WAK

Wiederaufarbeitungsanlage Karlsruhe
Rückbau- und Entsorgungs- GmbH

Decommissioning Projects at the Nuclear Research Center Karlsruhe

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Executive Director

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Contents of the presentation

- Situation in Germany concerning decommissioning of nuclear facilities
- Overview of the activities of the company EWN and the status of decommissioning of nuclear facilities on the premises of the Karlsruhe research center
- Recommendations of lessons learned

Research Reactors in Germany with Thermal Outputs of 0.1 MW and more

Research reactor	MW_{th}	Operation	Status
FRMZ Mainz (TRIGA)	0.1	1965-	in operation
FRG-1, GKSS Geesthacht Research Center	5	1958-	decommissioned
BER-2, Hahn-Meitner Institute Berlin	19	1963-	in operation
FRJ-2, Jülich Research Center	23	1962-	decommissioned
FRM-II, University of Munich	20	2003-	in operation
HD TRIGA II Heidelberg	0.25	1978-	dismantled
FRM, University of Munich	4	1957-	decommissioned
FRH TRIGA, Medical University Hanover	0.25	1973-96	
FMRB, PTB Braunschweig	1	1967-95	decommissioned
FRN, GSF Neuherberg/Munich	1	1972-82	decommissioned
FRF-2, University of Frankfurt	1	1977-83	decommissioned
RFR, VKTA Rossendorf	10	1957-91	under dismantling
FRJ-1, Jülich Research Center	10	1962-85	under dismantling
FRG-2, GKSS Geesthacht Research Center	15	1963-95	decommissioned
NS Otto Hahn (nuclear ship)	38	1968-79	dismantled
FR 2, Karlsruhe Research Center	44	1961-81	in safe enclosure

Nuclear Power Plants and prototype reactors in Germany, which are currently being decommissioned

NPP unit	MW_e	Operation	Plant type
MZFR, Karlsruhe Research Center	58	1965-84	Heavy water-moderated PWR
KKR, Rheinsberg	70	1966-90	Pressurized water reactor of Soviet design
KGR-1, Greifswald	440	1973-90	
KGR-2, Greifswald	440	1974-90	
KGR-3, Greifswald	440	1977-90	
KGR-4, Greifswald	440	1979-90	
KGR-5, Greifswald	440	1989-90	
KMK, Mühlheim-Kärlich	1219		PWR, did not take up operation due to court order
VAK, Kahl	16	1960-85	Boiling water reactor
KRB-A, Gundremmingen	250	1966-77	
KWL, Lingen	254	1968-77	
HDR, Karlstein/Kahl, green field	25	1969-71	
KWO, Obrigheim	340	1968-2005	Pressurized water reactor (PWR)
KKS, Stade	640	1972-2005	PWR
KWW, Würgassen	670	1971-95	Boiling water reactor
KKN, Niederaichbach, green field	106	1972-74	Gas-cooled, heavy water- moderated reactor
AVR, Jülich	15	1966-88	Gas-cooled high-temperature reactor
THTR 300, Hamm-Uentrop	308	1984-88	
KNK-II, Karlsruhe Research Center	20	1977-91	Sodium-cooled reactor
SNR 300, Kalkar	300	No operation	Completely dismantled

Fuel Element Fabrication Facilities and Reprocessing (without facilities in large-scale institutions)

Location	Fabrication	Operator	Status
Reprocessing facilities (WAK)	Uranium, PU	WAK/FZK	Operation 1972-91 under dismantling
NUKEM-old, Hanau		Nukem	Operation 1962-88 dismantling completed
NUKEM 2, Hanau		Nukem	Did not take up operation
HOBEG, Hanau	Fuel spheres for HTR	Hobeg	Operation 1972-88 dismantling completed
Uranium processing facility, Hanau		Siemens	Operation 1969-94 dismantling completed
MOX facility (old), Hanau	Mixed-oxide fuel elements	Siemens	Operation 1969-91 dismantling completed
MOX facility (new), Hanau		Siemens	Given up during construction (95% completed)
Fuel element fabrication facility, Karlstein		Siemens	Operation 1982-96, decommissioned, under dismantling
ANF Lingen		ANF	Operation since 1979
URANIUM Mines WISMUT	Uranium	WISMUT	Shut down 1991 remediation of the sites, nearly completed

Situation today

Decisions in 1989/90

- fast breeder reactor SNR-300 in Kalkar was not commissioned
- not to construct the industrial reprocessing plant at Wackersdorf

Major amendments of Atomic Energy Act 2002

- Use of nuclear energy is limited (17 NPP in operation today)
  - agreement between utility-companies and government
  the last NPP will be shut down in 2020
- No new nuclear power station will be constructed
- Reprocessing of nuclear fuel is prohibited after year 2005

The EWN-Group

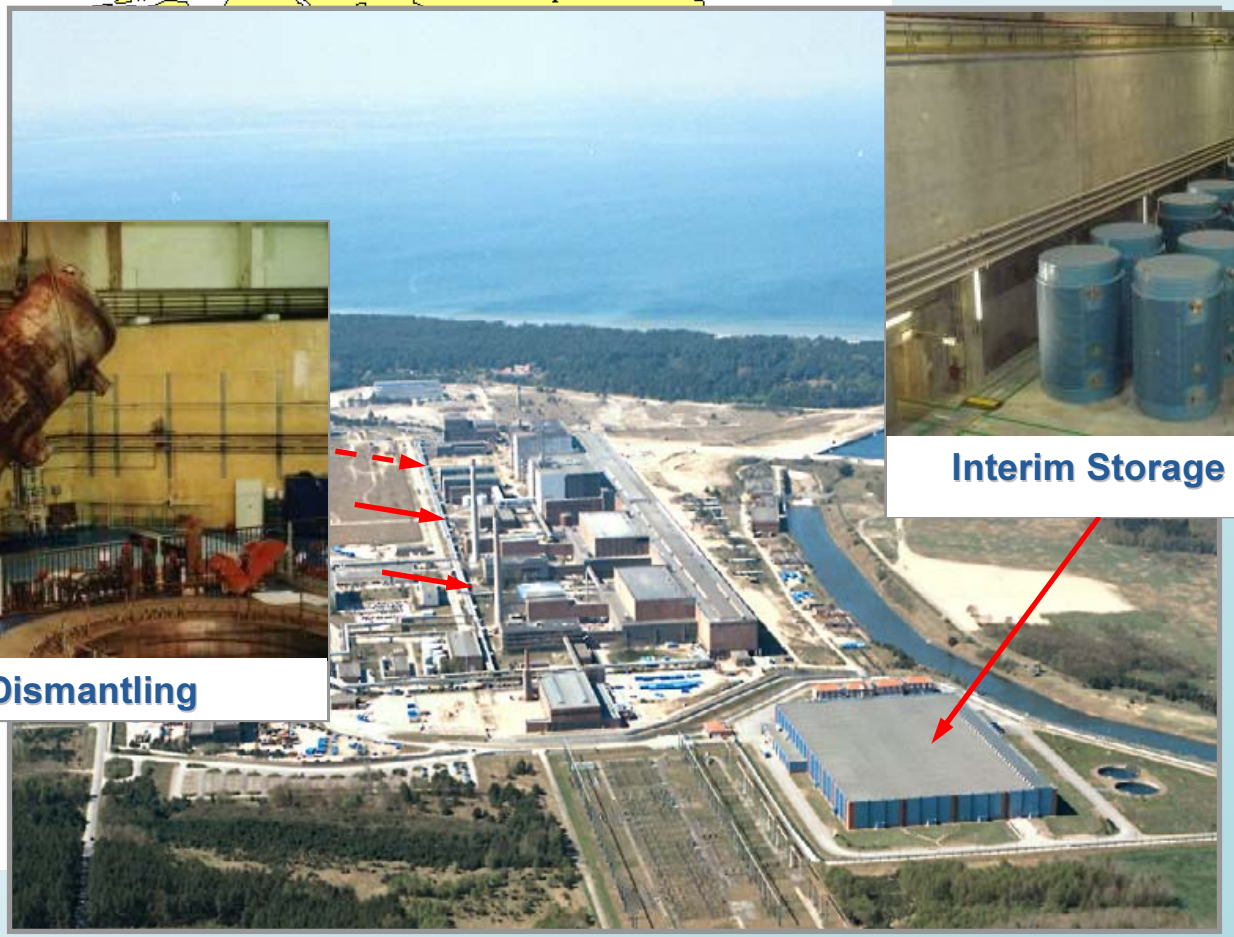
Task of EWN

decommissioning and waste management of nearly all nuclear facilities belonging to the public

Nuclear Sites and Subsidiaries

The EWN-Group

EWN / ZLN GmbH
Greifswald

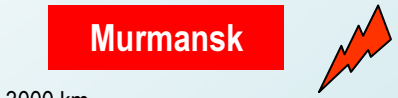


Reactor Dismantling

Interim Storage North (ZLN)

The EWN-Group

Submarine-Project



The EWN-Group

Transport of the Reactor Vessel

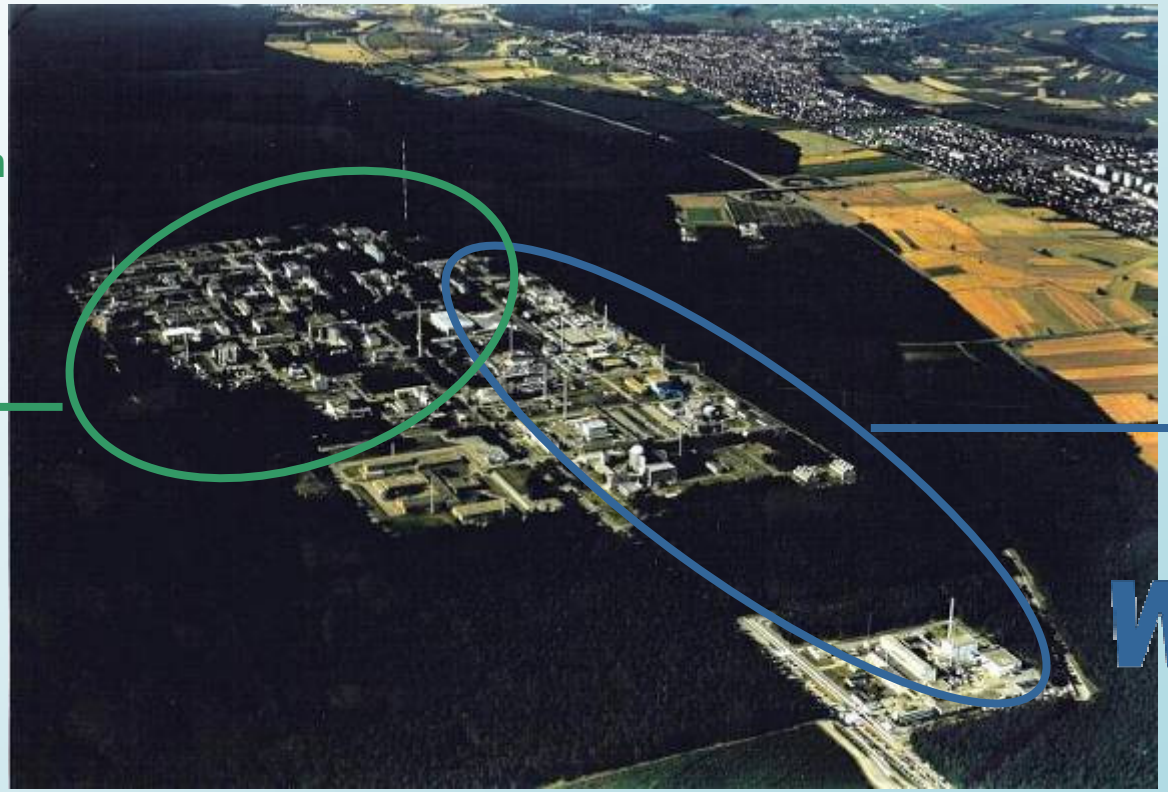
The EWN-Group

AVR GmbH
Jülich

Dismantling of the High-Temperature Reactor

Situation of the Karlsruhe Research Center

Universität Karlsruhe (TH) + Forschungszentrum Karlsruhe = KIT Karlsruhe Institute of Technology



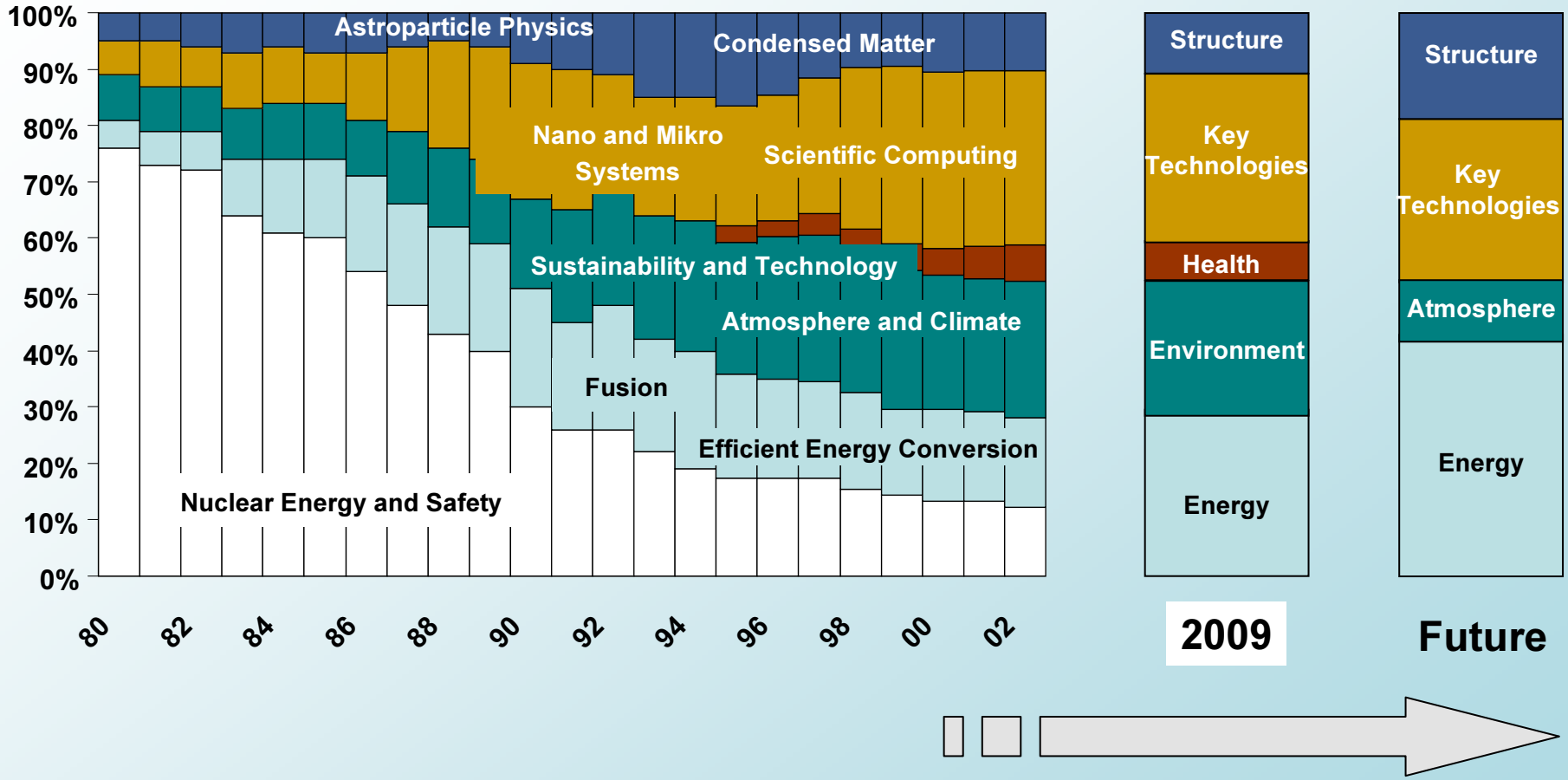
Research

KIT Karlsruhe Institute of Technology

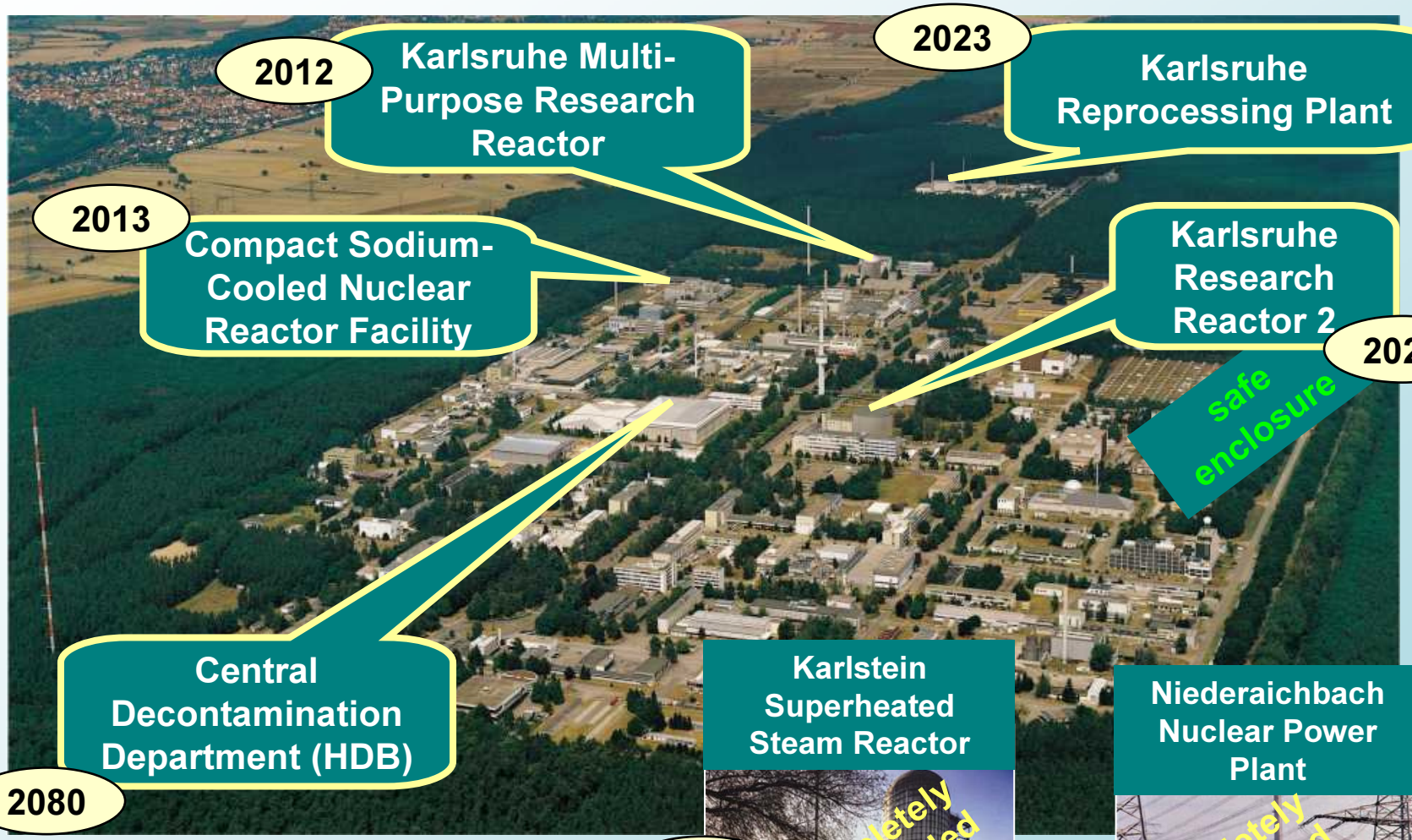
WAK

Nuclear Plants

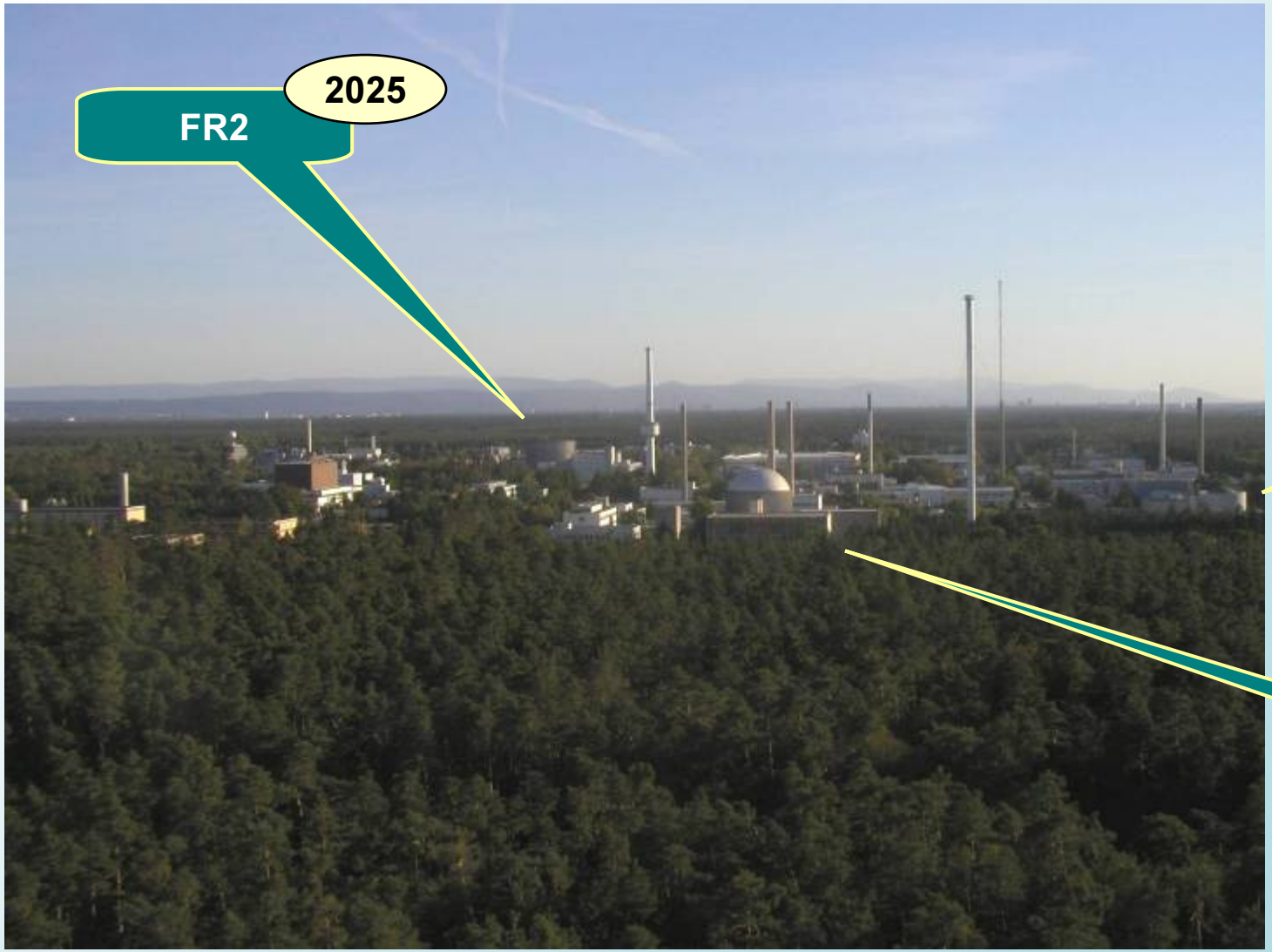
Research fields at FZ Karlsruhe



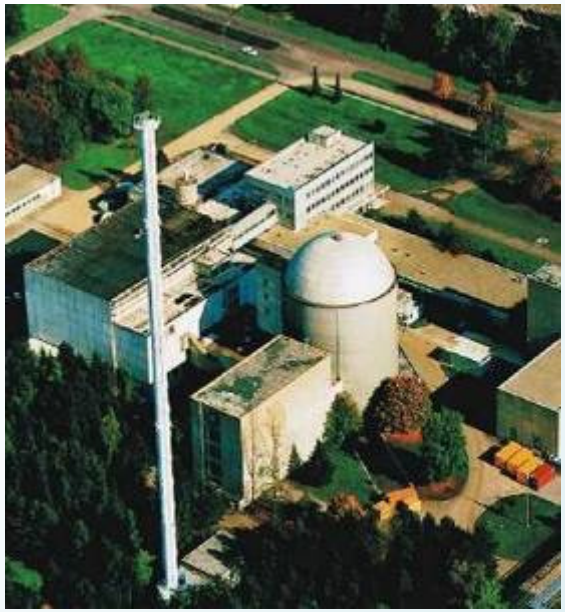
Nuclear Facilities Decommissioning Division at a Glance



Aeriel View from the North to the Reactor Decommissioning Projects



Multipurpose Reactor (MZFR)

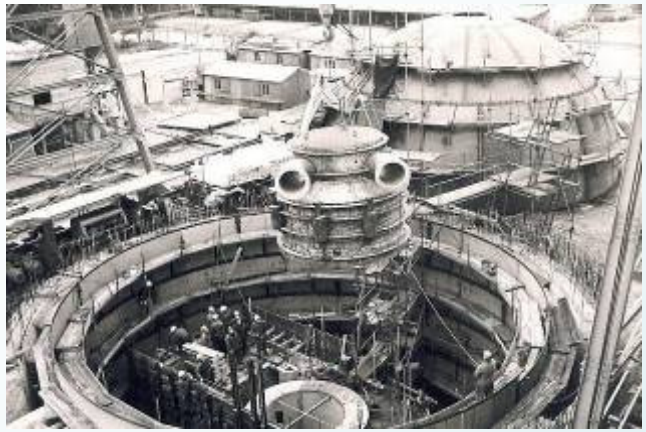


1961 – 1965
Construction

1965 – 1984
Operation

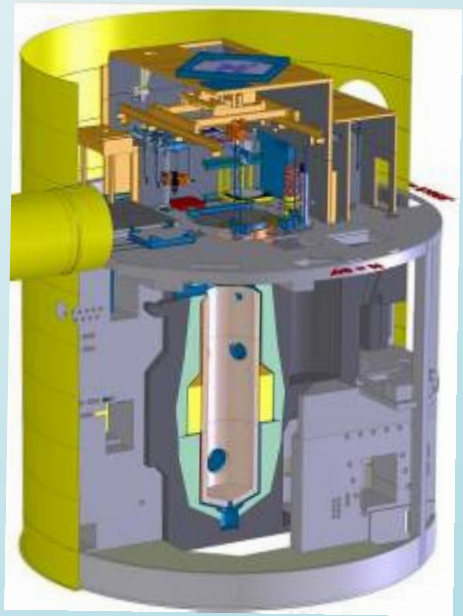
1984 – 2012
Dismantling

Compact Sodium Cooled Nuclear Reactor Facility (KNK)



1966 – 1969 Construction

1971 – 1991 Operation



1991 – 2013 Decommissioning

Future Project: Decommissioning of the Hot Cells (HZ)

2009 – 2012
Dismantling of the first sections

FR 2 Research Reactor

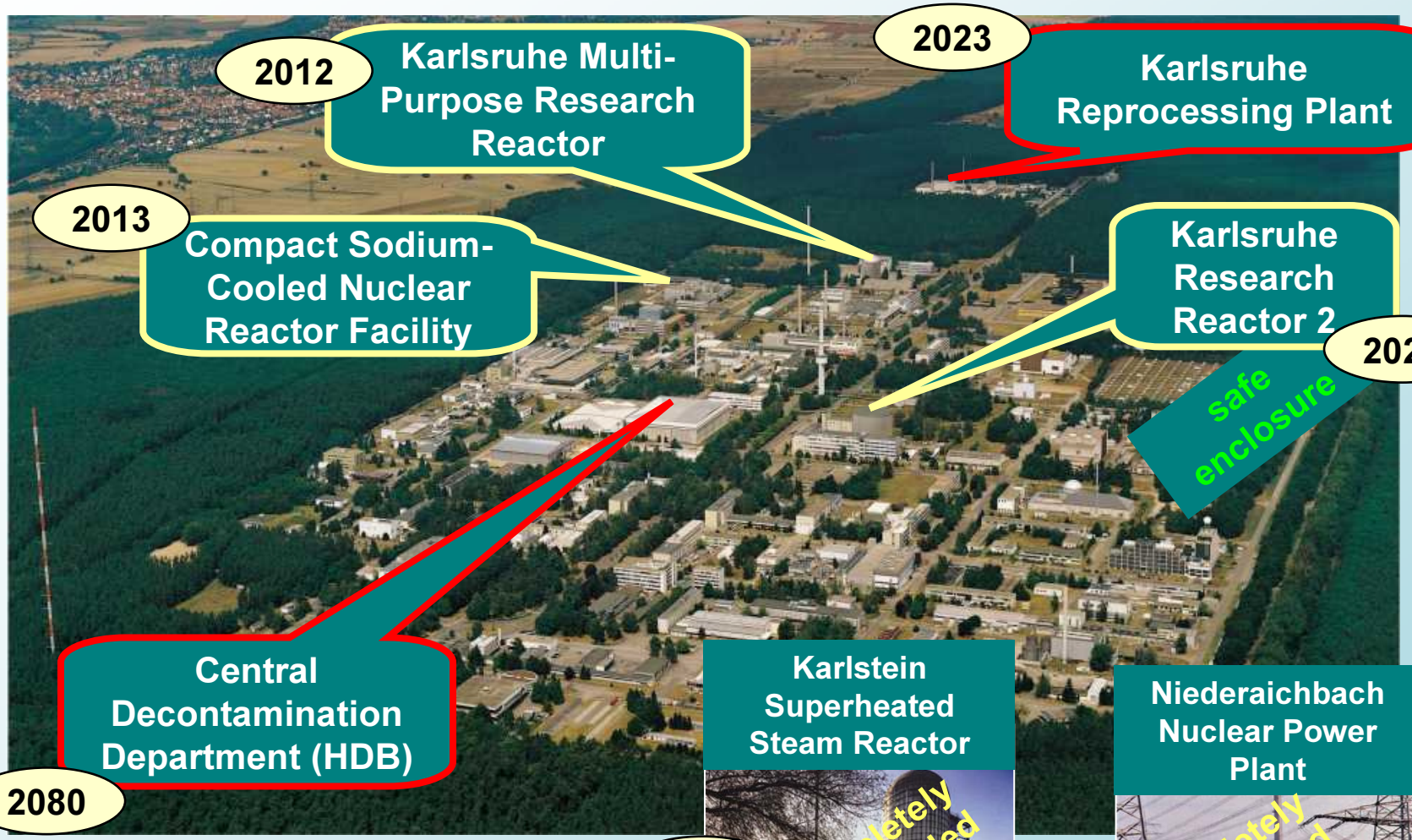
D2O-moderated research reactor
44 MWth (neutron source)
Operation 1961-1981

Dismantling of experimental loops primary and secondary system

Safe enclosure of the reactor block
1991 – 1996

Decision today
complete dismantling
- easy tools for remote dismantling available
- overall costs with dismantling after 30 year much higher

Nuclear Facilities Decommissioning Division at a Glance



Fuel Reprocessing Plant WAK

Reprocessing Building

- 2000 t of process equipment dismantled out of it 100 t remote controlled
- 1200 t of debris disposed
- 98% of the radioactive inventory (4,8E14 Bq) disposed of as low active waste (interim storage)

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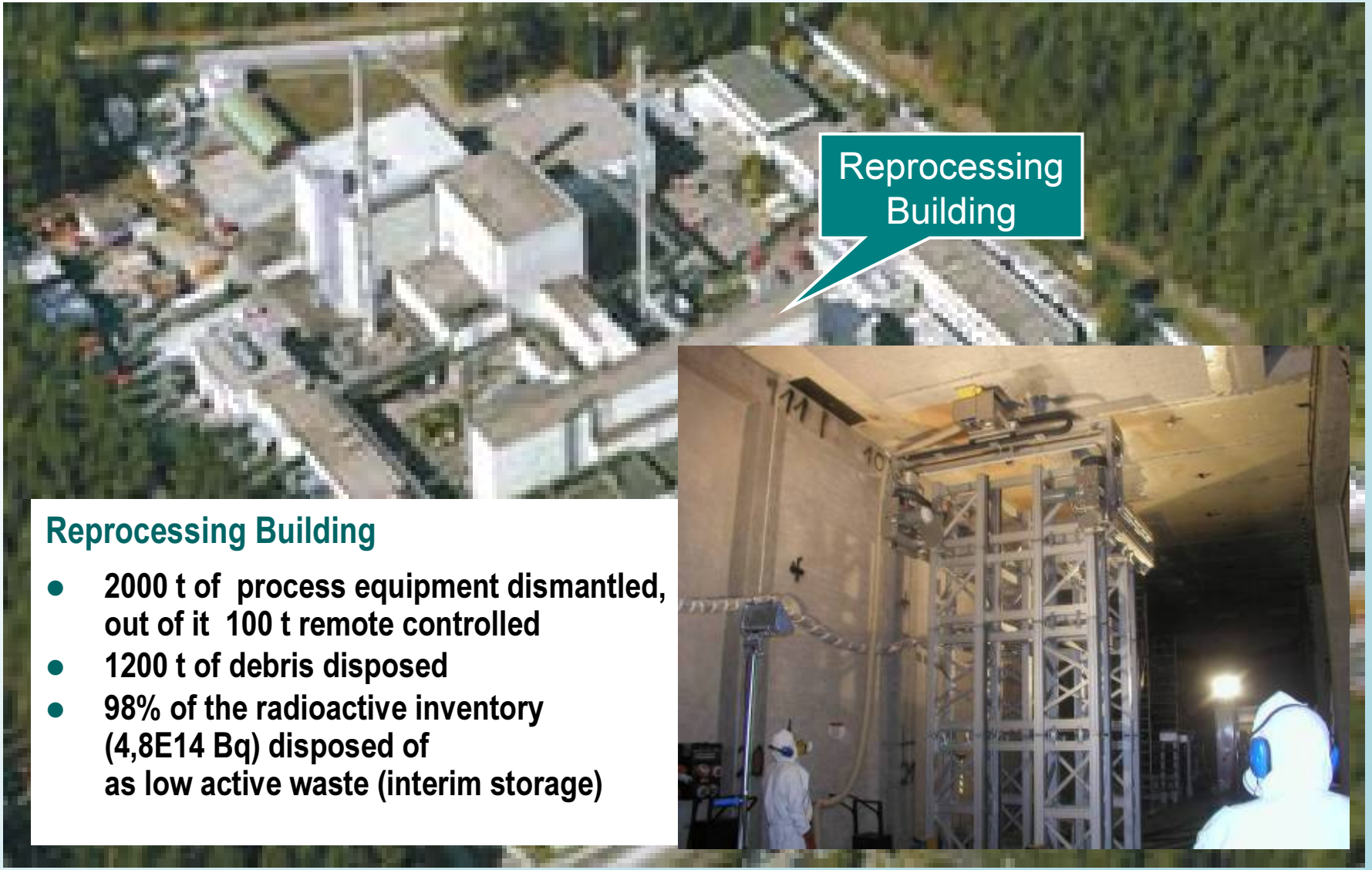

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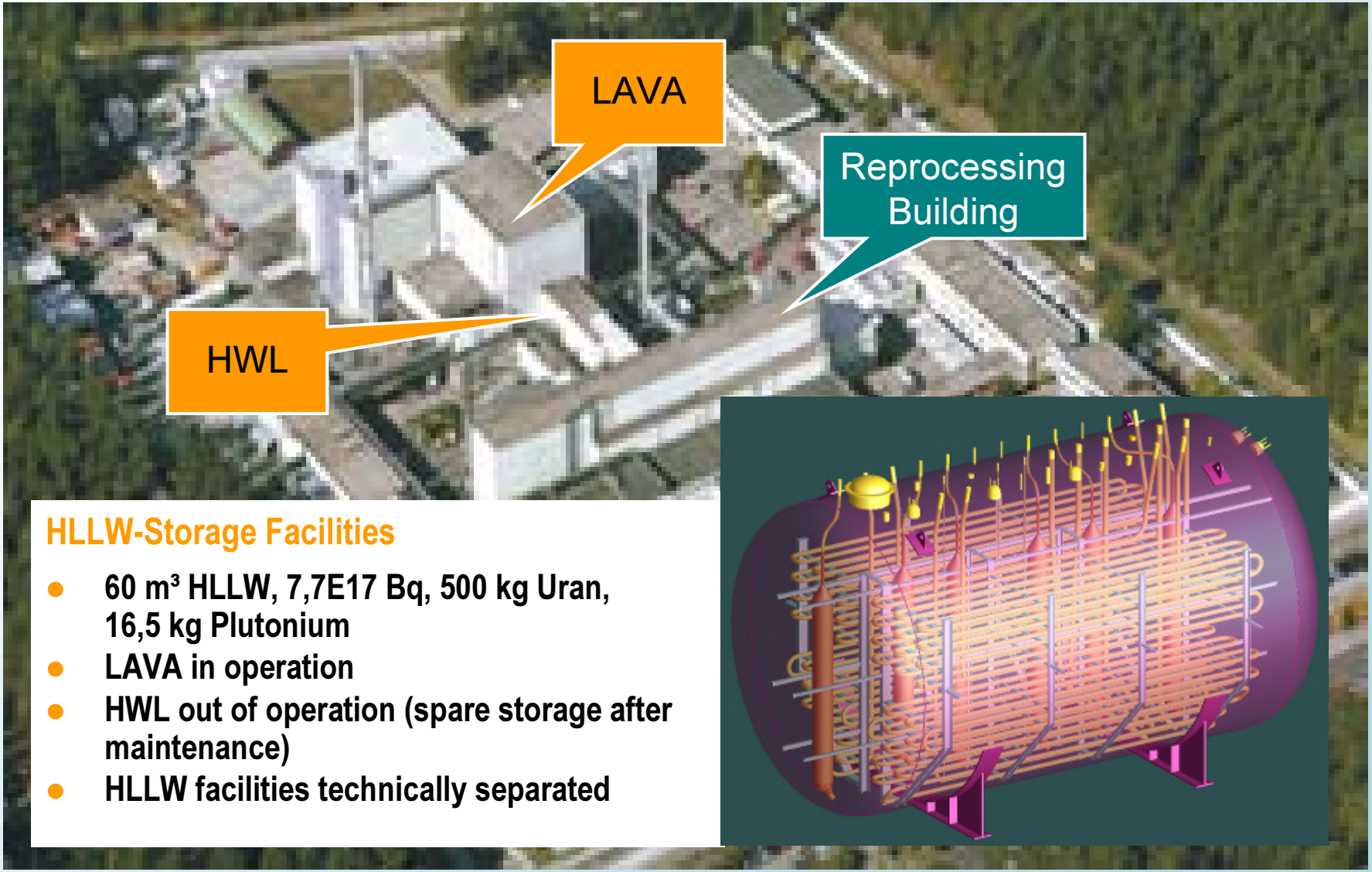
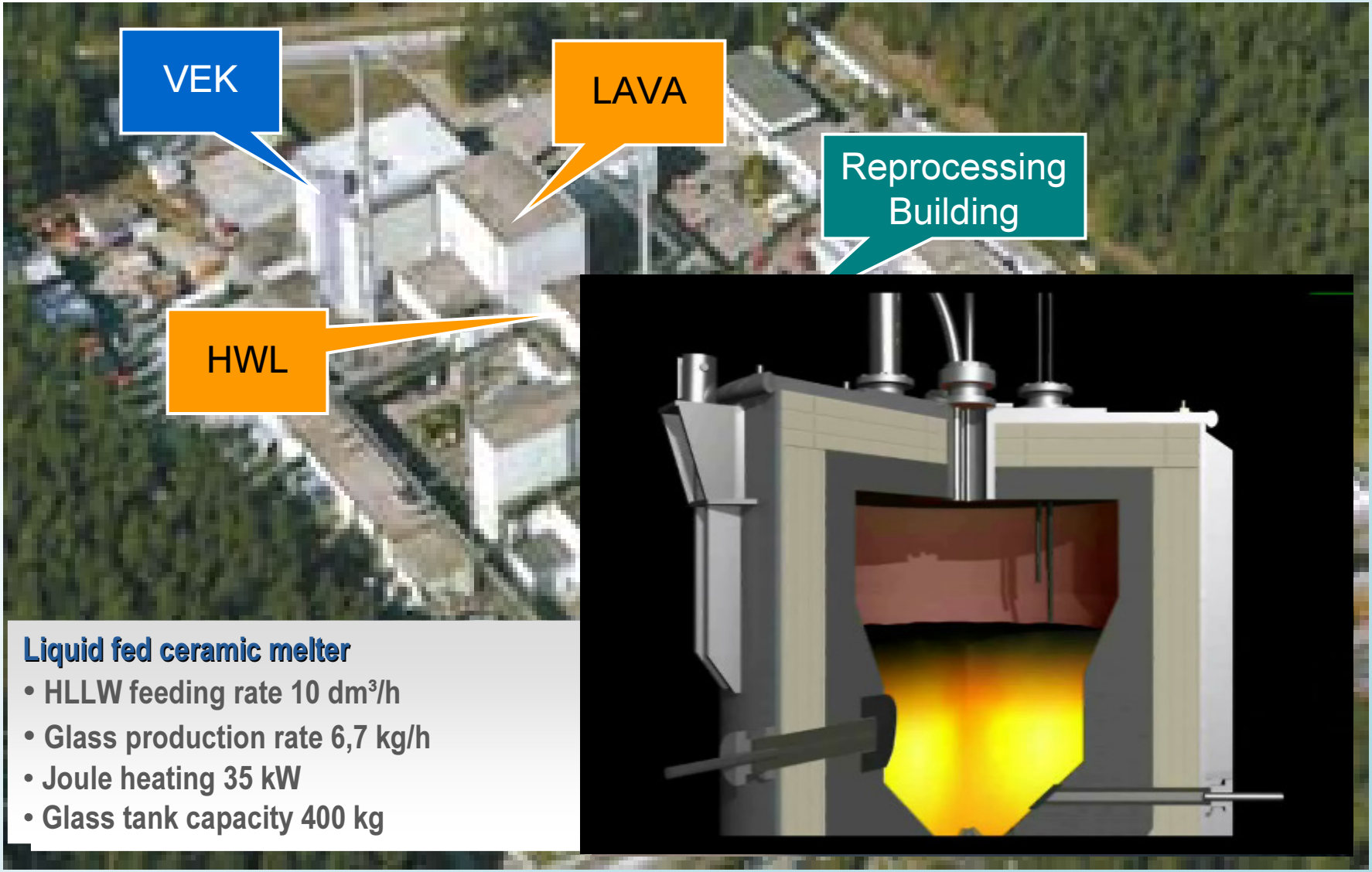


HLLW-Storage Facilities

- 60 m³ HLLW, 7,7E17 Bq, 500 kg Uran, 16,5 kg Plutonium
- LAVA in operation
- HWL out of operation (spare storage after maintenance)
- HLLW facilities technically separated

Fuel Reprocessing Plant WAK



Liquid fed ceramic melter

- HLLW feeding rate 10 dm^3/h
- Glass production rate 6,7 kg/h
- Joule heating 35 kW
- Glass tank capacity 400 kg

Waste Treatment and Storage at the EWN Group

Mother — **EWN GmbH**

Subsidiary — **AVR GmbH**

Subsidiary — **WAK GmbH**

waste production

NPP Greifswald

NPP Rheinsberg

waste treatment and storage

ZLN Greifswald

Research Center Jülich

Research Center Karlsruhe / HDB

final disposal

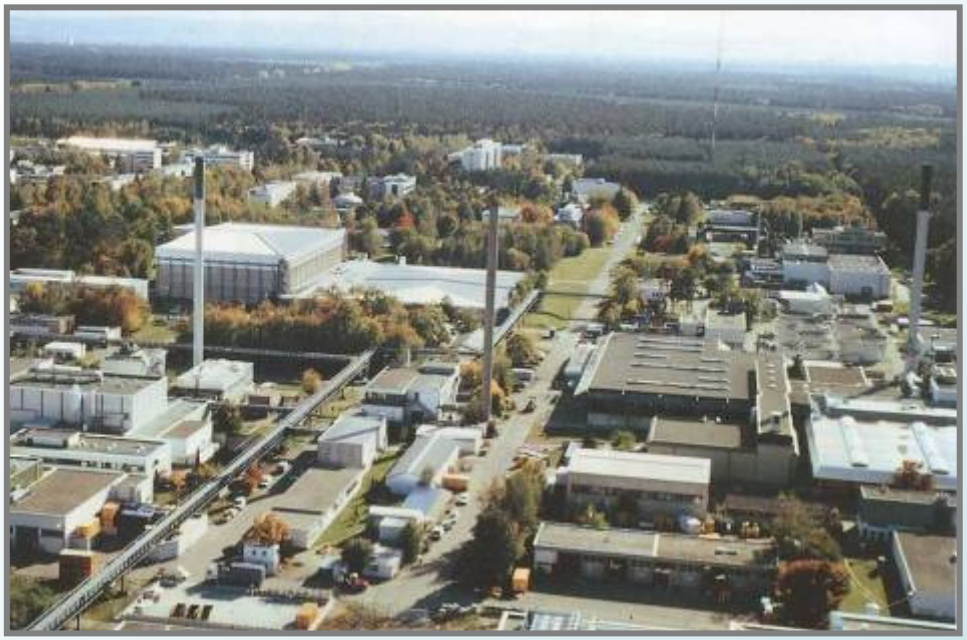
Gorleben (from 2040+)

KONRAD (from 2014)

ERAM (until 1998)

ASSE (until 1978)

Waste Management Facilities (HDB)



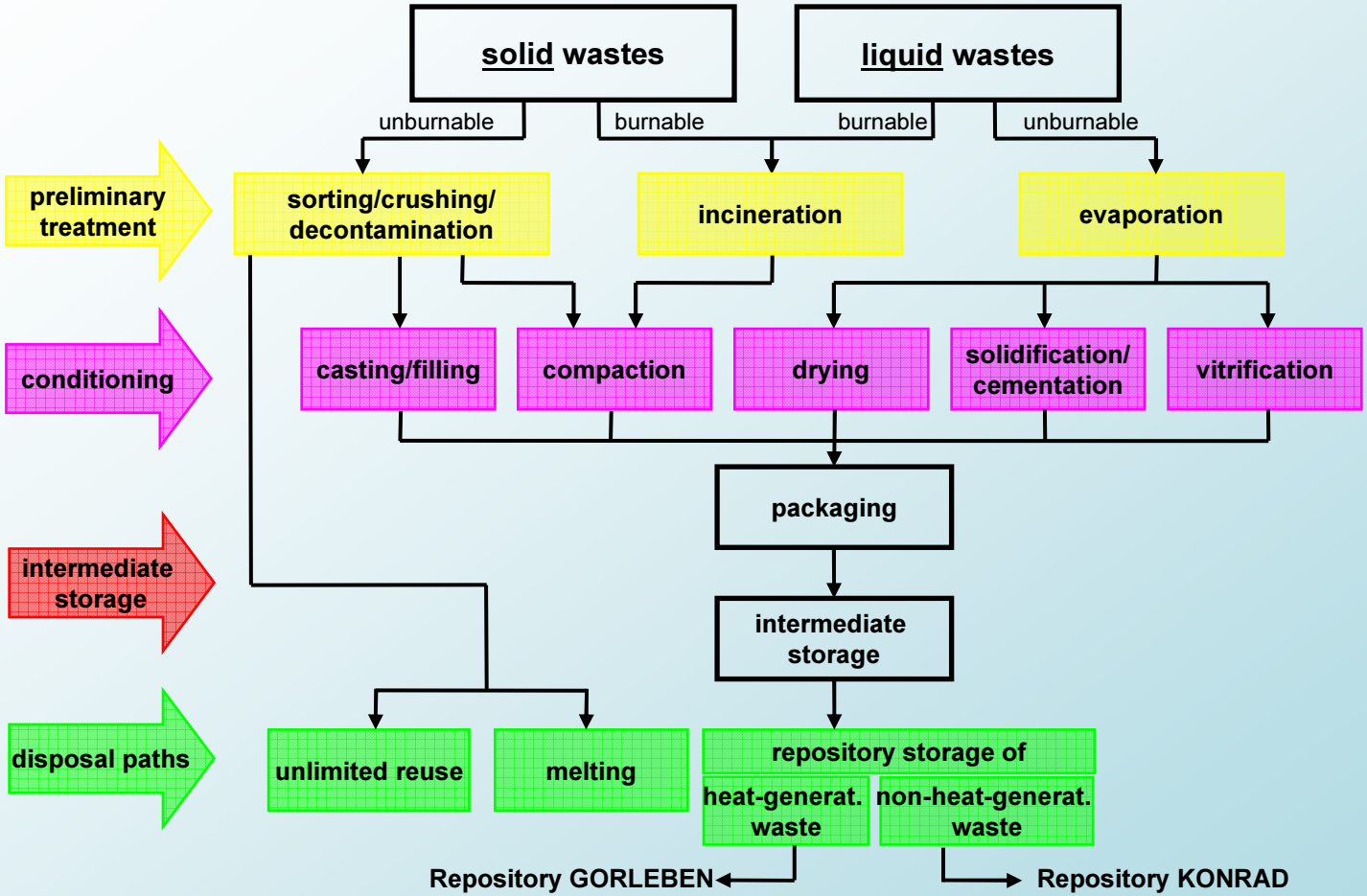
Compaction

Decontamination

Disassembling

ILW Handling

Radioactive Waste Processing Paths



Waste Management Facilities (HDB)

Product Control

Product Control

Interim Storage

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Preparing D&D Work

First Step:

- Complete recording of the nuclide inventory
  (nuclide composition / level of contamination)
- Documentation of construction and building
  (e.g. installation)

Second step:

- Upgrade of safety barriers
  (no spread of contamination outside and to the staff)
- Upgrade of ventilation systems including control systems of released radioactivity
- Upgrade of cranes

D&D Strategies

- Complete decommissioning including waste management
- Partitioning of the whole decommissioning project in different parts (manageable duration), each with own license
- Basic rules for D&D:
  - as simple as possible
  - if possible, using standard tools for dismantling

Waste Management

- If possible, waste management on site
- Necessary waste management facilities:
  - Treatment of liquids (evaporation, cementation)
  - Possibilities for decontamination and release of materials
  - Cementation of concentrates and solid waste
  - Super compaction
  - When indicated, facility for drying (increases long time stability of the waste)
  - Existence of adequate and proofed mobile facilities

Basic Conditions for Waste management

- Possibilities for clearance
  (to be established by authorities)
- Safe interim storage
  (even for longer periods of time)
- Final disposal

Waste Management

Immediate packing of the waste using

– Drums

– MOSAIK containers

– Containers (stackable and stable)

Summary

- Germany has a lot of D&D experiences
- Experience of the Karlsruhe Decommissioning projects and of waste management can be used for smaller nuclear facilities and laboratories

I wish you a pleasant week with a lot of impressions and information which are useful for your own decommissioning projects