TRACTEBEL engie Tractebel Nuclear 60 years of experience at your side

NIA Fusion Business Group Meeting

October 2022



PUBLIC

INTERNAL



CONFIDENTIAL

Offering you an A-Z value proposition



combining strategy, design, engineering and project management

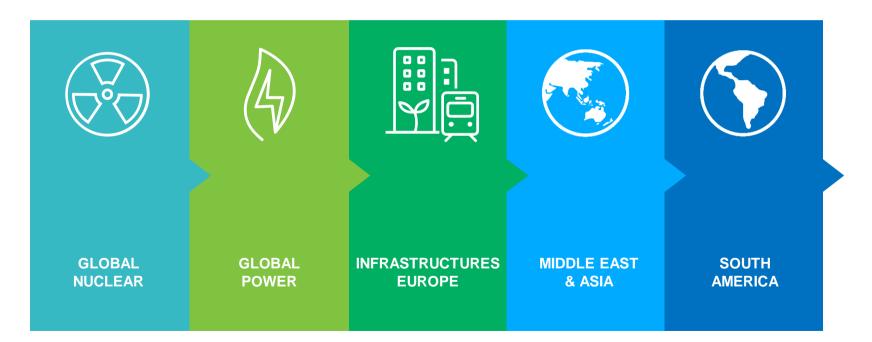
\rightarrow	STRATEGY	\rightarrow	PRE-INVESTMENT	\rightarrow	
_	Digital Tools Master Plans		Basic Design		
	Roadmaps Technical & Regulatory		Due Diligence Environmental Impact Assessm Master Plans & Policy Studies	nent & Licensing	
	Consultancy		Power System Development & Pre-Feasibility & Feasibility Stu		
Training for Plannin	g, Project Management & Operation, Sustaina	ble Develo	pment, Risk Management & Safety C	onsulting	

÷	DECOMMISSIONING		÷	IMPLEMENTATION
	Dismantling Site Redevelopment Studies Waste Management	Modification, Renovation, Lifetime extension Operation Support Solutions Simulators & Training Strategic Operation & Maintenance		Commissioning Detailed Design Engineering Procurement Construction Management Front-End Engineering Design
		Engineering		Owner's or Lender's Engineer Project & Contract Management Quality Assurance



4,800 imaginative experts

Through a network organisation with 5 Business Areas



2021 Key figures





4,800 employees

+70 presence in 70 countries

>**150** projects in over 150 countries

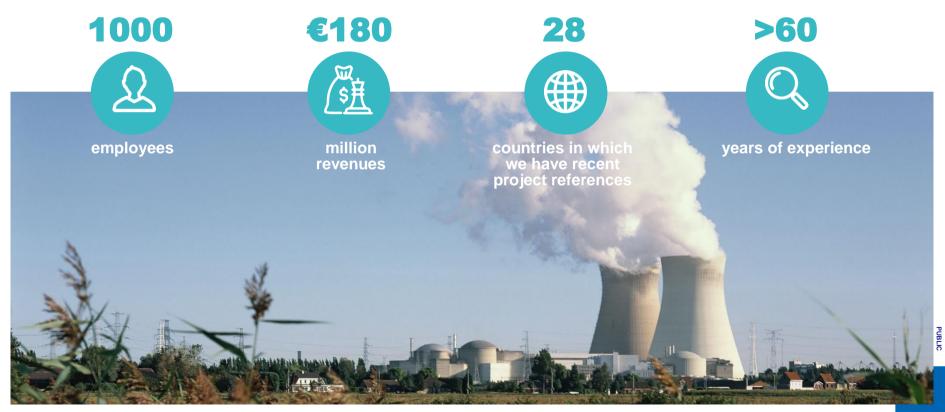
0,27 High safety standard: frequency rate 0,27



OfficesProjects



Global Nuclear Area: key figures



Global Nuclear Area: services across the full lifecycle of nuclear facilities



Gen IV, Fusion, SMR, R&D and Innovation Advanced Modelling & Calculation Compliance to emerging Regulation Medical Applications Industrial & Military Applications Site & Cyber Security



Gen III, Research Reactors Country Site Survey Geotechnical & Seismic Analysis

Licensing & Permitting Equipment Qualification Civil Engineering Airplane Crash Studies Construction & Commissioning Oversight PLANT OPERATION SUPPORT

Plant Modifications Plant Life Extension Ageing Management Safety Assessment Equipment Reliability Core & Fuel Studies In-Service Inspection Vibration Analysis Civil Structure Monitoring & Upgrading RADWASTE MANAGEMENT

Radwaste Characterization Treatment & Conditioning Facilities Radwaste & Spent Fuel Storage Long Term Repository Cask Licensing Support Radiation Protection ALARA Studies

DECOMMISSIONING & DISMANTLING

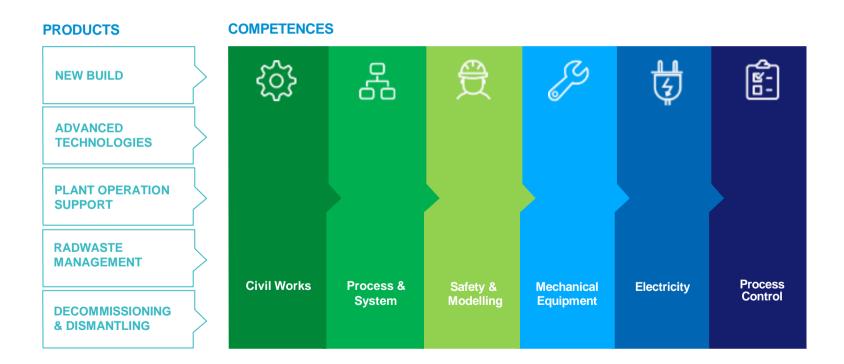
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Physical & Radiological Inventories Decommissioning Cost Assessment

Definition and Follow-up of Post-Operational Phase Licensing Documentation Cost & Project Schedule Dismantling Scenarios Project Management



Global Nuclear Area: providing integrated nuclear and non-nuclear solutions





Global Nuclear Area: relying on a full range of engineering expertise

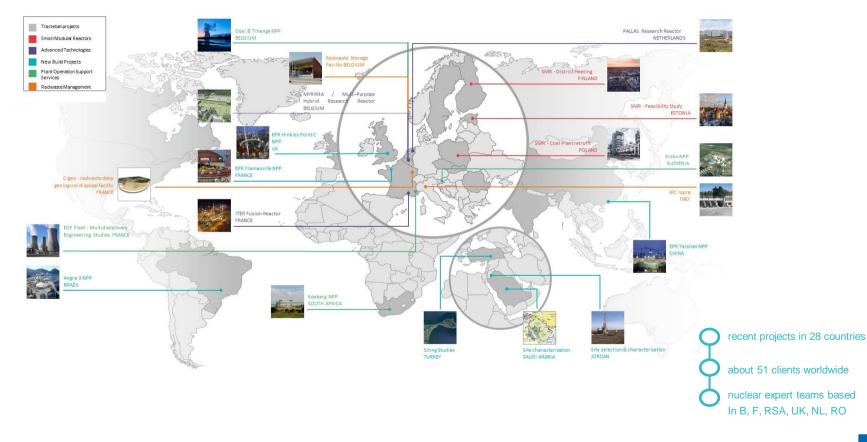
Impact Assessment, QHSE, BIM, Digital Tools solutions

Process & Systems	Mechanical Equipment	Safety & Modeling	Radwaste, Decommissioning & Radiation Protection	Electricity & Process Control	Civil Works & Geoscience
Nuclear Island and Heat Sink Systems & Equipment Fluid & Gas Systems Fire modeling & Simulation Fire Protection Systems Heating Ventilation & Air Conditioning Nuclear Filtration	Ageing Management Welding Quality Control & Expertise In-Service Inspection Programming Quality Surveillance Supplier Qualification Equipment Design Specifications	Core & Fuel Studies Thermal-hydraulics Piping & Mechanical Integrity Seismic & Structural Integrity Licensing & Safety Analysis PSA Studies Severe Accidents	Radiological characterization Waste Inventory Waste treatment & conditioning Waste storage & disposal Decontamination & Decommissioning ALARA / Radiation Protection Studies	Design of I&C and Electrical Systems & Equipment Hardware & Software Qualification Supplier Qualification Test Programming Technical audit of existing installations NPP Simulator	Seismology, geo- technology and hydrogeology Civil engineering design Seismic Studies Vibration analyses, PSA & SMA Structural design for dropped loads, explosions and Airplane Crash
Supporting			egration (including layout ir Management, Data Manag	÷ .	

PUBLIC

competences

Global Nuclear Area: Worldwide presence



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Contacts FR/UK – Fusion projects



Contacts – FR – UK – Fusion Projects





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Overview of some key project references – Fusion, Advanced Technologies and other

ar Presentation

International Thermonuclear Experimental Reactor (ITER) – Owners' Engineer – BSI / BCW

ITER is a groundbreaking energy project bringing together 35 countries, which paves the way for commercial fusion power plants. Tractebel and partners are supervising the design, testing and commissioning of project site buildings.

CLIENT	ITER
LOCATION	Cadarache, France
PERIOD	2014-ongoing

SERVICES PROVIDED Follow-up of design, construction, testing and commissioning of ITER buildings and systems

 Disciplines include civil works, handling equipment, HVAC, electrical, I&C, fire, earthing and lightning protection



Tokamak Assembly Preparation Building

Adjacent to the Tokamak Complex, the Assembly Building (TAPB) will be the location for pre-assembly activities on the massive components of the ITER device before they are transported to the Tokamak Pit for installation

LOCATION

PERIOD 2

2018 - 2020

France

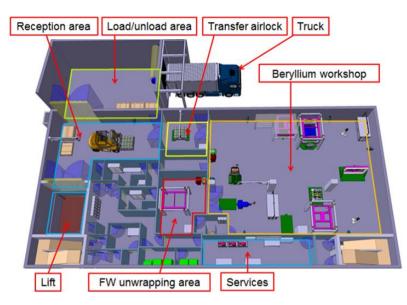
SERVICES PROVIDED TAPB Facility and Building design: civil works, fluids & networks, HVAC, fire protection, electricity, mechanical, system engineering.

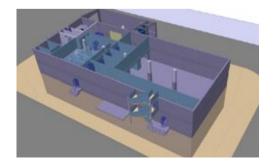
Construction permit and safety analyses

Support to tender and contract

Review of the constructor documents

Supervision of construction





Hot Cell Complex (HCC) Conceptual Design

ITER Hot Cell Complex (HCC) supports the operation, maintenance and decommissioning of the ITER Tokamak.

CLIENT	ITER Organization
LOCATION	France
PERIOD	2016 - 2018
SERVICES PROVIDED	Optimization of Hot Cell Cor

Optimization of Hot Cell Complex (HCC) preliminary design: safety analyses, compliance between the safety requirements and building design.

Disciplines include civil works, handling equipment, HVAC, electrical, I&C, earthing and lightning protection.



OMEGA consortium – TB04

CLIENT	OMEGA / Fusion 4 Energy
LOCATION	France / Spain
PERIOD	2020 - ongoing
SERVICES PROVIDED	Electrical and mechanical equipment qualification



ITER EC Launchers & ICRH Antenna

Support services in the area of nuclear safety and engineering for the ITER EC Launchers & ICRH Antenna

CLIENT	Fusion 4 Energy
LOCATION	FRANCE / SPAIN
PERIOD	2017 - ongoing

SERVICES PROVIDED

Mechanical support Assessment of regulatory requirements and directives including applicability and impacts (ESP, ESPN, and/or others identified by F4E) by Nuclear Qualification - EC Upper Launcher Cooling circuit design - compliance of the concept and preliminary design of the cooling system



Civil Engineering support

CLIENT	Fusion 4 Energy
LOCATION	FRANCE / SPAIN
PERIOD	2018 - ongoing
SERVICES PROVIDED	Provision of civil engi

Provision of civil engineering services definition, assessment and implementation of civil engineering services.



Innovative MYRRHA Research Reactor

MYRRHA (Multi-purpose Hybrid Research Reactor for High-tech Applications) is the world's first prototype of a high-power research reactor driven by a particle accelerator, namely the MINERVA Accelerator. Its ambition is to offer a technological solution to reduce nuclear waste and produce medical radioisotopes for innovative cancer treatments.

> lated to the design of the Buildings and s of the 100 MeV

CLIENT	SCK·CEN
LOCATION	Belgium
PERIOD	2019 – 2026
SERVICES PROVIDED	EPCM mission related to the d and construction of the Buildir Auxiliary Systems of the 100 M MINERVA proton accelerator.



PALLAS Multi-Purpose Reactor

Pallas is a nuclear multi-purpose research reactor to produce medical radioisotopes and to supply a wide range of irradiation services.

LIENT	Pallas
DCATION	The Netherlands
ERIOD	2015 - 2024
ERVICES	Owner's Engineer
ROVIDED	Assistance to the Tendering process for
	Nuclear Island Designer
	Development of Safety Approach
	Development of Functional and Safety
	Breakdown Structure
	Review of Site Characterization Study
	Organization of Vendor's Conference
	Completion Bid Invitation Specification (BIS)
	Bids Assessment
	Contract Negotiation
	Preparation of Design
	Licensing
	Construction Mononement

Construction Management

IBA – Proteus®One

Engineering Services for the Standard Proteus®One Proton Therapy System

CLIENT	
LOCATION	Belgium
PERIOD	2019 – 2021
SERVICES PROVIDED	Review and complementing of technical documentation
	Development of a standard design and its integration into a standardized 3D Building Information Model (BIM)

Scope split definition and drafting of technical specifications

ormation



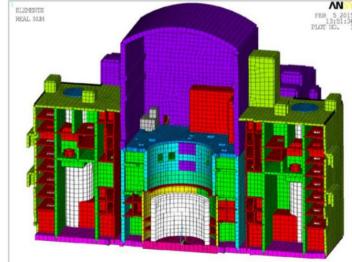
ASTRID

The reactor ASTRID is a French prototype project of a sodium-fast cooled reactor (600MW gross), carried by the CEA. Its purpose is to develop a new "4th generation" of nuclear reactors.

CLIENT	BOUYGUES TP
LOCATION	France
PERIOD	2012
SERVICES PROVIDED	Technical assistance for the preliminary design in the study phase of the ASTRID project to define technical

- solutions and to predimension
 The HR building which ensures the reactor's containment and accommodate the internal
- containment and accommodate the internal structures, support of the primary circuit
- The HKL building (fuel building) and HVX (Special operations building)

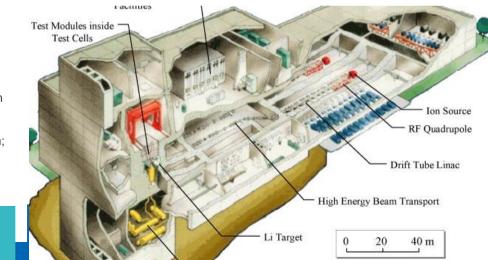






IFMIF, the International Fusion Materials Irradiation Facility, is an accelerator-based neutron source that will use Li(d,xn) reactions to generate a flux of neutrons with a broad peak at 14 MeV equivalent to the conditions of the Deuterium-Tritium reactions in a fusion power plant. IFMIF is conceived for fusion materials testing





CLIENT	SCK CEN (for the benefit of F4E)
LOCATION	Belgium/Japan
PERIOD	2012 - 2013
SERVICES PROVIDED	Engineering Support

Task 1: Cost estimate (including: estimation of Conventional facility & Common parts; compilation & critical analysis of other facilities' costs estimated by the IFMIF team; construction planning)

Task 2: Design of auxiliary systems for Accelerator and Test facilities

Task 3: Safety specific studies

Task 4: Reliability, Availability, Maintainability (RAM) analyses



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EPR Hinkley Point C

- CLIENT EDF Edvance
- LOCATION United Kingdom
- PERIOD 2011 ongoing: UK1220 - Basic design and optimization studies

2015 – ongoing: UK1221 - Detailed design (calculations and drawings)

2019- ongoing: UK1229 - Site Design Liaison Team

SERVICES PROVIDED Design studies and structures geometry optimization Containment, Inner structures, APC shield building, HL1/4 Implementation studies Pool liner studies 3D reinforcement drawings with TEKLA software

RACTEBEL

Moorside

Tractebel acts as Owner's Engineer to support NUGEN for the development and the construction of a new Nuclear Power Plant at Moorside, UK

CLIENT	NuGeneration Ltd
LOCATION	United Kingdom
PERIOD	2014 - 2017
SERVICES	Owner's Engineer
PROVIDED	Site Characterization (on/off-shore
	investigations),
	 Freshwater Feasibility studies,
	A multiple Duilding concept design

- Auxiliary Building concept design
- Development of BIS & Owners Requirements,
- Layout design development,
- BOP optioneering,
- Constructability Review,
- Grid Infrastructure and Power Supply,
- Radwaste & Decommissioning,
- Technical Integration,
- Operational Readiness support,
- EPC & Engineering Oversight,
- GDA Issue & Finding resolution follow and technical support.



EPR Taishan

Civil engineering studies for the construction of 2 European Pressurized Reactor (EPR) units at the Taishan site in China. Tractebel has provided substantial technical expertise and several innovative solutions in civil engineering structures, liners and structural steel design. Tractebel implemented a high number of design modifications and made several design changes at the client's request.

CLIENT	AREVA NP
LOCATION	China
PERIOD	2008 - 2015
SERVICES	• Civil engineering s

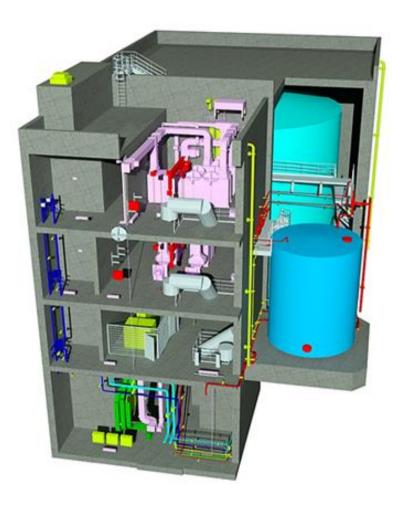
PROVIDED

- Civil engineering studies for the buildings
- Formwork execution drawings and steel
 framework of the execution works
- Execution of the construction drawings for the pool liners and steel structure
- Support to the Chinese client (CNPDC) in realizing part of the steel framework on its Shenzhen premises
- On-site technical support during construction

EPR Flamanville

A third nuclear reactor is under construction at the Flamanville nuclear power plant site located in Northwest France. This new European Pressurised Reactor (EPR), which will add 1,650 MW to the existing 2,600 MW of this plant's power capacity, is expected to be commissioned in 2019.

CLIENT	EDF CNEN
LOCATION	France
PERIOD	2018 - 2020
SERVICES PROVIDED	Studies Global management, coordination and planning
	VISA of execution plans
	Civil engineering design and execution studies, networks, waterproofing, thermal insulation, caulking
	Engineering support on mechanical, HVAC, electricity expertises
	On-site technical assistance during construction phase
	Development of a 3D model



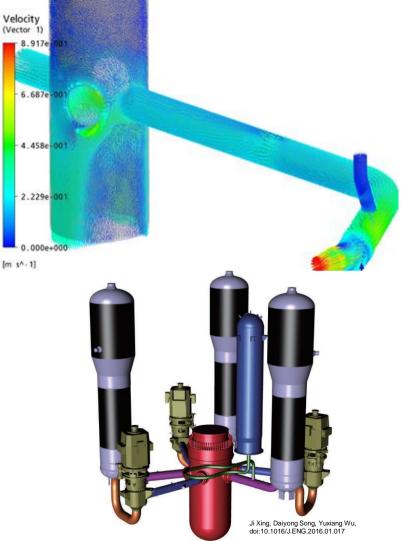
Office of Nuclear Regulation

Tractebel is a Technical Support Framework supplier for Fuel & Core and Fault studies (Lot 1) to the ONR, UK

CLIENT	ONR
LOCATION	United Kingdom
PERIOD	2018 - 2022

SERVICES PROVIDED Technical support:

- State-of-the-art coupling between Fuel and Core studies and Thermal-Hydraulic modelling
- · Vendor-Independent fuel and core modelling
- Training courses on modelling code
- Severe Accident analysis and integration with fault studies
- Project facilitated with the correct establishment of security and export control procedures.
- Support given to the Generic Design Assessment of the HPR1000 within the Nuclear New Build arena



Angra 3's completion

Angra 3's construction started in 1984, but was suspended in 2015, when over 60% of the project had already been completed. Angra Eurobras NES consortium (Tractebel & Empresarios Agrupados) will structure the project's completion.

CLIENT	Brazil's National Bank for Economic and Social Development (BNDES)
LOCATION	Rio de Janeiro, Brazil
PERIOD	2021-2026

SERVICES PROVIDED

Disclosu

- definition of the required investments
 detailed planning & schedule for the construction
- and specifications of the contract model for one or more engineering, procurement and construction contractors.

Koeberg Steam Generator

Engineering Support in the frame of the replacement of the steam generators on both Koeberg NPP units (two 900 MW Pressurized Water Reactor) in accordance with international relevant operational and safety practice

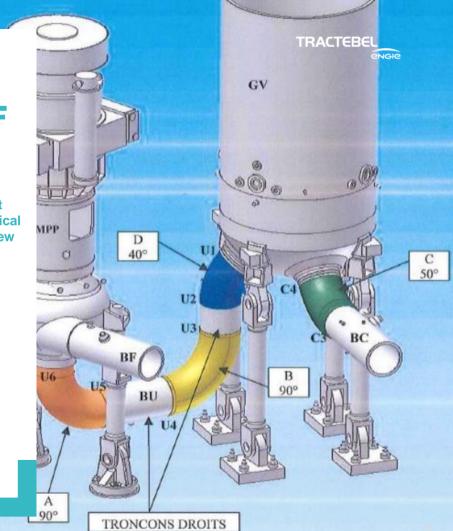
CLIENT	ESKOM
LOCATION	South Africa, Koeberg
PERIOD	2010 - 2020
SERVICES PROVIDED	Owner's Engineering Support Services
	 Review and verification of the multi-disciplinary engineering studies, Follow-up of the SG manufacturing, Quality Assurance and Quality Control activities, Licensing support, Engineering support and site management during the
	installation of the Steam Generators,
	 Review of the commissioning procedure and supervision during commissioning and start-up activitie



Primary Elbows Replacement for the EDF 900 MW Fleet

As part of the strategy to extend the life of the PWR fleet, EDF must replace a set of sensitive primary pipe components whose mechanical justification is not established beyond the 4th Periodic Safety Review

CLIENT	EDF
LOCATION	France
PERIOD	2018 - 2026
SERVICES PROVIDED	Site survey and design studies Lay-out & shielding studies; calculation of primary loops;
	Planification of activities during outages;
	Tool development;
	Qualification of cutting, decontamination, welding & grinding methods;
	Realisation of replacement operations



Krsko - Safety Upgrade Program Bunkered Building 2

NEK performs Lifetime extension operations of Krsko Nuclear Power Plant and is currently implementing an Upgrading Safety Program (post Fukushima) splitted into three main phases. The 3rd phase plans the construction of the Bunkered Building 2 (BB2) for ultimate emergency housing water injection auxiliary system in the water-cooling system.

LOCATION Slovenia

PERIOD 2

2017 - 2021

SERVICES PROVIDED Conceptual design review Basic design of BB2 and wells, buried piping systems, pillboxes...

> Advanced seismic analyses: soil-structure interaction, seismic simulations, spectrum calculations... (SHAKE, SASSI softwares). Execution studies review, modification and configuration management

On-site construction following-up





Site Selection & Characterization

The Hashemite Kingdom of Jordan decided to develop the first NPP in Jordan. The Jordan Atomic Energy Commission (JAEC) contracted a Consortium led by Tractebel for the "Site Selection & Characterization Work"

CLIENT
LOCATION
PERIOD
SERVICES PRO

Jordan Atomic Energy Commission (JAEC) Jordan

2009 - 2013

Site Survey

- Stage 1: Site characterization and selection for the Aqaba nuclear power plant,
- Stage 2: Site survey and selection for the central region nuclear power plant,
- Stage 3: Countrywide Survey (CWS) of the Hashemite Kingdom of Jordan,
- Stage 4: Identification of site area within the CWS preferred candidate site

Jules Horowitz Reactor

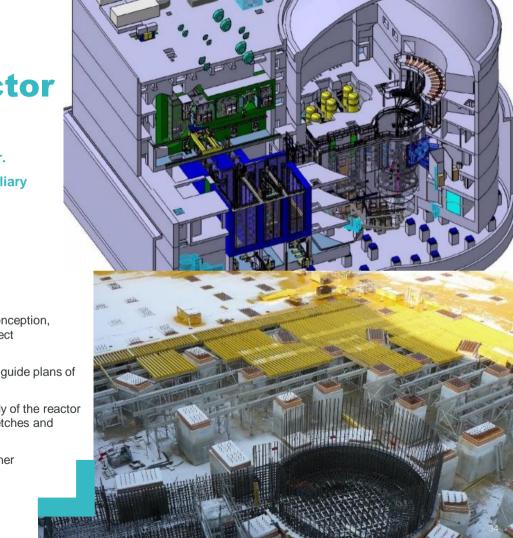
Experimental research reactor to support medical sector.

Nuclear island (Reactor Building and BAN (Nuclear Auxiliary Building) putting on an anti-seismic support.

CLIENT	EDF CNEN
LOCATION	France
PERIOD	2002 - 2016
SERVICES PROVIDED	Civil works studies, anti-earthquake conception, analysis of the structural integrity, project management
	Definition studies, technical notes and guide plan the nuclear island
	Development and implementation study of the rea

Development and implementation study of the reactor building, reinforcement preliminary sketches and guide plans

On-site technical assistance to the owner





Small Modular Reactors Feasibility for Estonia

Feasibility study on the suitability of small modular nuclear reactors for Estonia's electricity supply and climate goals beyond 2030

	FERMI ENERGIA
	Estonia
PERIOD	2020 – on-going
SERVICES PROVIDED	Technico-economic assessment of bes suited SMR technologies considering:

- Market fit
- Time to market
- Cost competitiveness
- Equity and finance
- Safety and security
- Sustainability and long-term waste solutions
- · Delivery certainty and supply chain readiness

Site screening and site selection study: suitability of geographical areas for the first Estonian SMR, identification of first site

mic assessment of best

Fortum, Tractebel to assist in Estonian SMR deployment 28 January 2020

Estonia's Fermi Energia has signed Memoranda of Understanding (MoUs) with Finnish power company Fortum and Belgian engineering firm Tractebel to cooperate on studying the deployment of small modular reactors (SMRs) in the Baltic country.



Fermi Energia alustab koostööd Fortumi ja **Tractebel Engiega**

Home » Uudised » Fermi Energia alustab koostööd Fortumi ia Tractebel Englega



Uudised / 28. jaan. 2020

Fermi Energia allkirjastas täna koostoolepingud Soome energiaettevõttega

A STATISTICS IN COMPANY

Small Modular Reactor Pre-feasibility for Helsinki District Heating

Inception report of the suitability of SMRs to replace coal plants supplying the district heating and cooling network by 2035. Great complementarity BL NUC and BL URBAN – integration of DHC and nuclear BOP competence

CLIENT	HELEN
LOCATION	Finland
PERIOD	2020 - 2021

SERVICES Inception report (phase 1) to address suitability of SMRs considering:

- Technical specifications of the DHC network
- Best suited technology
- Typical economic data

Cigéo

The Cigeo project aims at the deep disposal of the radioactive waste, primarily from NPPs and from the reprocessing of the spent fuel. Cigeo will be built along the border of the Meuse and Haute-Marne departments in eastern France.

CLIENT	ANDRA
LOCATION	France
PERIOD	2013 - 2020
SERVICES	Architect Engineering
PROVIDED	Nuclear surface facilitie

- Devising the layout of new buildings over a surface area of 250 x 300 m
- Semi-buried nuclear buildings laid out in such a way to resist malicious acts
- Lifespan of 80 or even 150 years

Underground infrastructure

- Infrastructure
- System Engineering and Compliance with / Traceability of Requirements
- Nuclear Hub
- Project Inspection

