

# Decommissioning in Sweden at OKG

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# Swedish nuclear Program

From operation to large scale decom execution in 5 years.  
Learnings and reflections from a 4 station Uniper programme.

The background image shows a large industrial facility, likely a nuclear power plant, with a prominent white containment dome and a tall, dark chimney. In the foreground, there is a high-voltage electrical substation with several tall metal pylons and cross-arms supporting power lines. The scene is set against a clear blue sky with some light clouds. The foreground is partially obscured by out-of-focus green foliage. A paved road or path runs horizontally across the lower part of the image.

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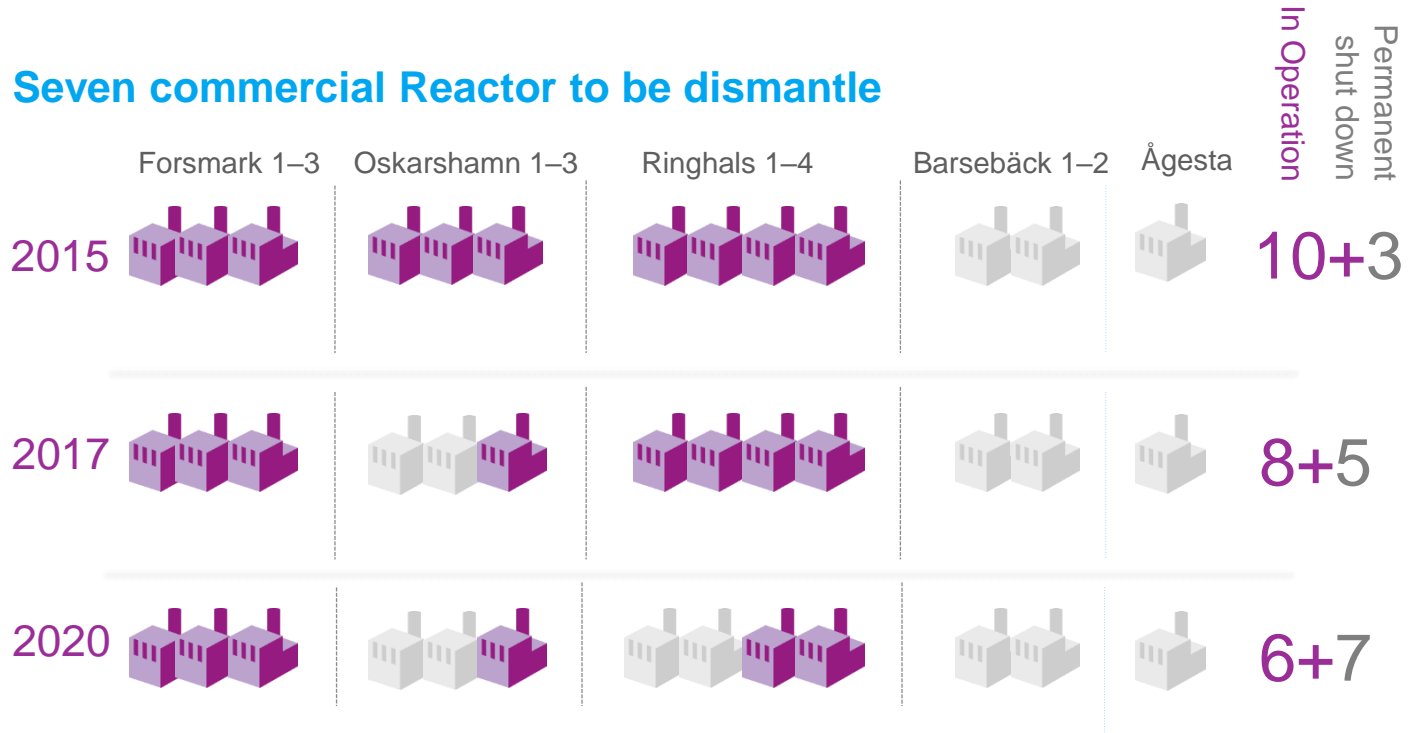
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# Nuclear Decommissioning

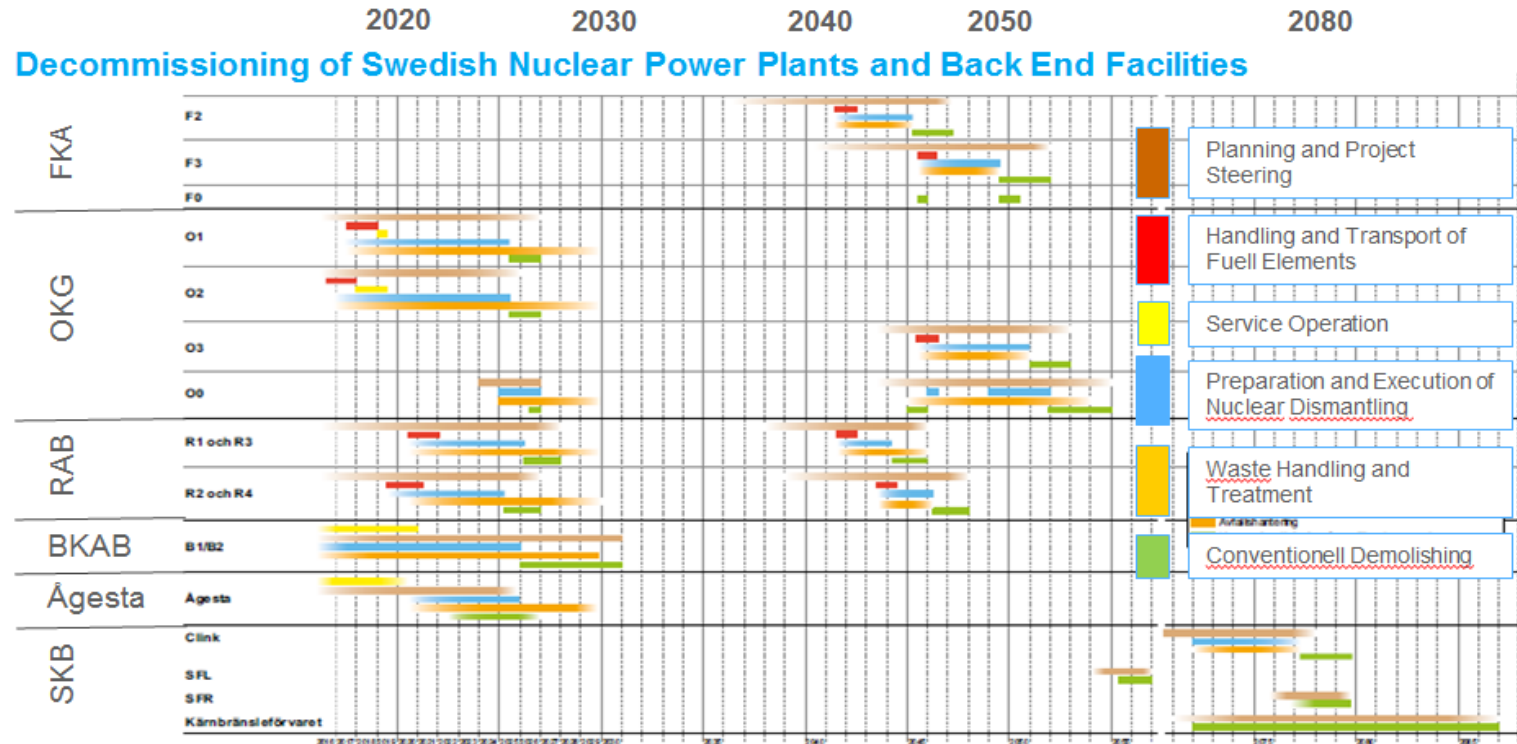
- An important Part of the Swedish nuclear Portfolio

## Seven commercial Reactor to be dismantle



# The actual assumed timeline

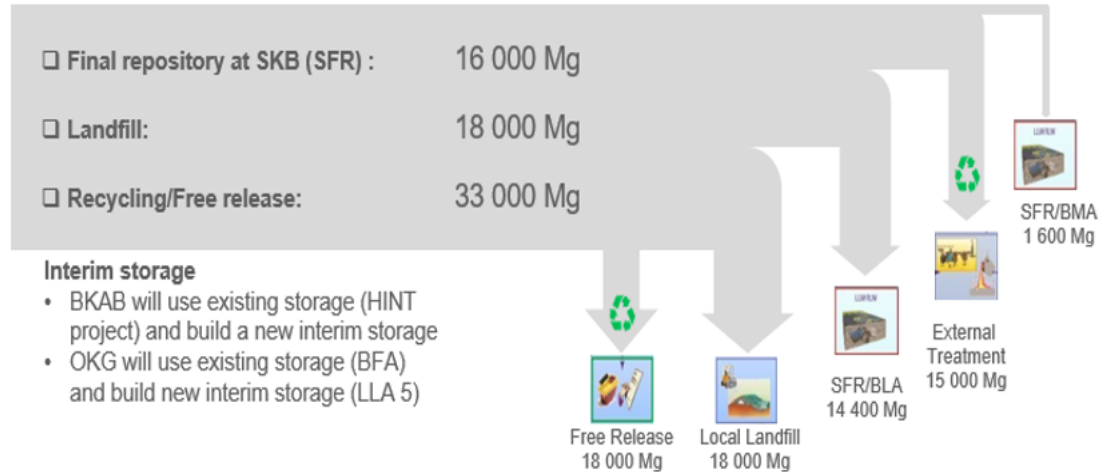
(Swedish D&Dof nuclear Power Plants and back end facilities)



(Source: SSM based on SKB FUD 2016)

# Disposal Routes are pending decision on waste strategy

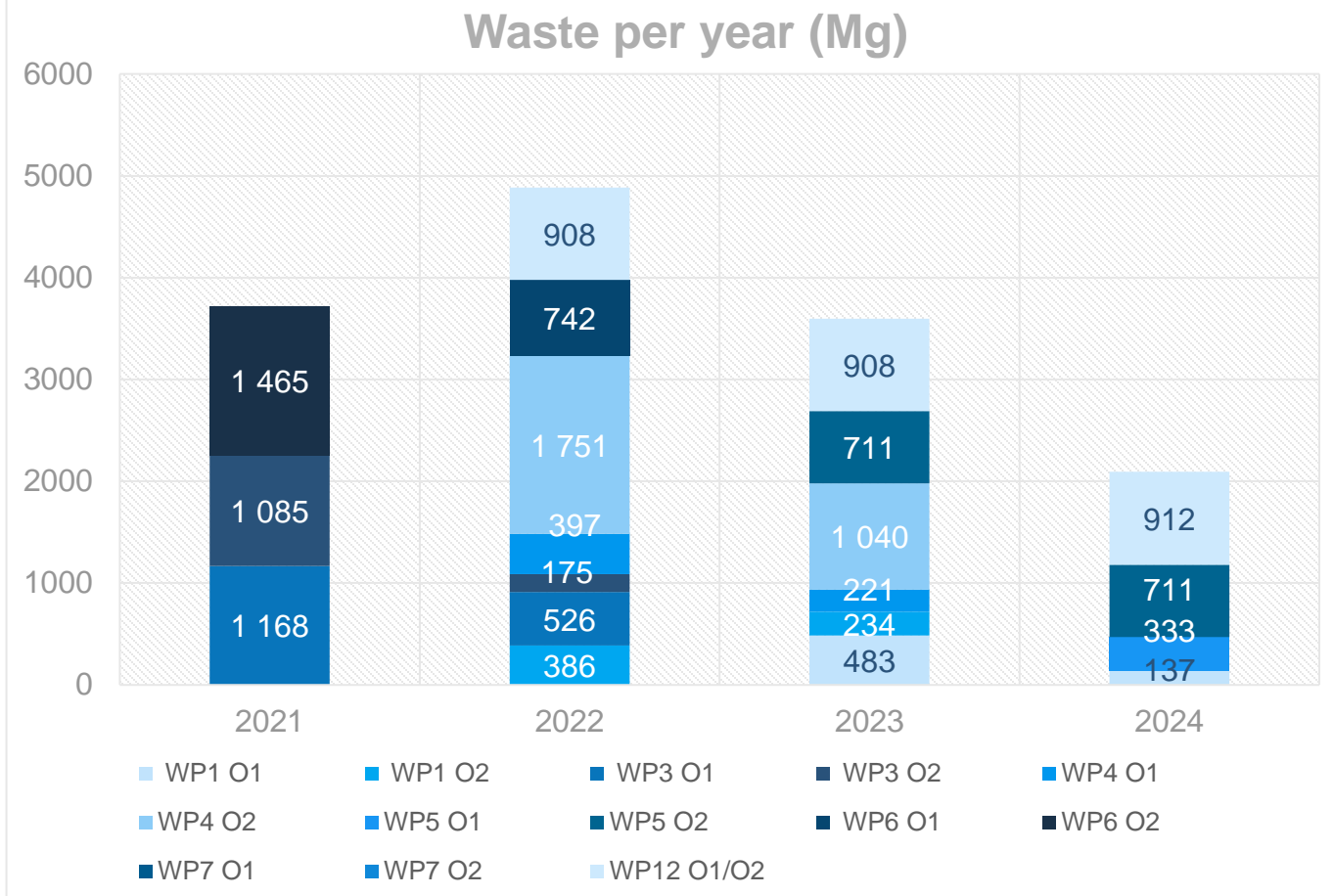
Distribution of the total Rad. Waste volume, 67 000 ton, for BKAB/OKG



## The dismantled material is spread into different disposal routes

- Disposal route is decided on cost base (respecting available final storage volume)
- Based on the results of the negotiation for external waste treatment and/or system supplier for waste treatment the fraction for the different disposal routes will be optimised
- Actual implication shows that the volume for external treatment (free release) may increase and the use of an external landfill is possible. That can lead to reduced volumes of radioactive waste
- On same cost level avoidance of waste and increased free release is preferred
- The volume of Free Release is based on Free Release without any decontamination measures

# Waste flow D&D





# Uniper Nuclear Sweden

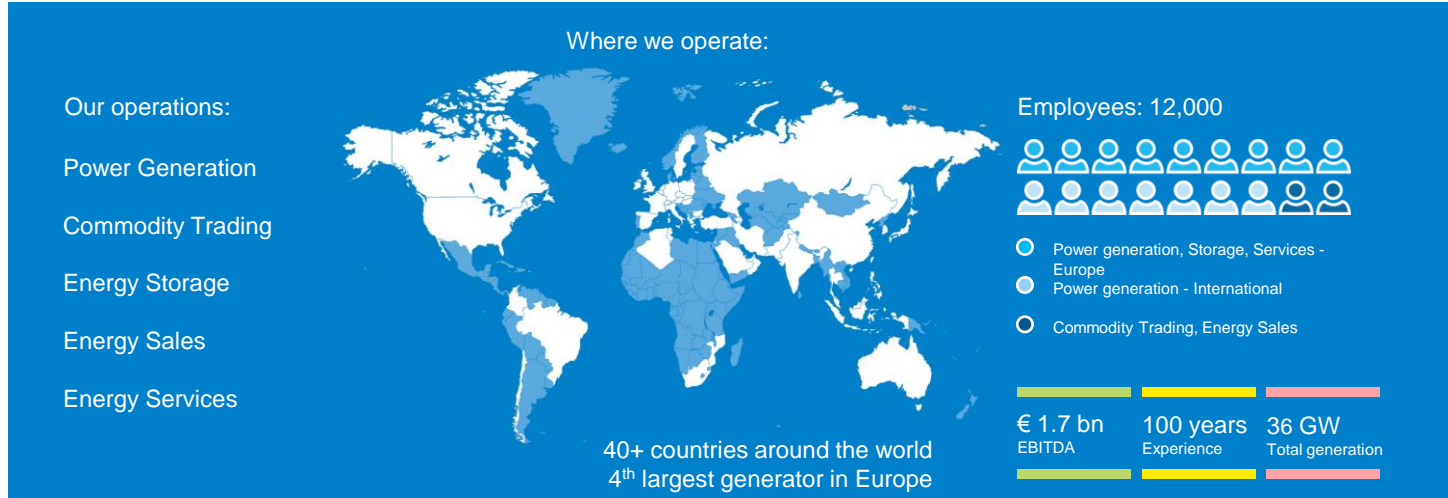
Sydkraft Nuclear Service

A photograph of a nuclear power plant facility, likely Barsebäck, situated along a body of water. The plant features several large, white, rectangular containment domes and tall smokestacks. The foreground shows a rocky shoreline with some greenery and white flowers. The sky is blue with scattered white clouds.

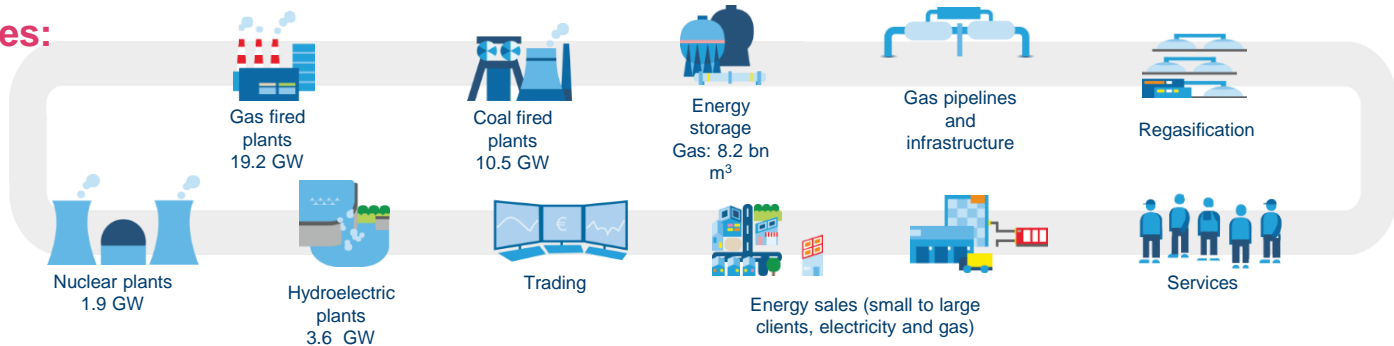
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# We are Uniper



## Main activities:

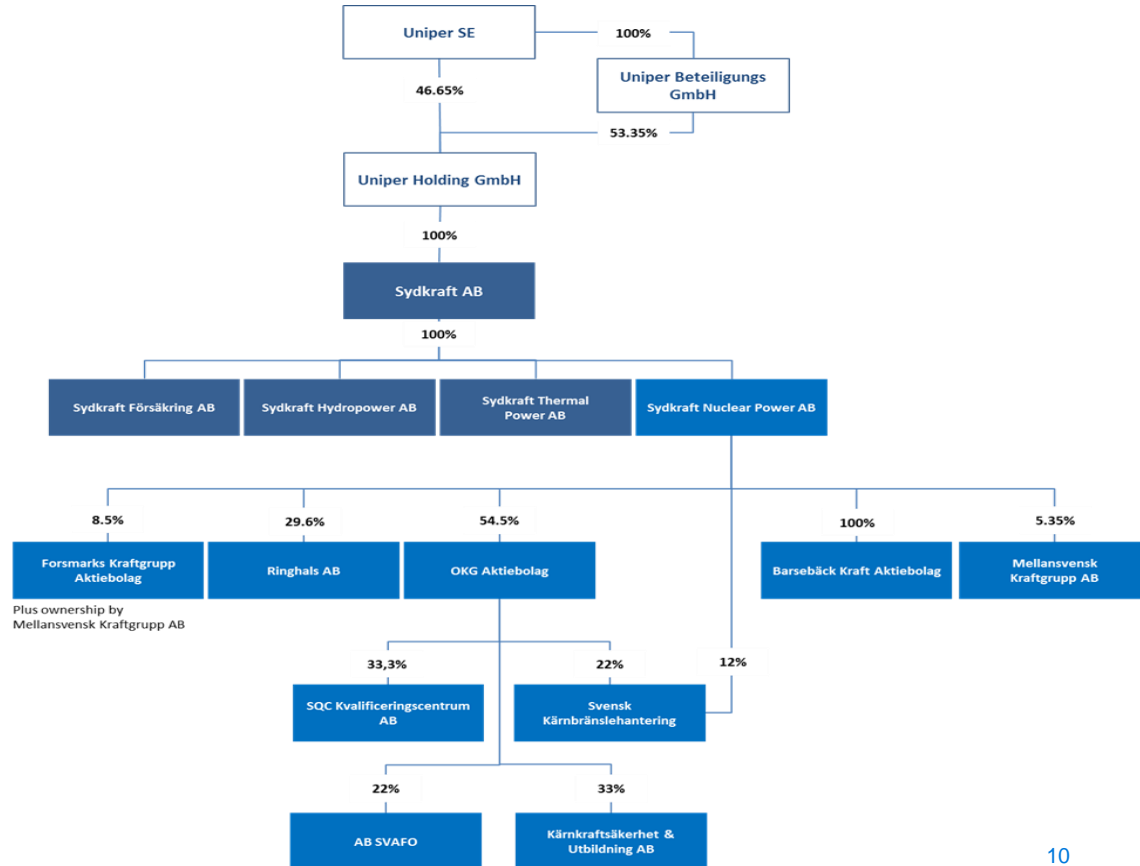


# Sydskraft Nuclear Power AB (SNP)




- Manages Uniper's nuclear power portfolio
- Has ownership interests in all active nuclear power plants in Sweden

## Business Mission of SNP

*"Optimize the value of our nuclear power portfolio and create possibilities for a safe and competitive business by integrating superior knowledge of the Swedish system and utilizing the strengths of international expertise."*



# Uniper D&D Portfolio

Site Locations	NPP Oskarshamn	Key Site Characteristics
		<p><b>Owner:</b> Uniper (54,5%) / Fortum (45,5%)</p> <p><b># of Units:</b> 2 of 3 (O1+2)</p> <p><b>Commercial Operation:</b> 1972 / 1974</p> <p><b>End-of-Operation:</b> 2017 / 2015</p> <p><b>Reactor Type:</b> BWRs</p> <p><b>Gross Capacity [MW]:</b> 492 / 661</p> <p><b>Electricity produced [GWh]:</b> 263,000</p>
	<p data-bbox="857 576 1070 601"><b>NPP Barsebäck</b></p> 	<p><b>Owner:</b> Uniper (100%)</p> <p><b># of Units:</b> 2</p> <p><b>Commercial Operation:</b> 1975 / 1977</p> <p><b>End-of-Operation:</b> 1999 / 2005</p> <p><b>Reactor Type:</b> BWRs</p> <p><b>Gross Capacity [MW]:</b> 615 / 615</p> <p><b>Electricity produced [GWh]:</b> 202,000</p>

BWR = Boiling Water Reactor \*Oskarshamn 1+2 and Barsebäck 1+2 have produced >3 times the total amount of Electricity consumed in SWE.

*Assets currently under consideration for D&D are the Uniper operated Sites Barsebäck (Units 1+2 located at the Swedish West Coast (Malmö Area)) and Oskarshamn (Unit 1+2 situated at the East Coast (near Isle of Gotland))*

## Pre-decom. activities

- Development of NDD strategy
- Optimisation of Service operation
- “Shut down” –strategy
- Resource planning
- Permitting and licensing
- Facility characterisation
- Radiation calculation
- Owners engineering
- Decommissioning planning
- Development of withdraw strategies
- Virtual technologies for NDD
- Waste management strategy
- Waste management planning

## Facility shutdown activities

- Optimisation of service operation
- “Shut down” –strategy
- Radiological inventory characterization to support detailed planning
- Removal of system fluids, operational waste and redundant material (as consultants)

## Dismantling in controlled area

- Procurement of equipment for decontamination and dismantling
- Preparations and support for dismantling
- Pre-dismantling decontamination
- Dismantling planning and steering
- Volume driven dismantling, dismantling of main process systems, structures and components
- Dismantling contaminated large components incl. heavy equipment, heavy lifting
- Dismantling activated large components e.g.. RPV Internals and RPV Segmentation, Biological Shield
- Dismantling of contaminated activated building structures
- Dismantling infrastructure & logistics
- Removal contamination from buildings structures & areas outside buildings
- Final radioactivity survey for release of buildings

## Conventional dismantling, demolition and site restoration

- Procurement of equipment for conventional dismantling and demolition
- Development of reuse strategies
- Dismantling of systems and building components outside the controlled area
- Demolition of buildings and structures
- Final cleanup, landscaping and refurbishment
- Final radioactivity survey of site

## Waste processing, storage and disposal

- Waste management system
- Management of historical/legacy
- Logistics planning
- Interim storage
- Development of waste disposal routes
- Supervision of waste treatment
- Waste documentation
- Waste handling & logistics
- Liquid waste treatment (NURES®, BORES®)
- Solid waste treatment
- Recycling
- Waste handling, packing & logistics
- Waste solidification with LOCKIT®
- Final disposal consultancy for LILW

## Project management, engineering & support

- Project management including control tower
- Site management
- Work Supervision
- HSE plan and supervision
- RP plan and supervision

## Radiation safety and Environment protection

- Radiation and environmental safety monitoring (as consultants)



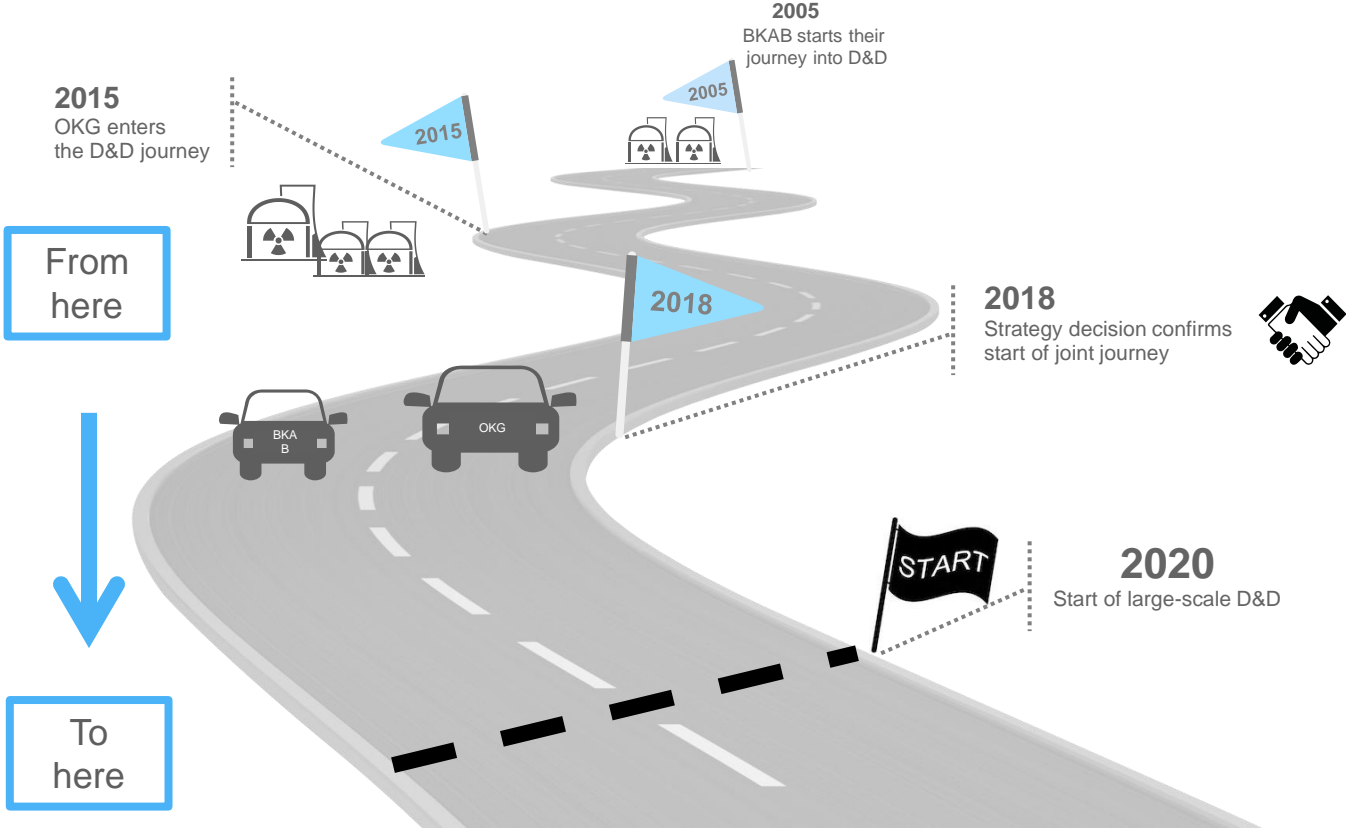
# Nuclear D&D at Uniper

Transition from operation to Decommissioning

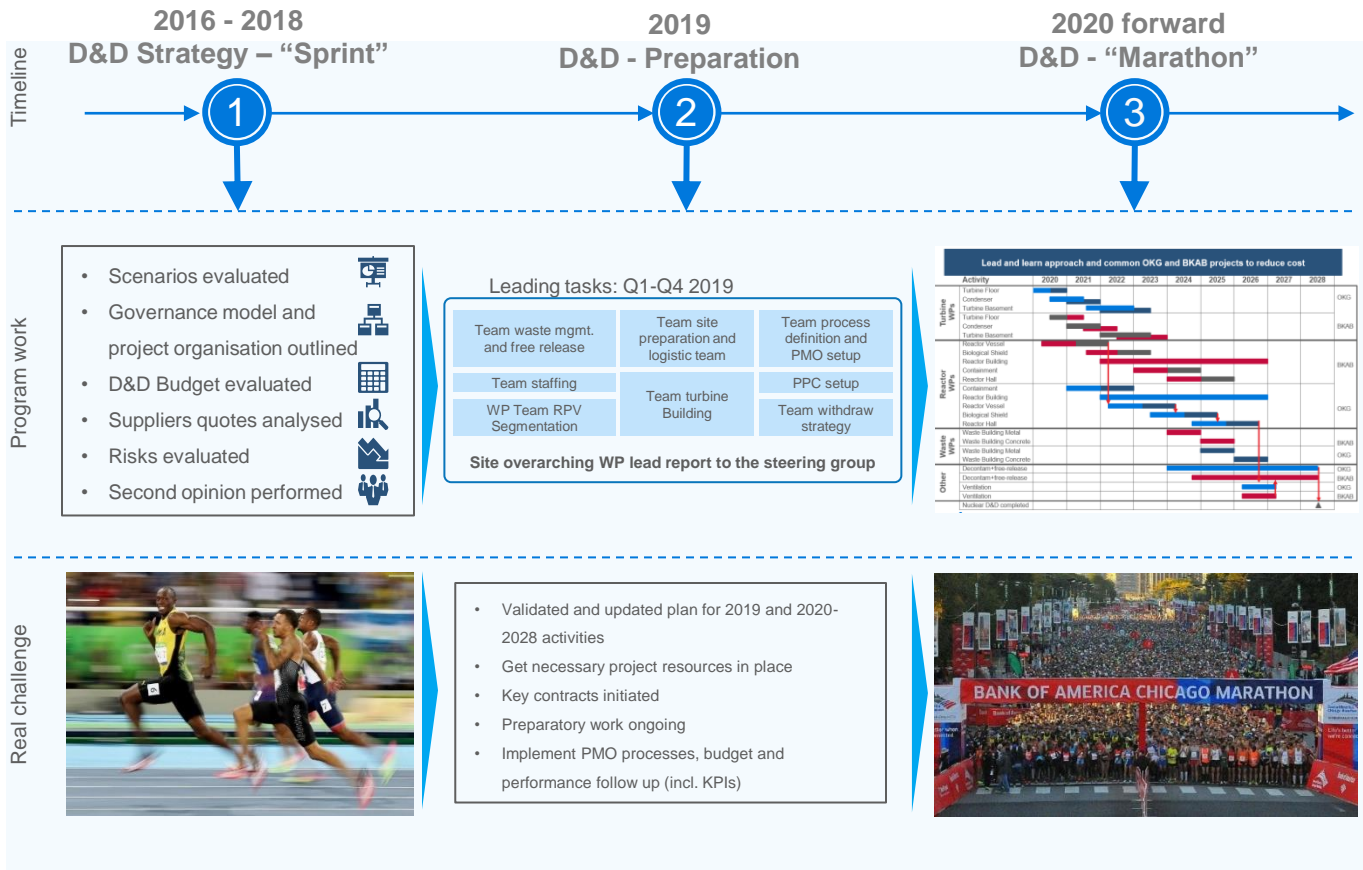
The background image shows two workers in high-visibility yellow-green vests and white hard hats walking towards the camera on a wide, light-colored paved surface. In the background, there are several industrial buildings. On the left is a tall, white building with vertical black slats. To the right is a long, low building with many windows. The sky is blue with scattered white clouds. The Uniper logo is overlaid in the bottom right corner.

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# The journey from strategy to execution



# Get ready for execution

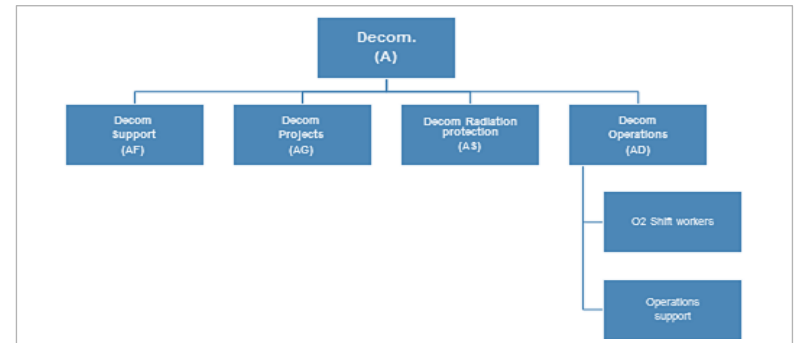
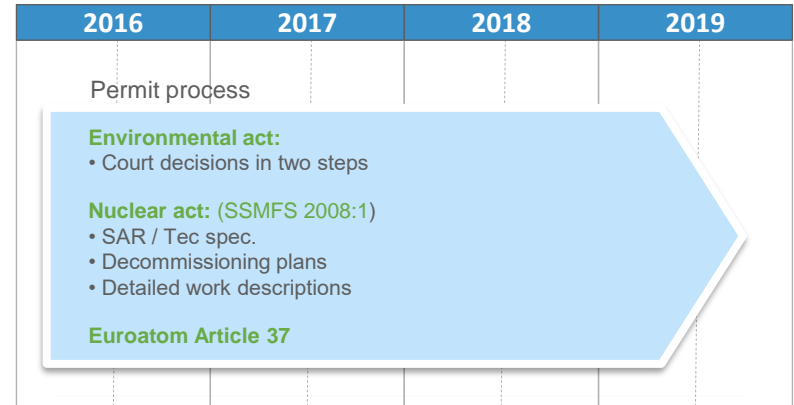


# Measures taken after the shutdown decision

(OKG)

In 2015 a project was started with two main tasks

1. Initiate time critical activities such as the licensing process, planning for the removal of damaged and irradiated fuel, writing specifications for segmentation of the reactor internals.
2. Prepare for an organizational change for decommissioning. The project did run this process until the new organization could start and take over decommissioning at OKG in the summer of 2016.

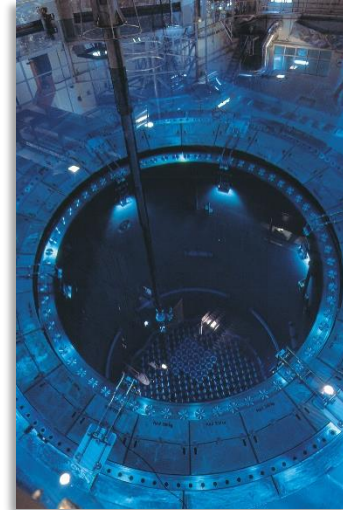




# Get ready for execution, 2019 prerequisites

What does it take to go from strategy to execution during 2019 at OKG:

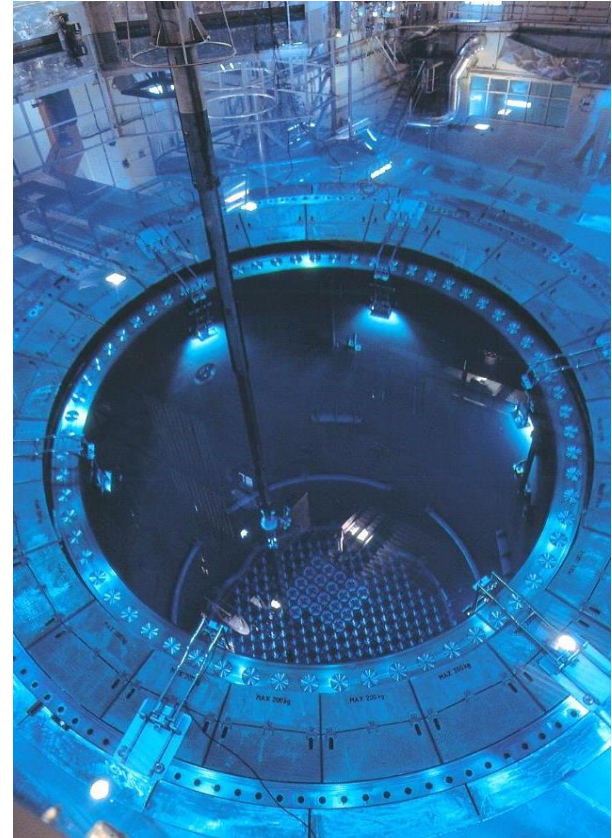
1. Establish joint OKG, BKAB and SNP teams.
2. Perform site specific preparation tasks such as for example system shut down and cable cutting
3. Setting up and secure resources for the agreed D&D organisation as defined in the strategy decision



# Preparations at OKG

## What did it take to start big scale decommissioning at OKG?

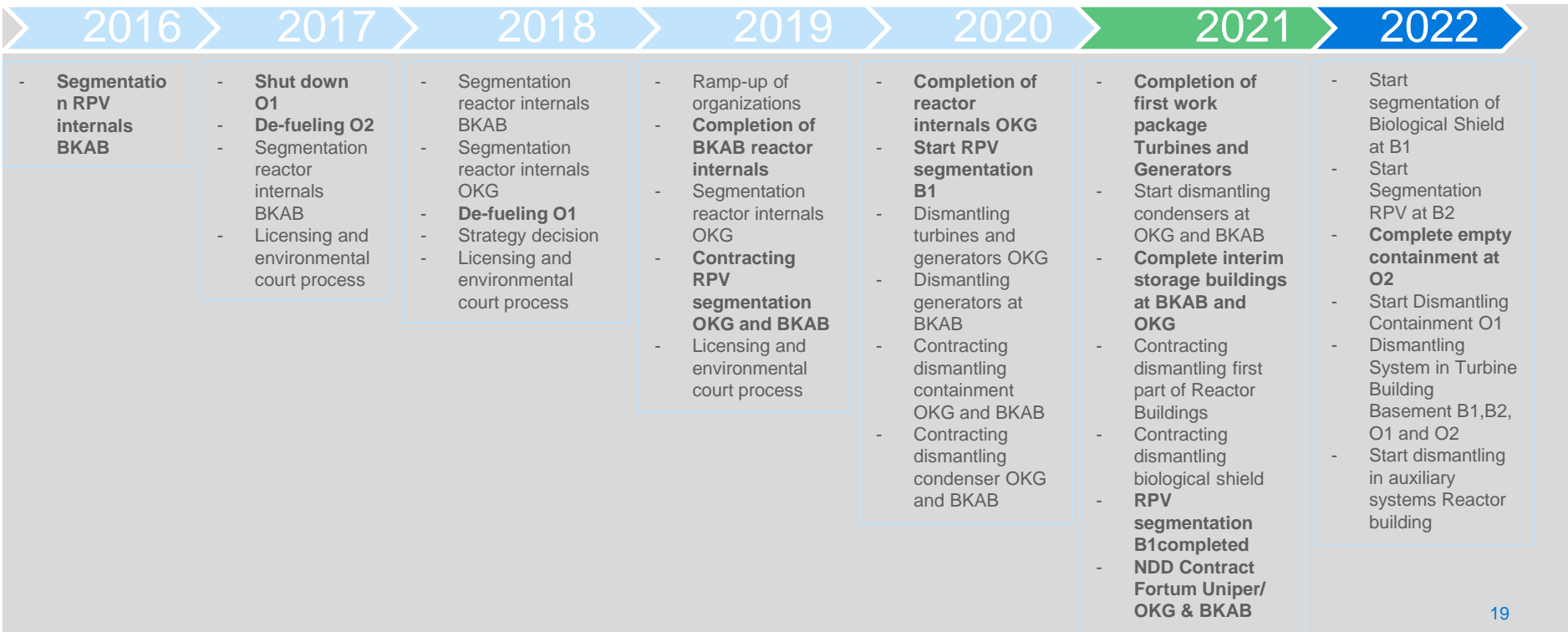
- Obtaining all necessary permits based on the nuclear act, environmental act and also European requirements
- Detailed project planning including for example categorization and supplier specifications
- Removal of high radioactive material such as spent fuel and reactor internals
- Plant preparation and separation including post operational clean out.



# Timeline & Present Status

## NDD Program Sweden

Start large scale Dismantling



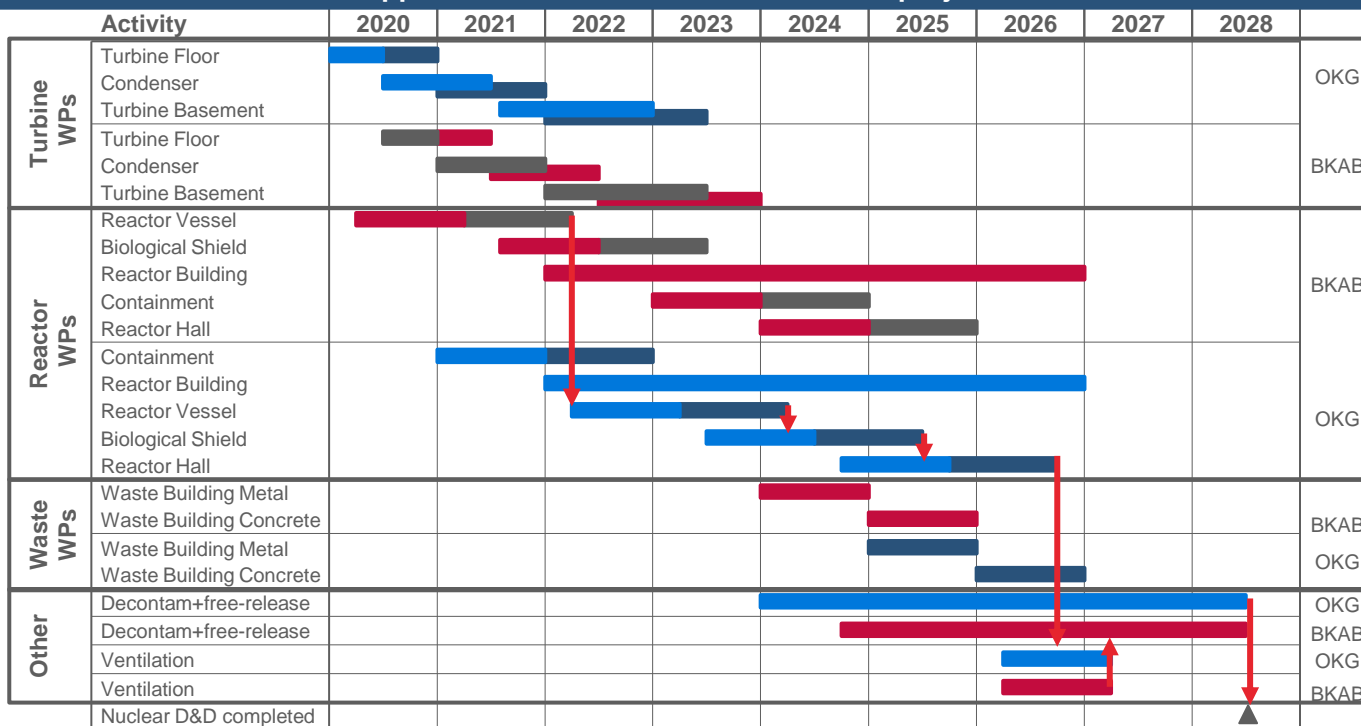
# 2020, start of D&D sequence

O2  
O1

B2  
B1

↓ Critical line

## Lead and learn approach and common OKG and BKAB projects to reduce cost





# Strengths

- Availability of staff at OKG
- The decommissioning is financed through a fund
- Coordination with the sister plants Barsebäck unit 1&2 gives synergies
- The Swedish system for final storage of nuclear waste and fuel



# Challenges

- Transition within the company by reductions of staff during the second half of 2017 and simultaneously change the mind set for parts of the company from operation to decommissioning
- Finding all the needed competences
- New interfaces with different authorities and other stakeholders
- 6 plants to be decommissioned in Sweden at the same time

# Differences in mind-set

Operation	Decommissioning
Based on permanent structures, both in plant configuration and organisational structures	Numerous of temporary structures, both organisational and for the plant design
Well established operational requirements	Changing requirements for decommissioning. Reduced, new and developing requirements
Nuclear and radiological risks are dominating	Reduced nuclear risk, changed radiological risk, significant increase of conventional industrial risker
Focus on the system function	Focus on material handling
Repetitive activities	High degree of one off activities and flexibility is required
Known workers environment	Changing workers environment
Established ways for communication	New ways for communication
Handling and transport of material according to routines	Big amount of material needs to be handled and transported

# OKG Results from the start in 2016

*So far the main activities of the master time schedule has been met. The basis for the master time schedule have been the time it takes to remove the irradiated and damaged fuel from the plants*

## Organisation

- Reorganisation Aug 1<sup>st</sup> -16
- Shut down OKG 1 and transfer to D&D organisation Aug 1<sup>st</sup> -17

## Permits

- Approval of Article 37 application from Euroatom
- Produced and implemented a new SAR for OKG unit 2 service operation
- Production of D&D SAR
- Entered into service operation according to the environmental Application for D&D according to the environmental act has been filed

## Removal of irradiated fuel and other components

- All irradiated fuel has left OKG 1 & 2
- The project for segmentation of reactor internals is closed out

## Large scale decommissioning

- Large scale decommissioning ongoing
- New company for decommissioning services established



# Summary

- Decommissioning of nuclear Power Plants in our programme is 25% executed and follows a clear defined concept
- Post Operation is a short Period due to the Fact that unloading of spend fuel is a proven process and follows a challenging Time Line
- Back End Solution is clear defined and basic for the D&D Planning. Interim Storages are needed to ensure the Project Time Line
- Licensing Process allows a straight Time Line into the Dismantling of the Plants
- Dismantling follows a Safe and Pragmatic approach what allows short execution Time
- But still a lot of Challenges needs to be solved to reach the Plan

Let us support you in your transition and decommissioning

**Questions?**