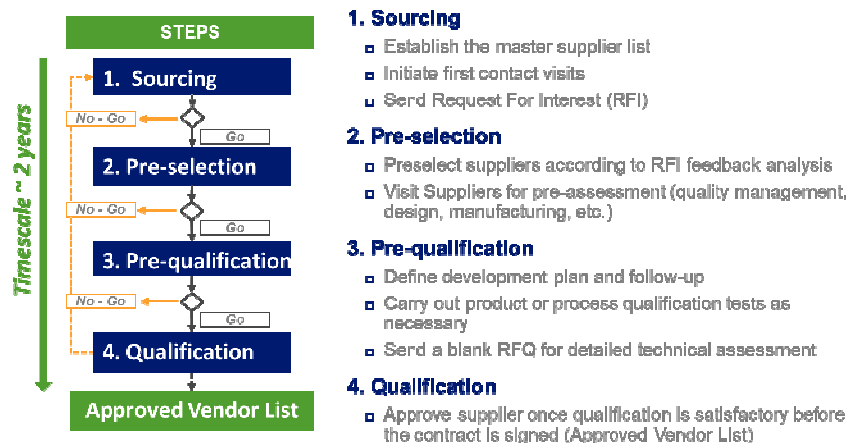
- ◆ Welder training schools
- ◆ Welding Machines
- ◆ Welding electrodes and filler wire
- ◆ Welding electrode holders and guns
- ◆ Electrode storage ovens
- ◆ Welder's helmet
- ◆ Gloves
- ◆ Protective vest
- ◆ Electrical cable
- ◆ Welding and cutting gases
- ◆ Bottles for shipping and storing the welding gases
- ◆ Gas hoses for welding
- ◆ Fuel for running the diesel generator welding machines



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A ROBUST 4-STEP LOCALIZATION METHODOLOGY



French team has developed a robust and comprehensive qualification process



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A GRADED APPROACH FOR THE PURCHASING & SUPPLY CHAIN STRATEGY

- According to the safety grade of the component, the Purchasing & Supply Chain strategy towards the suppliers market is graded :

Quality grading	Component status	QA requirements	HSE requirements to be considered
SAFETY GRADE 1&2 (NUC)	Products and services safety related	ISO-9001 complemented by nuclear specific requirements TS-18443	Environmental program ISO14001 Health & Safety program (OH SAS 18001)
STANDARD GRADE 3 (ISO)	Products and services non safety related but important for construction and/or operation	ISO-9001	
GRADE 4 or NOT CLASSIFIED (NC)	Other products and services	(ISO-9001 recommended)	

Quality requirements understanding is key



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A COLLABORATIVE APPROACH : A CULTURE OF PARTNERSHIP FOR THE BENEFIT OF LOCAL COMPANIES

Complementarity of (i) Czech experience in Nuclear field and Czech conditions with (ii) French knowledge of EPR

- **Within their scope of activity, local companies:**
 - Are experienced in nuclear business & regulations
 - Have a thorough knowledge of country legislation
 - Are well versed in domestic standards & industrial practices
- **Within EPR projects, French companies:**
 - Have experience in our technologies
 - Are familiar with worldwide nuclear requirements
 - Benefit from experience feedback on our previous and undergoing projects



EDF can ease relations to join forces for mutual gain and to optimize localization



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INDUSTRIAL MAPPING TO SUPPORT LOCALIZATION ASSESSMENT PROGRAM ON GOING

■ Identification and screening of 175 Czech companies mainly:

- Engineering, erection services and civil works, 45 suppliers
- Valves, 11 suppliers
- Vessels, Heat Exchangers, filters, 14 suppliers
- Electrical distribution, 12 suppliers
- Pumps, 8 suppliers



■ Partnership meetings In 2017

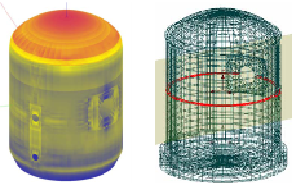


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EPR PROJECT – CZECH REPUBLIC INTEGRATION OF NEW SUPPLIERS IN EPR PROJECTS



CERVENKA Consulting Ltd.

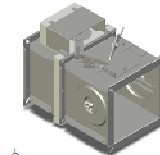
Nonlinear Structural Analysis for Verification of
Containment Design for Finnish EPR™ project

MANDÍK, a.s.

Delivery of Dampers including Extension
Pieces and Protection Grids for Finnish
EPR™ project, covering:

- Seismic Verification by Vibration Test
- Pressure Verification Calculation

*as sub-supplier of Brochier Power Systems
GmbH*



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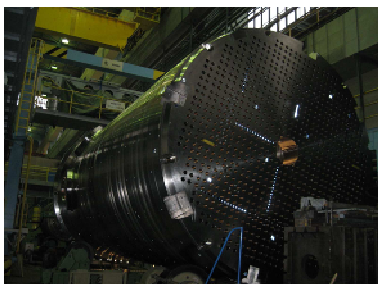
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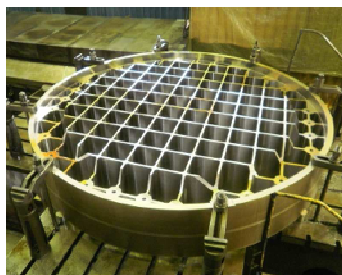
EPR PROJECT – CZECH REPUBLIC INTEGRATION OF NEW SUPPLIERS IN EPR PROJECTS

SKODA JS

Supply and Manufacturing of
Reactor Vessel internals for
OL3 and Taishan 1



Supply and manufacturing
the support ring and the
handling equipment for
internals for OL3



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EPR PROJECT – CZECH REPUBLIC INTEGRATION OF NEW SUPPLIERS IN EPR PROJECTS

SKODA JS

REACTOR VESSEL SUPPORT
RING

PAINTING AND PACKAGING AND
SHIPMENT



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OPPORTUNITIES FOR CZECH COMPANIES IN NEW MARKET WORLDWIDE

- EPR reactor, propose **wide and long term opportunities for CZECH Industry**
- The suppliers of our supply chain **have several opportunities to enter in new markets worldwide**
- Thanks to previous investigations we are confident in the capacities of Czech companies to supply for EPR project



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HOW TO CONTACT US



Nuclear Supply Chain for EPR Project



EPR-CZECH-supplychain@edf.fr



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AGENDA

1. EDF / MHI proposal for EPR and ATMEA1 proposal in Czech Republic
2. EDF group presentation
3. EPR technology presentation
4. EDF localization strategy
5. **Hinkley Point C experience** with surrounding communities during the preparation, construction and operation phases
6. Conclusion



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Building **better energy** together

WELCOME



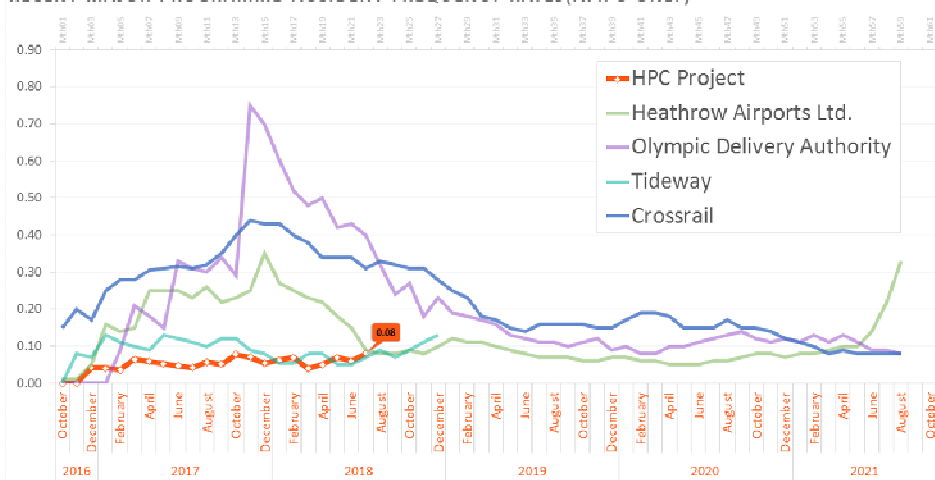
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ZERO HARM SAFETY AMBITION

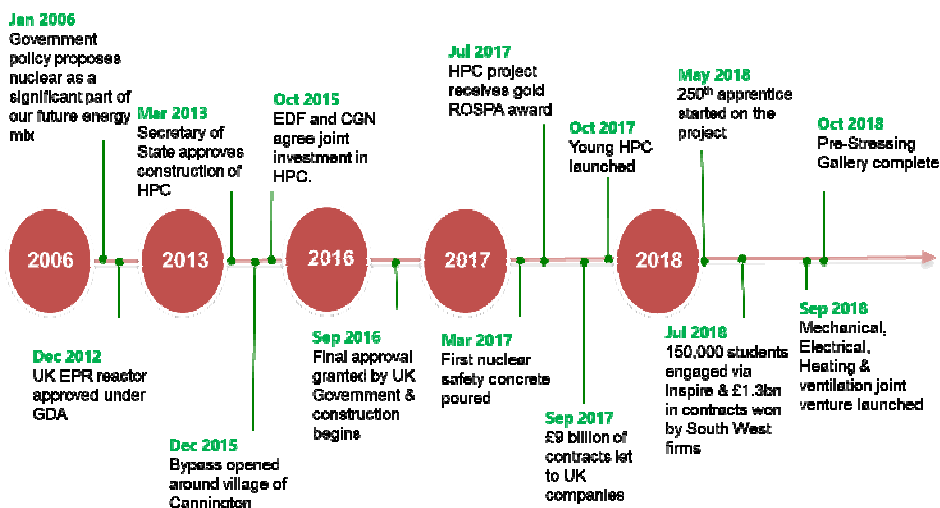
RECENT MAJOR PROGRAMME ACCIDENT FREQUENCY RATES (AFR-3 ONLY)



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The journey so far....



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A project critical for the UK's energy infrastructure

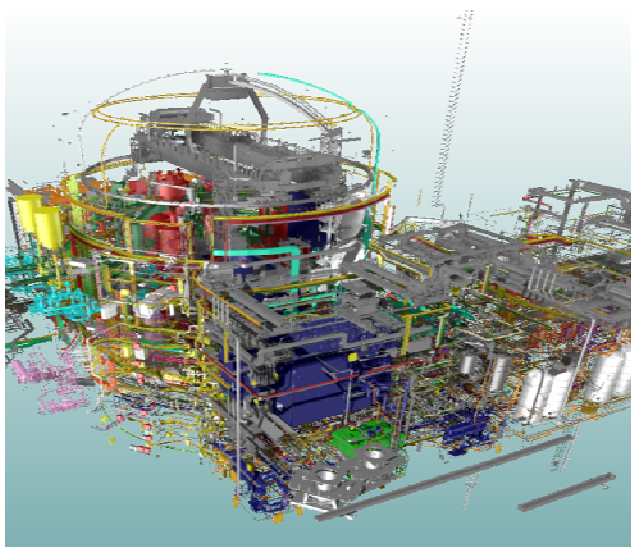
- EPR design capable of generating 7% of the UK's electricity
- Enough to power 6 million homes
- Avoids the emission of 9 million tonnes of CO₂ a year
- £4bn into regional economy over lifetime of the project



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Delivering in partnership



framatome



zavendkh
Babcock
Wilcox

Balfour Beatty Balfour
Beatty

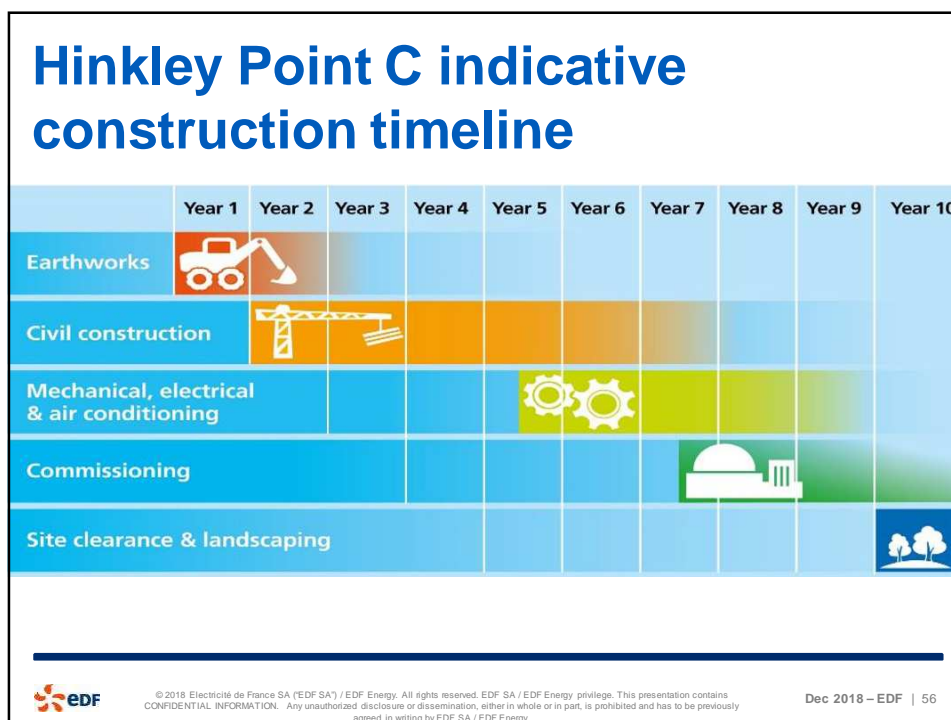
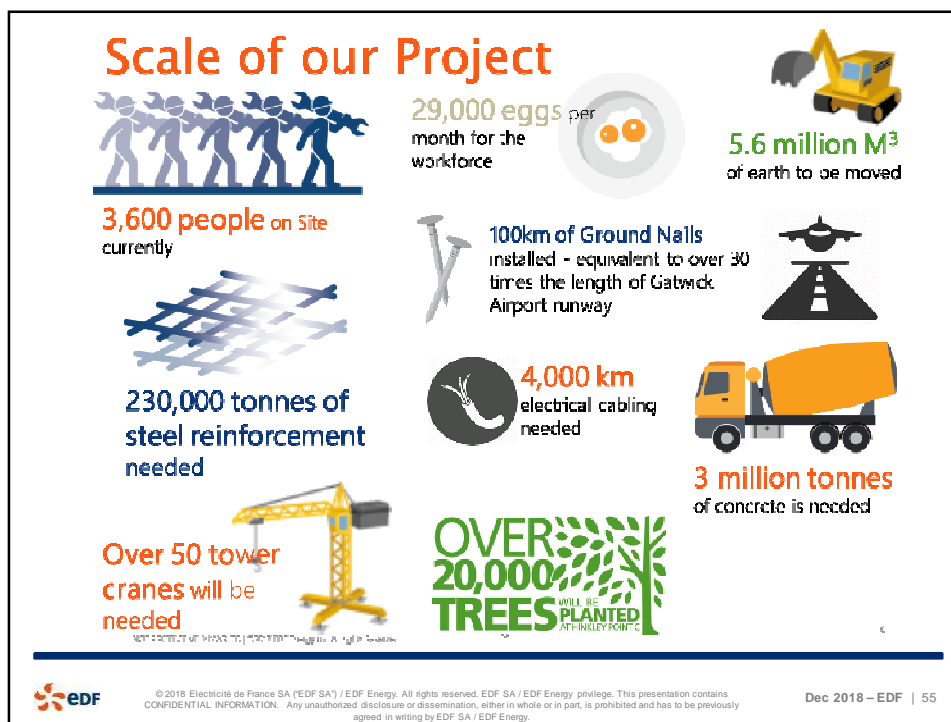
bylor

Balfour Beatty



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SHARING EXPERIENCE AND LEARNING LESSONS

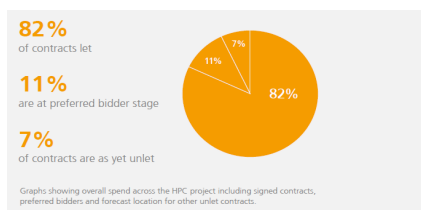
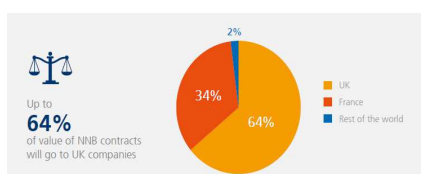


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PART OF THE UK'S INDUSTRIAL STRATEGY

- **64%** of the value of Hinkley Point C contracts to go to UK companies. **£10.6 bn** worth of contracts has been awarded.
- We have already spent **£850 million** with businesses in the region.
- And South-West firms have already won more than **£1.5bn** worth of contracts.



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SOUTH WEST SUPPLY CHAIN - £850 MILLION ALREADY SPENT



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JOBS AND SKILLS AT HINKLEY POINT C



- Creating **25,000 employment opportunities** throughout the construction phase
- Arranging and delivering programmes to help local people into work – aim is for **34% of workforce to be home-based**
- **273** apprentices have already worked on the project, **1000** apprenticeships anticipated
- **900 operational jobs** during 60 year life of power station



- STEM programme has engaged **150,000** young people to date
- **Invested over £6million with** local training centres to provide the skills and courses needed
- Working closely with National College for Nuclear which is based locally with Bridgwater and Taunton College



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MEGAN HANDLEY'S JOURNEY – PROJECT CONTROLS APPRENTICE



- Discovered the opportunity at a Young HPC event in 2017
- Started 3 year apprenticeship in 2018
- Is now earning whilst learning
- Studying towards Industry recognized qualification

Megan said:

"An HPC apprenticeship offers young people a way of getting into an industry that I believe would otherwise be difficult. It also provides an amazing way to be able to study and learn, whilst networking with knowledgeable and like-minded people, something you wouldn't do just by going to college."



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INVESTING IN OUR COMMUNITY

Somerset Energy Innovation Centre



Construction Skills and Innovation Centre



Community Fund



Inspire Education Programme



- ✓ Energy Skills Centre
- ✓ Construction Skills and Innovation Centre
- ✓ The Hinkley Ready Project – WSC
- ✓ Somerset Energy and Innovation Centre
- ✓ £20 Million Community Fund
- ✓ The Inspire Education Programme
- ✓ Sports Pitches
- ✓ Supporting local business and supply chain
- ✓ National College for Nuclear

Hinkley Ready



Chilton Trinity swimming pool



Energy Skills Centre



Sports Pitches



Business



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CONCLUSION

- Our proposal is based on **two competitive, safe and reliable reactor models**
 - EPR to offer a large range power model
 - ATMEA1 where middle range power is preferred
- Experience collected on on-going projects will benefit to next projects and make us more confident on the capabilities of our teams **to master implementation on time and on budget**
- **Localization demarche in Czech Republic is on-going**
- **EDF will maximize local benefits and apply its experience of relations with surrounding communities**



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DĚKUJI



MERCI



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