

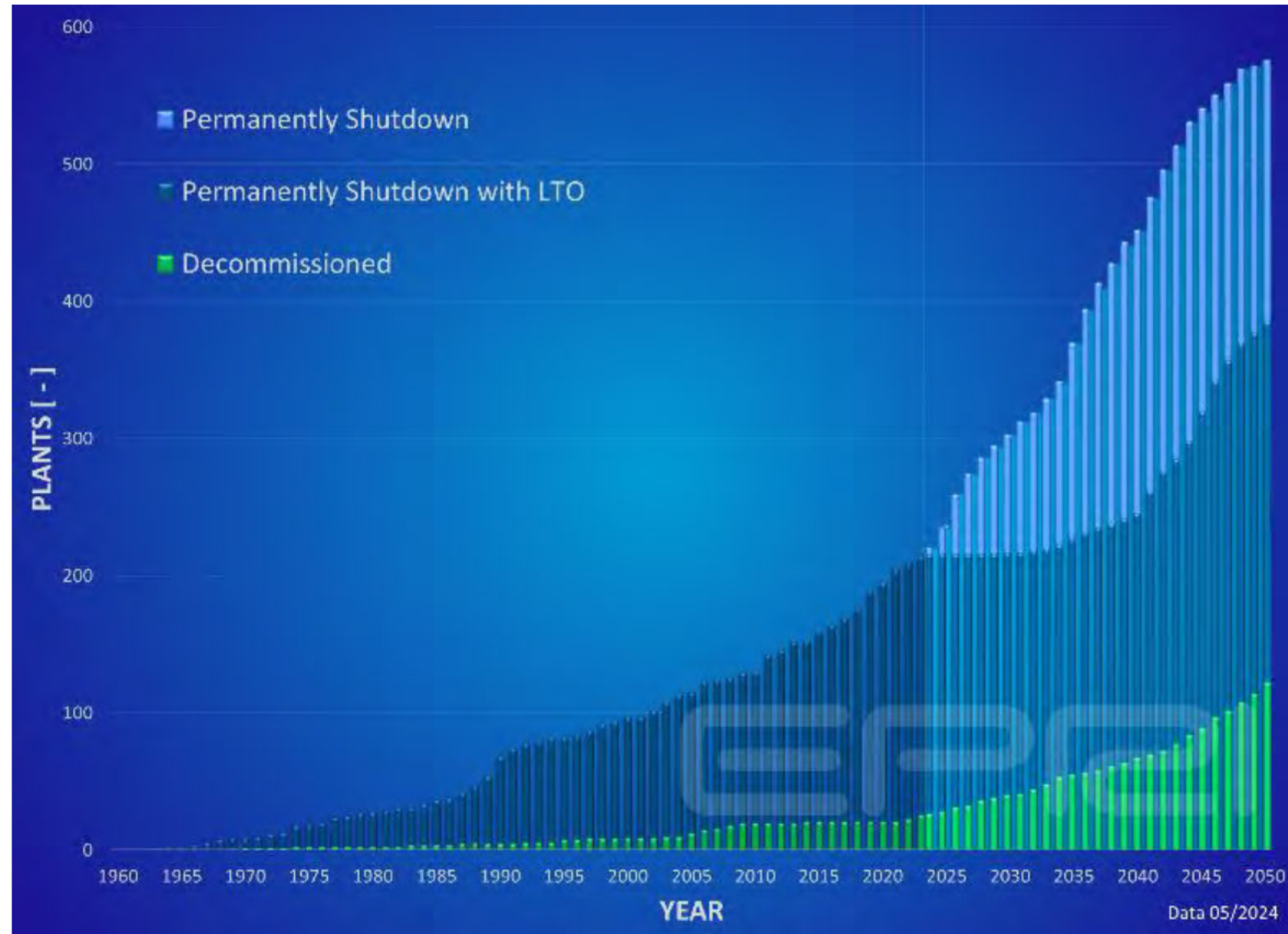
Decommissioning Experience in Europe



Dr.-Ing. Martin Brandauer
Principal Technical Leader

Worldwide Status and Plans for Decommissioning

- 220 power reactors shutdown for decommissioning, while only 26 plants are fully decommissioned
- Almost half of the 423 power reactors in operation around the world are expected to enter the decommissioning phase by 2050
- Facilities related to research, nuclear fuel & small industrial and medical applications amount to several thousands of decommissioning projects



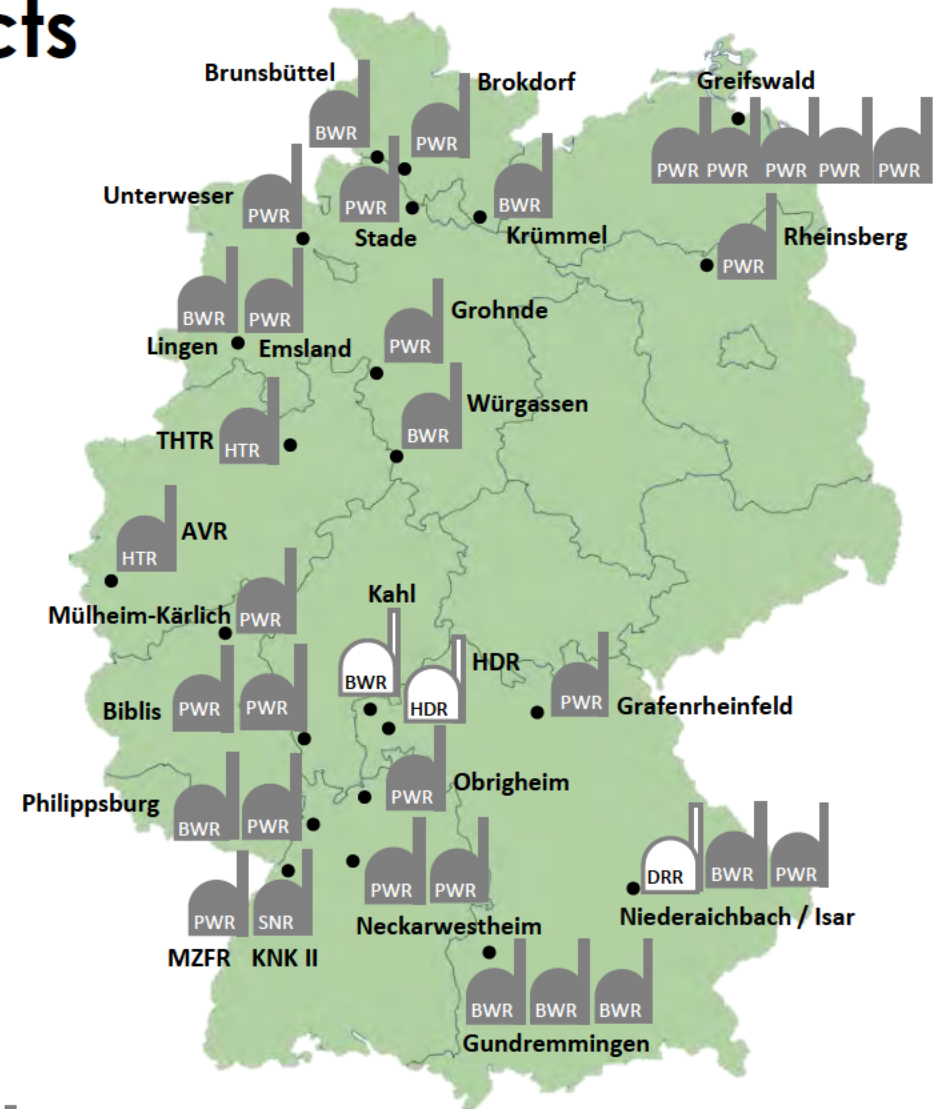


Germany

German NPPs Decommissioning Projects

Latest granted decommissioning licenses:

- Isar 1: 17 January 2017
- Neckarwestheim 1: 3 February 2017
- Biblis A: 30 March 2017
- Biblis B: 30 March 2017
- Philippsburg 1: 7 April 2017
- Unterweser: 5 February 2018
- Grafenrheinfeld: 11 April 2018
- Brunsbüttel: 21 December 2018
- Gundremmingen B: 19 March 2019
- Philippsburg 2: 17 December 2019
- Gundremmingen C: 26 May 2021
- Neckarwestheim II: 4 April 2023
- Grohnde: 6 December 2023
- Isar 2: 21 March 2024
- Krümmel: 20 June 2024
- Emsland: 26 September 2024
- Brokdorf: 23 October 2024



In Decommissioning

Released from regulatory control

Source: BMUV

Decontamination and Characterization of the Buildings

Wall decontamination



Electric handhold chiseling



Handhold measurement and documentation



Shaved walls after decontamination



Drill out of ducts and wire shafts



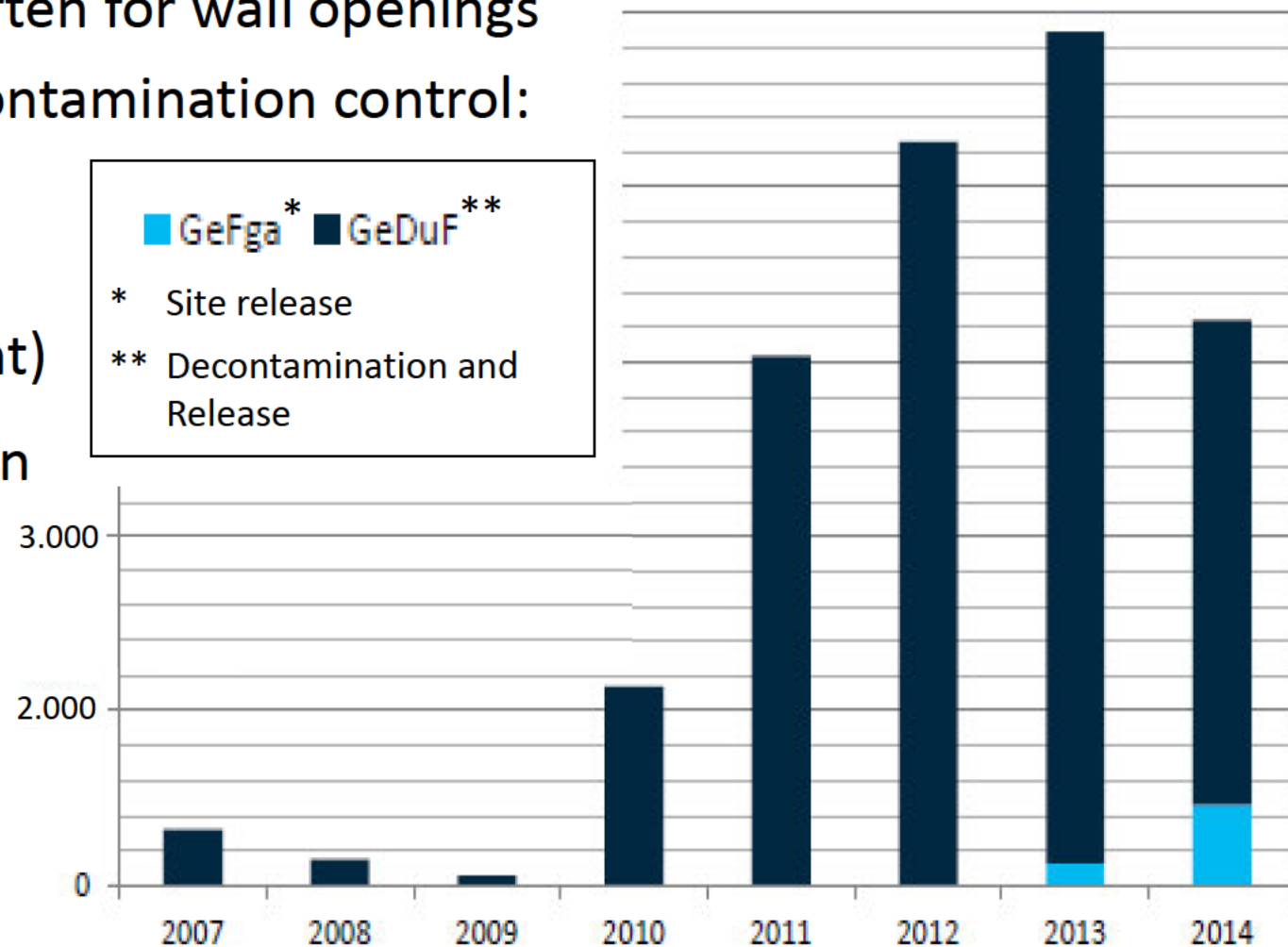
Decontamination of Residual Remains



Source: PreussenElektra

Facts from “clearance measurements” at Würgassen NPP

- Measurements with **contamination monitor** on mineral structure:
 - 26,295 decision measurements, often for wall openings
 - Preliminary investigation and decontamination control: approx. 100,000 measurements
- 12,739 measurements with **ISOCS** (typically 10 m² area per measurement)
- Collection and evaluation of more than 34,000 **material samples**
- Evaluations for the disposal of the removed material and the personnel monitoring: approximately 196,000 **laboratory analyses** conducted at Würgassen.



Source: PreussenElektra

NPP Stade – Increased Decontamination Effort

- Removal of 20.000 tons of concrete due to contamination found in the reactor sump area between the concrete and the steel liner
- 1.500 pieces of about 14 metric tons each had to be removed through wire-saw cutting
- Transportation, crushing, characterization and segregation, extended project duration by 3-year



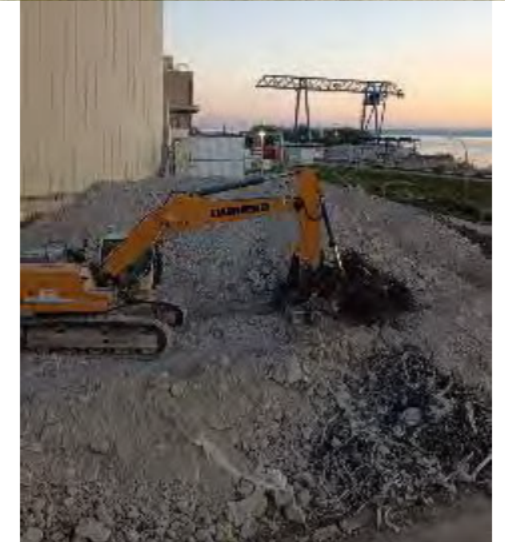
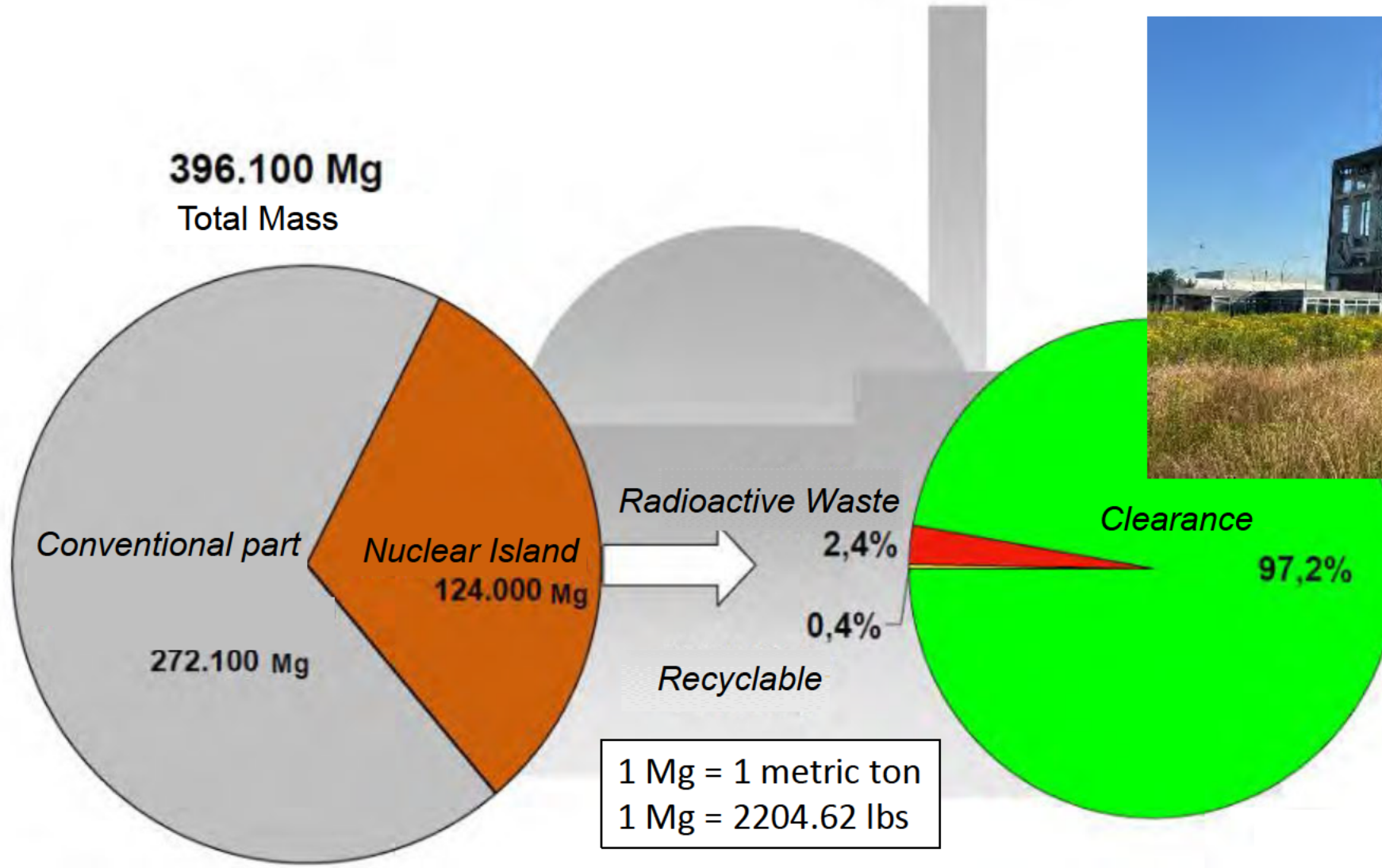
Source: PreussenElektra

Cleanout of the Containment at Stade



Source: PreussenElektra

Total Initially Estimated Waste Volume* of NPP Stade



* Latest estimates show no significant changes of final Mass-%.

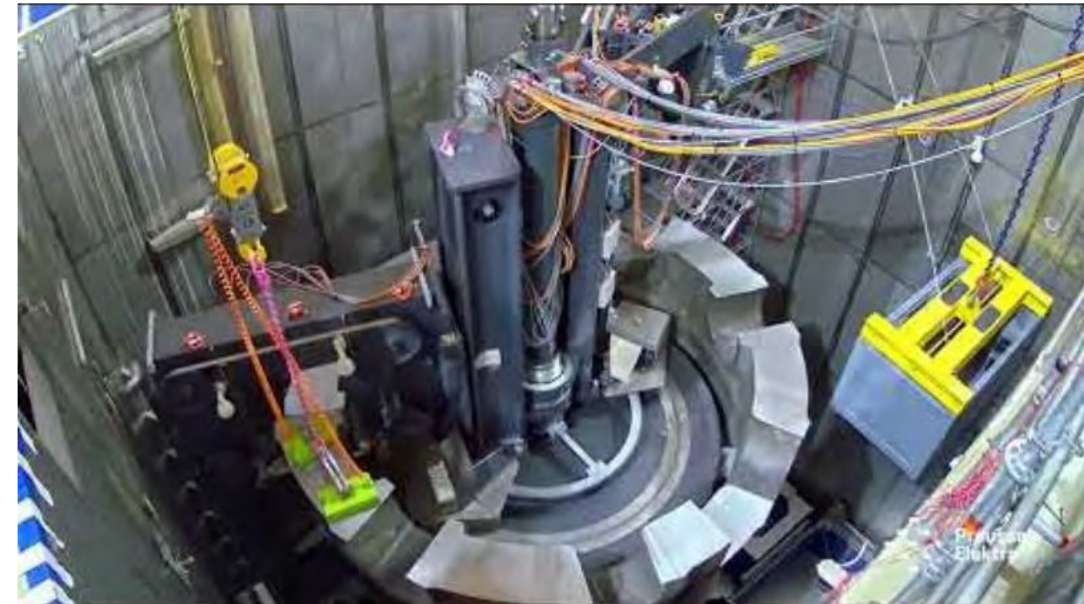
Source: PreussenElektra

The PreussenElektra Fleet Approach

- Würgassen and Stade Take-aways regarding time critical processes:
 - Start with the difficult tasks first and minimize respectively operational costs as soon as possible
 - Assess schedule risks and opportunities monetarily and track them forward
 - Steer and analyze schedule and critical path continuously
- Shortening the decommissioning duration significantly reduces the total operational costs

Source: PreussenElektra

Impressions of Unterweser





Spain

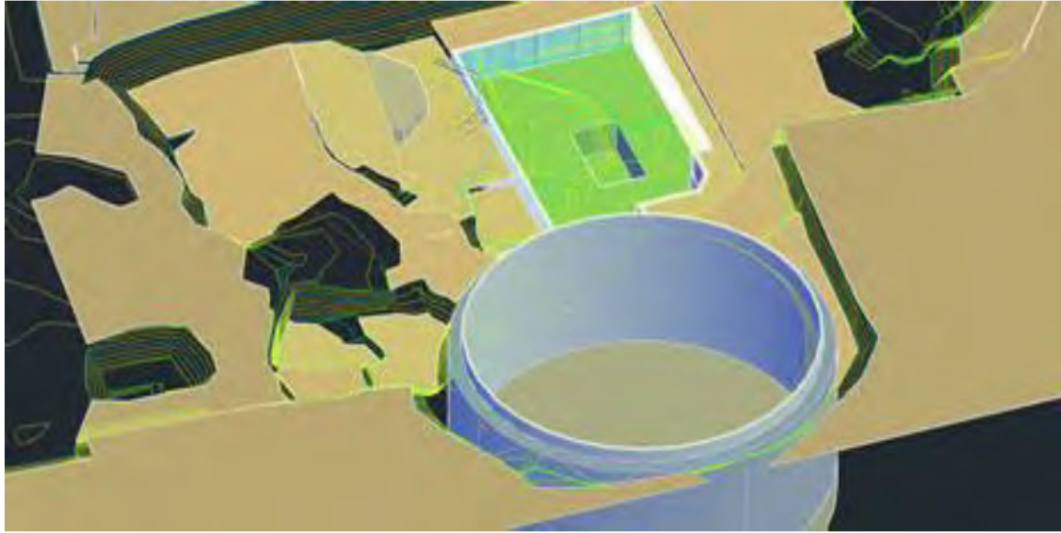
José Cabrera Power Plant (CNJC) Decommissioning Experience

- Background:
 - Single loop 160MWe PWR Located in central Spain
 - After spent fuel transferred to an ISFSI in 2010, plant license transferred to ENRESA who is completing the decommissioning
 - After decommissioning by ENRESA, the site license (covering only the ISFSI) will be returned to the utility Naturgy
- Major Activities:
 - Full system chemical decontamination conducted in 2006/2007
 - Turbine building remodeled as waste treatment/interim storage
 - Reactor and reactor internals segmented underwater in spent fuel pool with mechanical cutting
 - Soil washing cleared 85% of candidate material processed
 - Building/land areas cleared using NRC MARSSIM survey process
- Major challenge:
 - First of a Kind project, resulting in 9 years of approval process, in particular driven by site release limits (ongoing process)



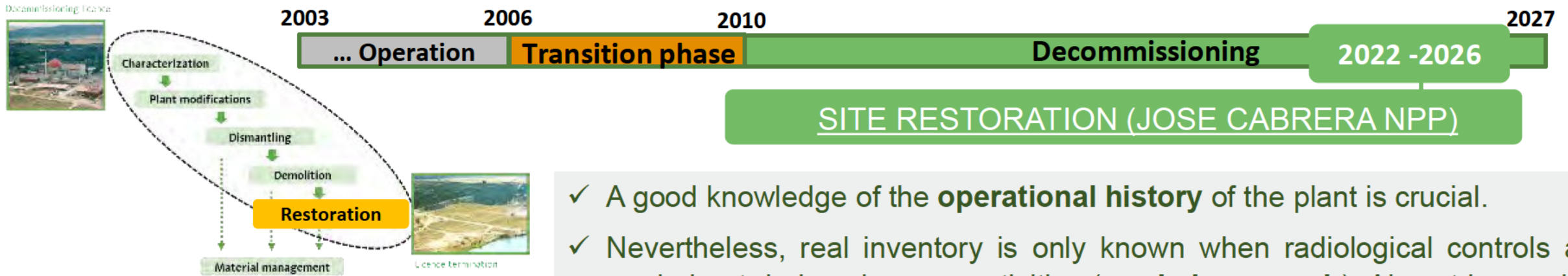
Source: EPRI Report 3002026759

Site Restoration at CNJC



Source: ENRESA

Lessons Learned CNJC Site Restoration



- ✓ Below ground level structures (basements of reactor building, Radwaste building, others)
- ✓ Open land areas
- ✓ Footprint of RW stores, tanks, evaporator
- ✓ Old trenches (RW initial stores)
- ✓ Discharge Channel
- ✓ Buried pipes

- ✓ A good knowledge of the **operational history** of the plant is crucial.
- ✓ Nevertheless, real inventory is only known when radiological controls are carried out during clean-up activities (**graded approach**). Almost impossible access to certain places (sinks, embedded pipes) until advanced demolition.
- ✓ **Design and approve Site Restoration Plan** as early as possible (Don't leave it for final stages. Important to get the release levels early, and to become conscious of how low they can be).
- ✓ **Anticipate regulatory challenges** (e.g. Spanish regulator prescribes RP 113 re-use levels)
- ✓ Anticipate **complex civil works below groundwater level remediation**
- ✓ Significant amount of material needs to be treated. **Keep your storage capacity until the end of the process** (declassifiable soil, VLLW)
- ✓ **Soil washing is a mature technology** (11000t treated, 85% released)

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