framatome

RIMA project proposal
Description of the industrial case

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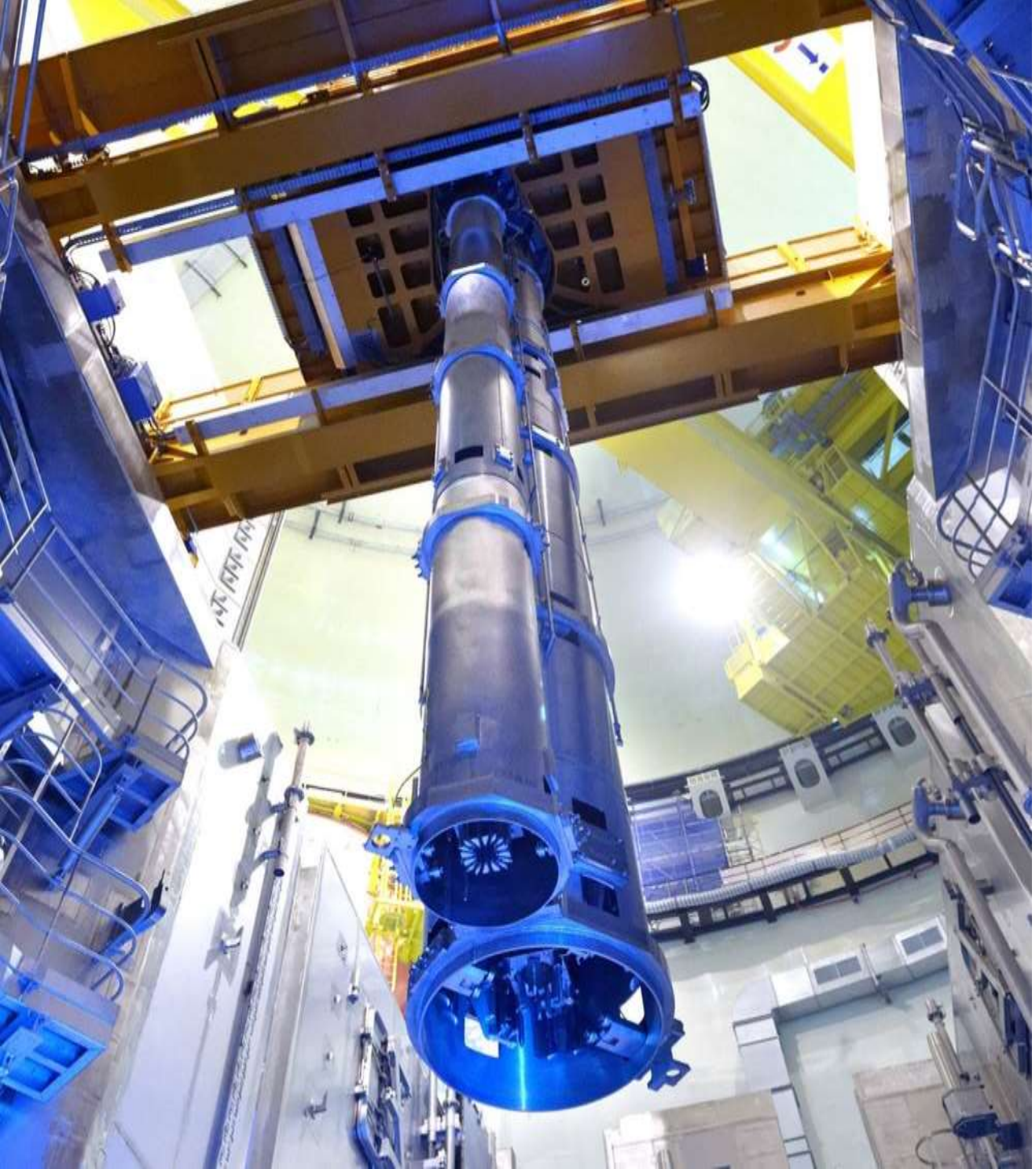


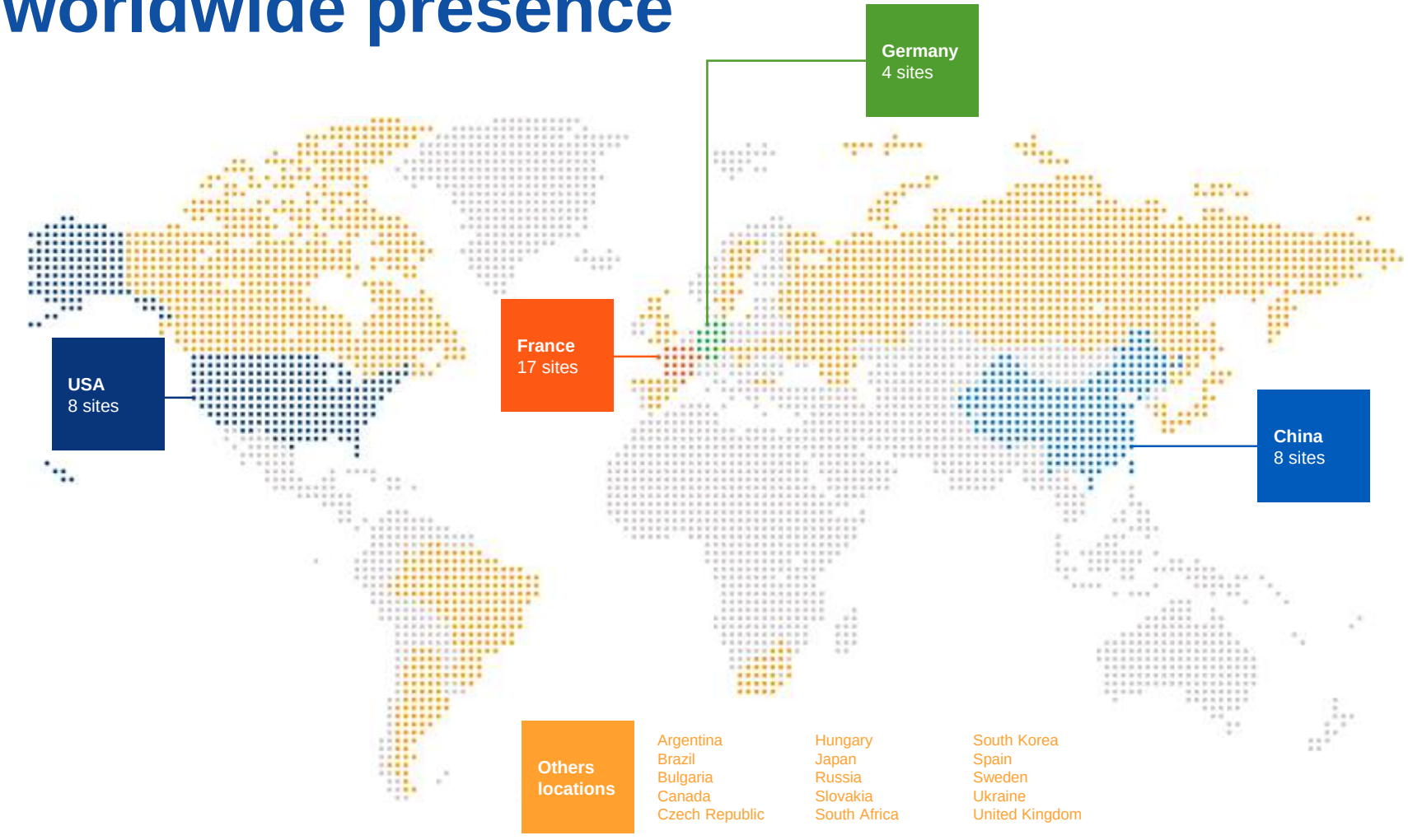
Framatome at a glance

For 60 years, Framatome's teams have been involved in developing safe and competitive nuclear power worldwide by:

- designing nuclear power plants,
- supplying nuclear steam supply systems,
- designing and manufacturing components and fuel assemblies,
- integrating automation systems,
- and servicing all types of nuclear reactors.

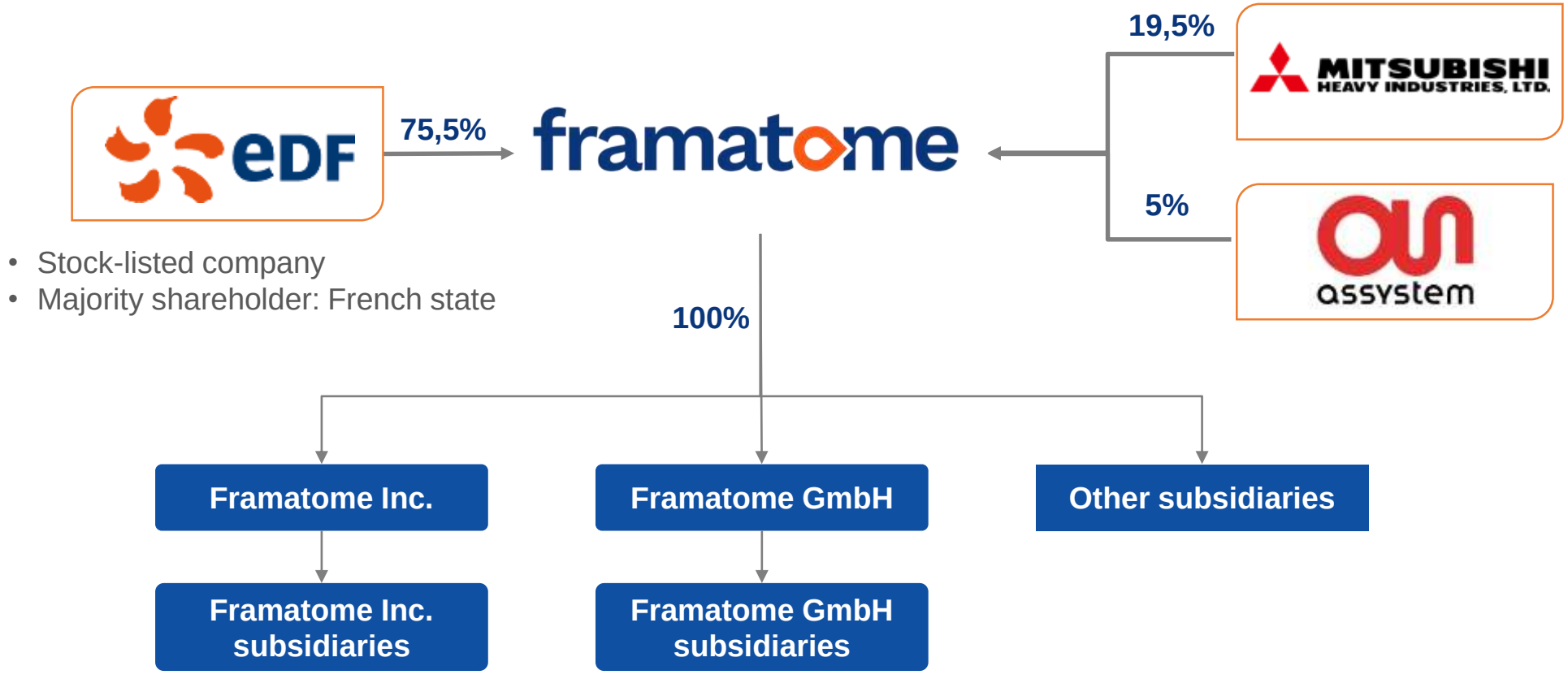
- **Original Equipment Manufacturer of 92 nuclear power plants**
- **14,000 employees serving more than 250 reactors worldwide and**
- **generating a turnover of € 3.3 billion in 2018**

Our worldwide presence



14 000 employees working on more than 250 reactors worldwide at 53 locations in 20 countries

Framatome shareholder structure



- Stock-listed company
- Majority shareholder: French state

Our activities in a nutshell

Engineering & Design Authority: **Development, design and licensing of Nuclear Steam Supply System (NSSS) and associated services**

Component Manufacturing: **design and manufacturing of heavy and mobile components for nuclear islands**

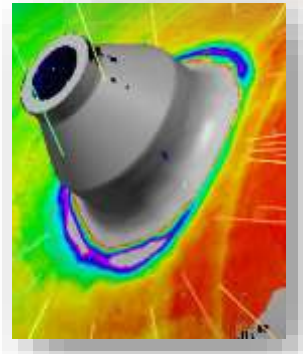
Instrumentation & Control (I&C): Design and fabrication of safety I&C and automation systems for nuclear power plants

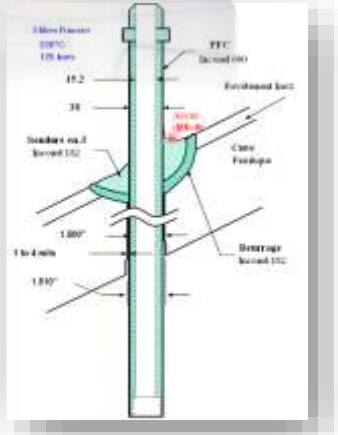
Fuel: **development, design, licensing and fabrication of fuel assemblies and core components for PWR, BWR reactors, and research reactors. Development of zirconium products**

Installed Base: **Maintenance, engineering services for existing nuclear fleets and reactors under construction**

Large Projects: **Management and contribution to nuclear reactor new ´build projects**

Objective as end-user





RIMA Challenge 3: Inspect/Repair of NPP equipment

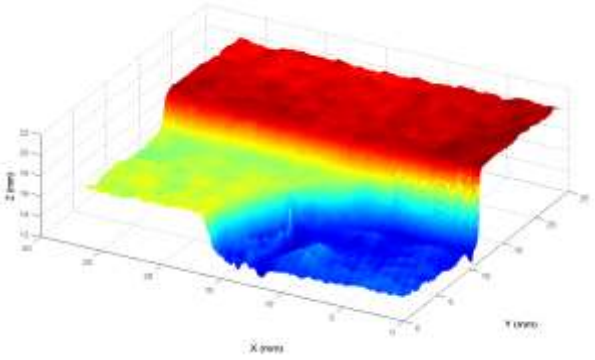
- Welding
  - Adaptive feedback robotic gas tungsten arc welding (TIG)
  - Bead placement with proper orientation in weld groove and subsequent adaptation to as-welded shape
- Non Destructive Testing
  - Weld inspection in power plants
  - Ultrasonic inspection to cover the full volume of the weld
  - Ultrasonic beam need to be oriented correctly according to the surface geometry and the expected defects

The component shape is **complex**, the **exact geometry is not known** and the **positioning accuracy** of the welding tool or the ultrasonic probe is important

Place and move a « tool » automatically and **relatively to the real geometry** of the component with a **multi-axis robot**

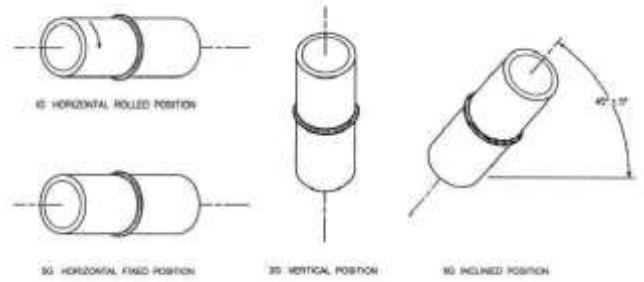
Actual status

- On site laser scan of the component
- Point cloud management to generate a CAD file of the component
- Robot programming taking in account component geometry, welding or ultrasonic inspection requirements
- On-site robot installation and adjustment
- Alignment correction (hardware and software) between the robot and the component to get the best trajectory
- Welding or ultrasonic inspection operations



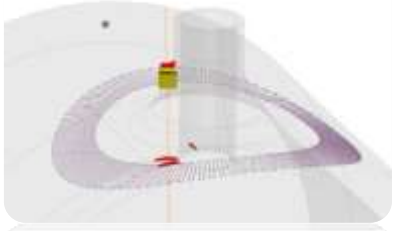
Generate excessive operations duration and operator dosimetry

Description of operations



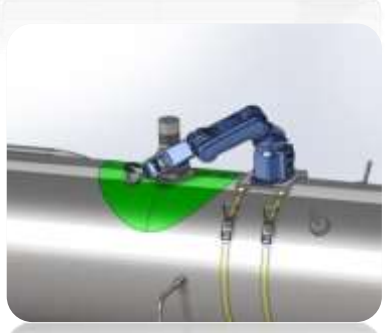
Welding

- TIG welding head (tungsten, wire feed, shielding gas)
  - Automatic voltage control to manage stand-off distance
- Adapt to standard, commercially available robots that are easy to transport to the workpiece
- Scan of environment to identify interferences
- Scan of weld / repair area and define bead placement
- Weld a single pass and scan as-welded configuration



Non Destructive Testing

- Use of a flexible ultrasonic array probe
- Use of a commercial robot
- Trajectory in daisy “shape”
- Ultrasonic probe distance and angle to the component could be measured by processing the ultrasonic signal



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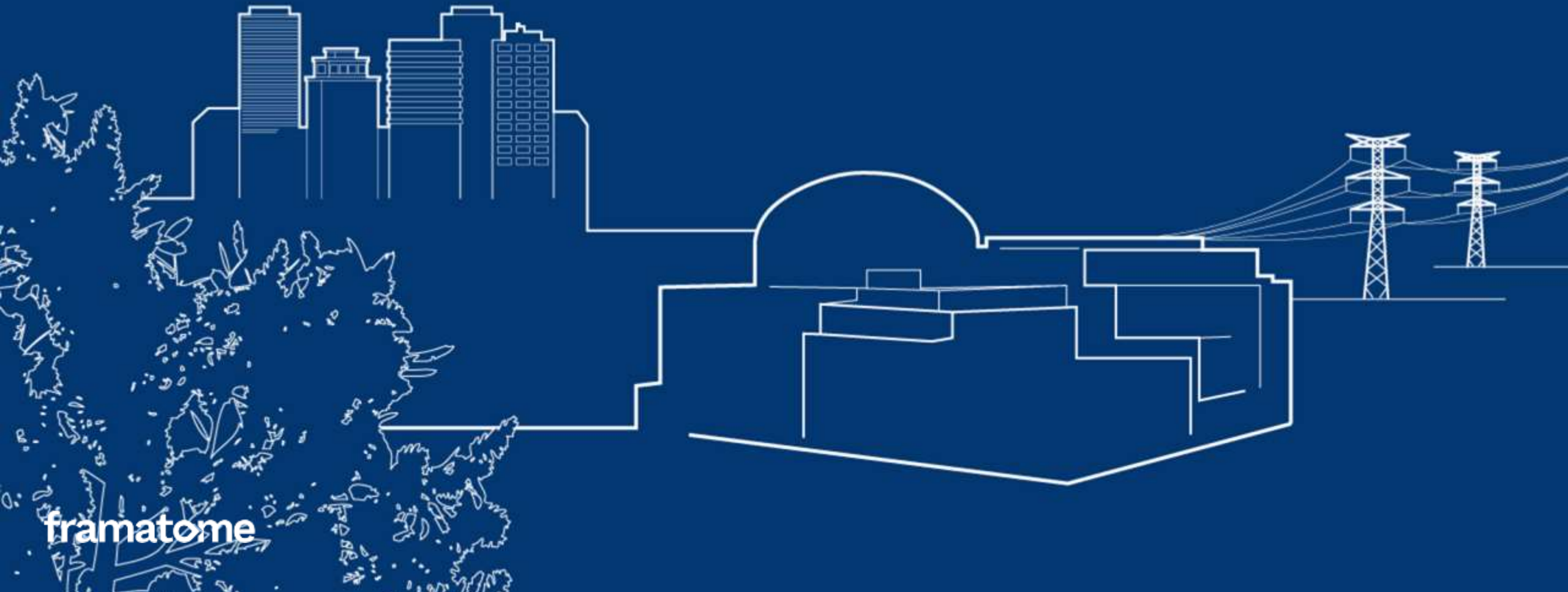

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