The German Experience

International Seminar on
Nuclear Decommissioning
11-12 Dec 2014, Milano, Italy

Iris Graffunder
EWN GmbH

National Programme / Legal Basis in Germany

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- **Decommissioning, Fuel disposal, Waste treatment and Interim storage of Nuclear Installations**

Responsible: Operating companies → „Polluter-pays“ principle

Decommissioning costs: approx. 700 – 1000 million Euro per NPP

- **Final disposal (licensing, construction and operation of a repository)**

Responsible: **Government**

But: operators has to pay everything → „Polluter-pays“ principle

Estimated costs repository KONRAD (LAW+MAW): 7,5 billion Euro (incl. 40 years operation)

- **Problem**

No repository → longer iterim storage periods → increasing costs

NPP Situation in Germany before Fukushima

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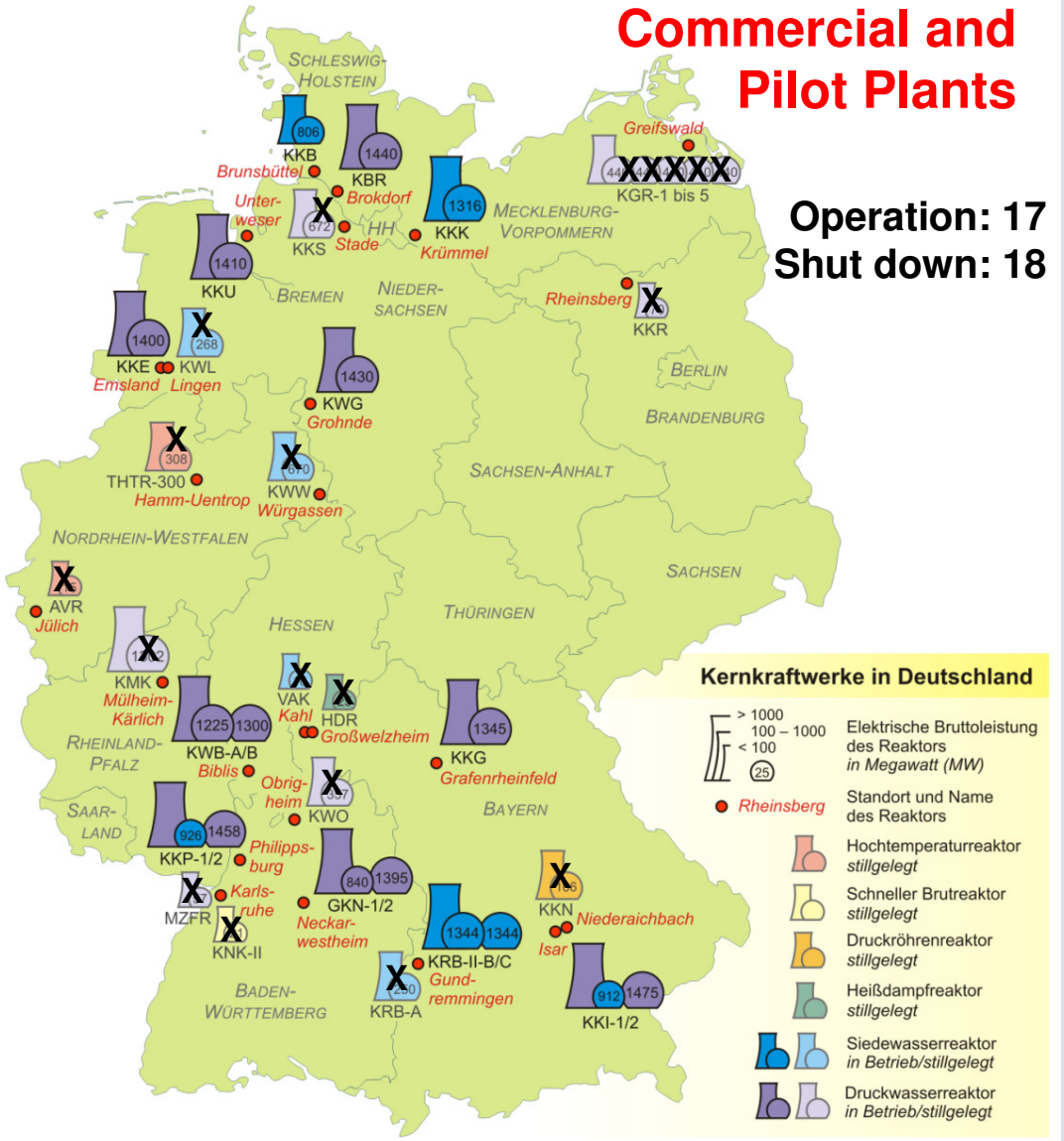
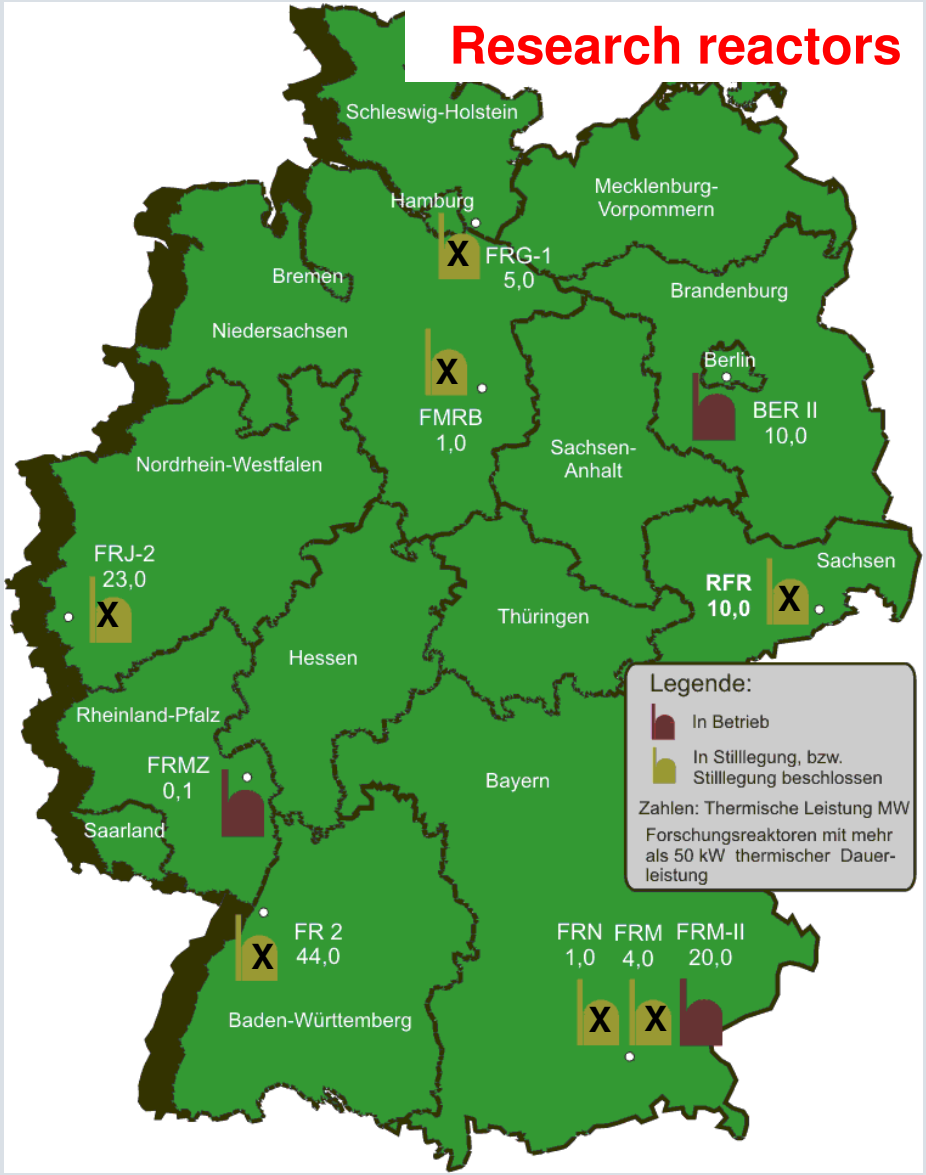
Commercial and Pilot Plants

Operation: 17
Shut down: 18



Research reactors



NPP Situation in Germany after Fukushima

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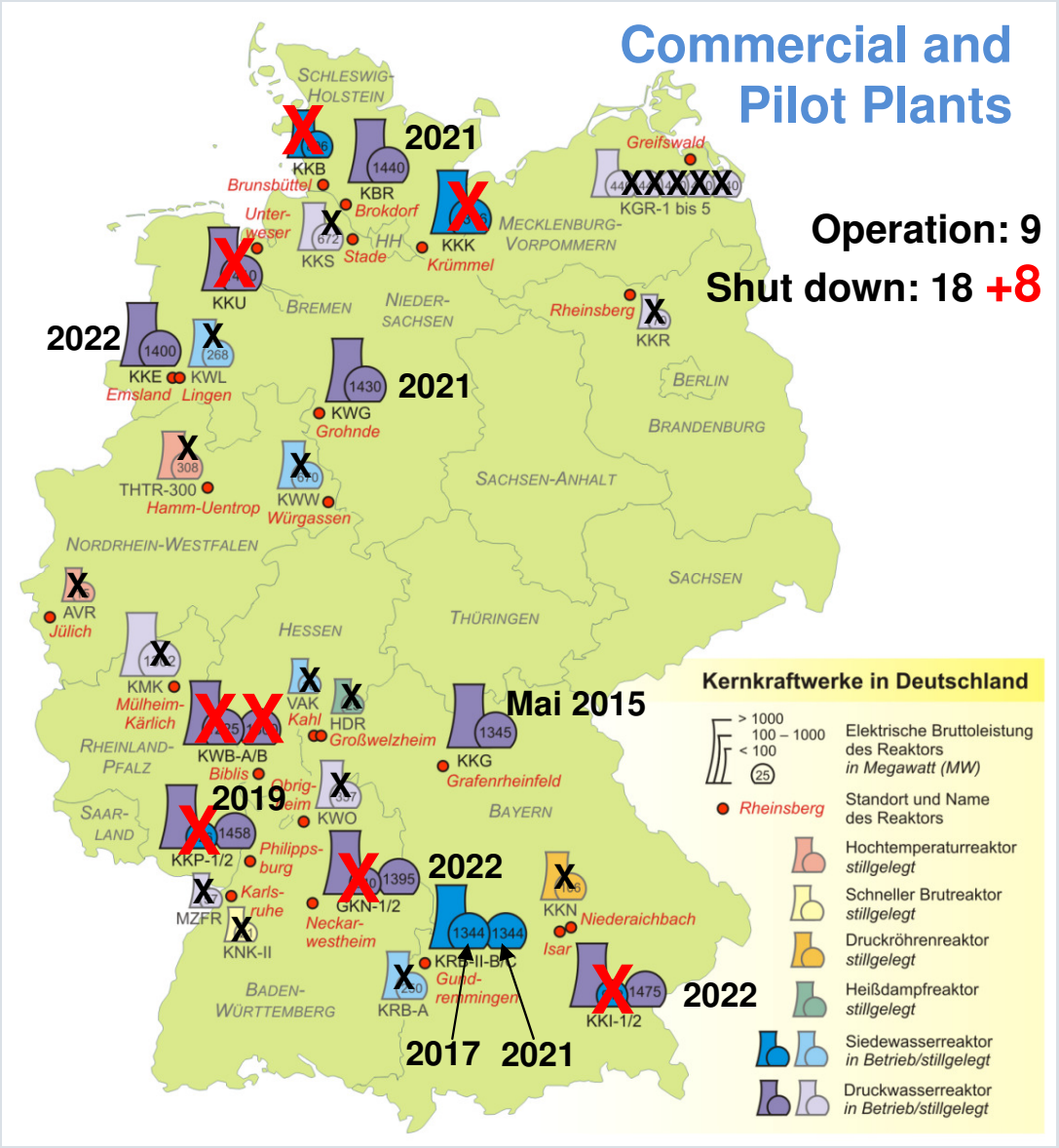

Shut down schedule

is fixed by law (revised Atomic law 24. Feb 2012)

Decommissioning Projects at EWN-Group

EWN Group is completely government-financed

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AVR GmbH
Subsidiary (from 2003)

WAK GmbH
Subsidiary (from 2006)
(since 2009: HDB, KNK, MZFR, FR2)

EWN GmbH
Parent Company

NPP Greifswald at Lubmin

NPP Rheinsberg

… and 25% Holding of DBE GmbH
(Building and operation company of federal facilities for final storage of radwaste) **since 2008**

Quantity of repository waste at EWN-Group

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	Parent Company EWN GmbH		Subsidiary AVR GmbH	Subsidiary WAK GmbH Including decommissioning projects and HDB
	NPP Greifswald	NPP Rheinsberg		
high level waste → Repository t.b.d.	61 CASTOR 440/84	4 CASTOR 440/84	152 CASTOR AVR	5 CASTOR HAW28M 4 CASTOR KNK several drums
low and medium level waste → KONRAD	7,790 m³	1,900 m³	4,821 m³	71,369 m³

Summation of KONRAD waste quantity: **85,880 m³**

→ corresponds to 77 % of public KONRAD waste quantity

and to 28 % of total KONRAD waste quantity

Decommissioning strategy at Greifswald Site …

… starts with waste management

- Construction of a large interim storage for spent fuel and waste → ZLN

Design of Interim Storage North ZLN

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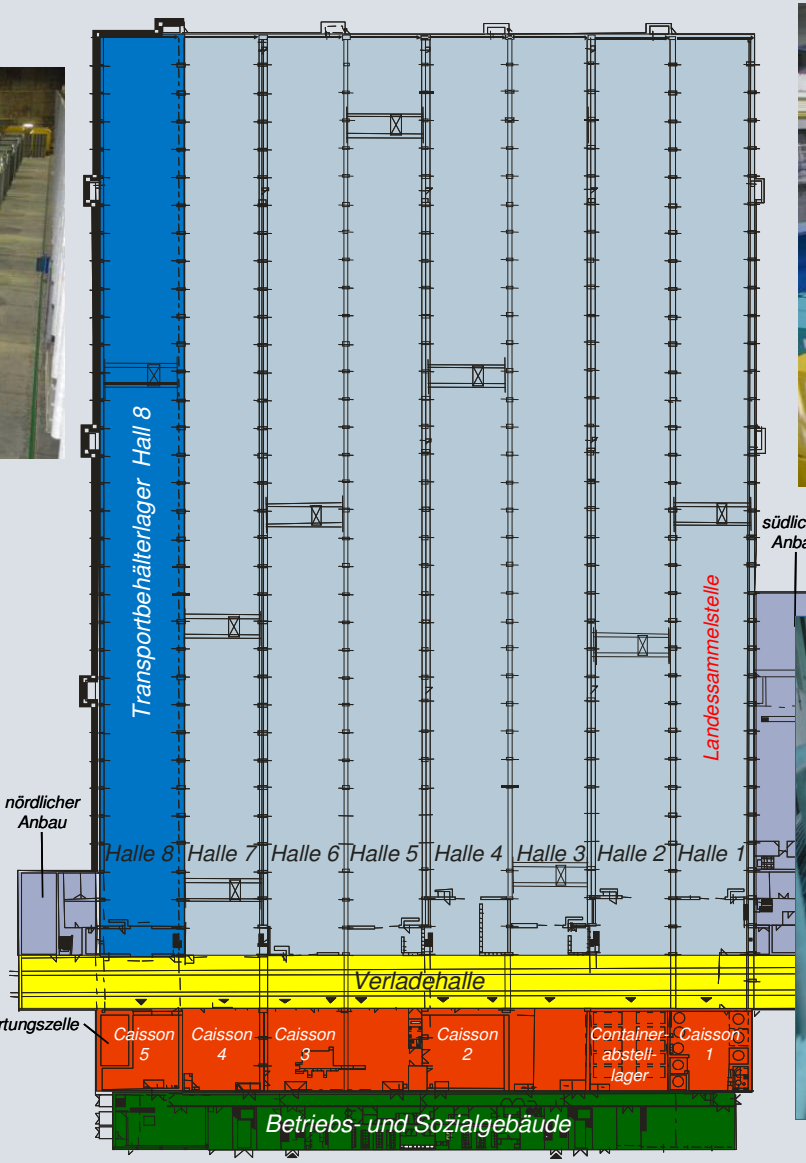
65 x CASTOR® 440

with VEK- and KNK-Castor casks



Container with mainly unprocessed waste

Removed vessels und steam generators

Decommissioning strategy at Greifswald Site

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- Packaging of spent fuel into CASTOR 440/84 casks and move it from reactor to ZLN
- Starting of dismantling in unit 5 with low contamination and low dose rate (for testing)
- Using equipment usual in the market
- In situ decontamination only for dose reduction not for free release
- Disassembly as large components as possible
  - steam generators
  - pressurizers
  - main cooling pumps etc.
- Storage of components at ZLN for decay and later treatment

Primary strategy for dismantling of reactor vessel

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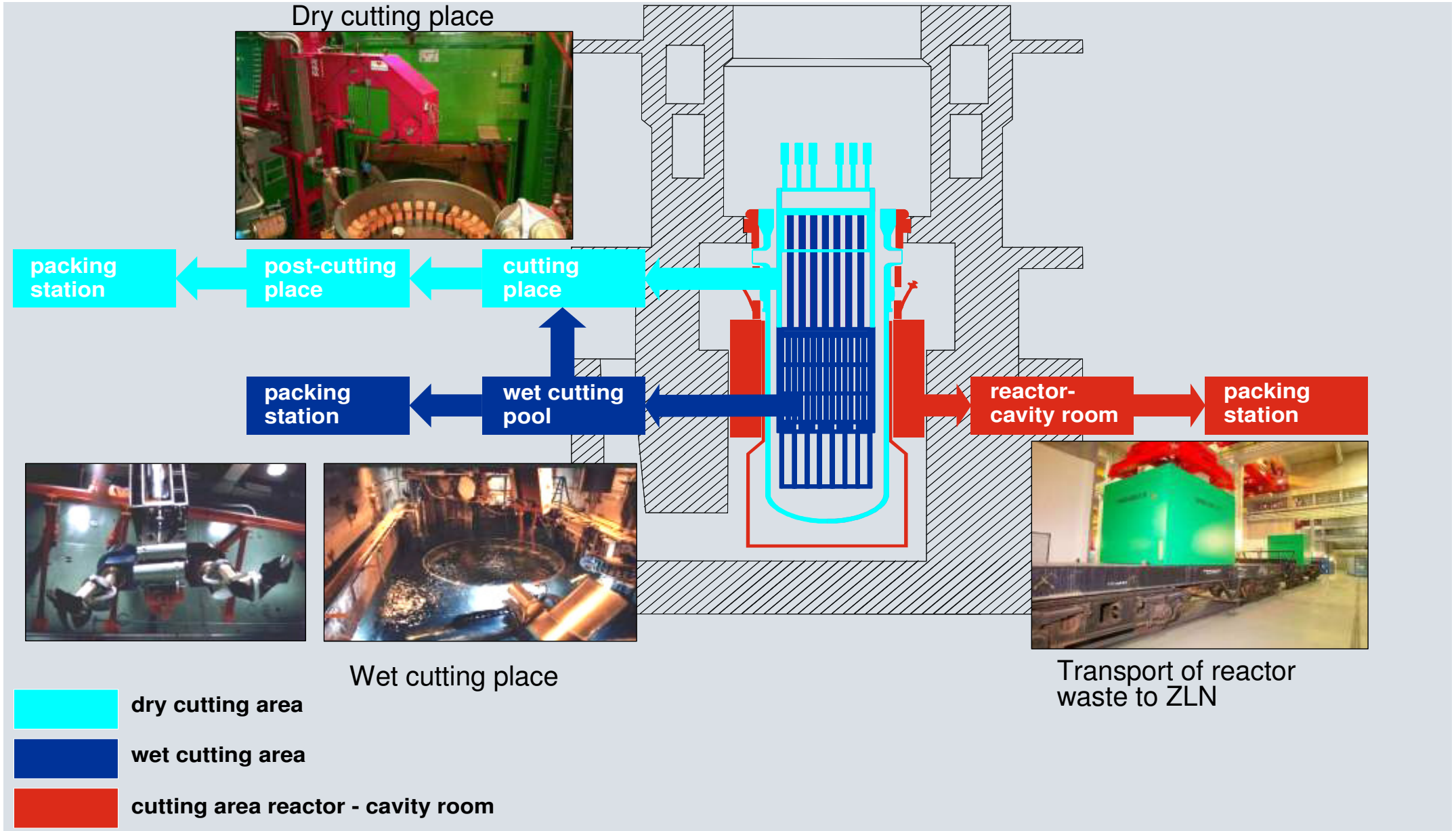

Changing strategy for dismantling of reactor vessels

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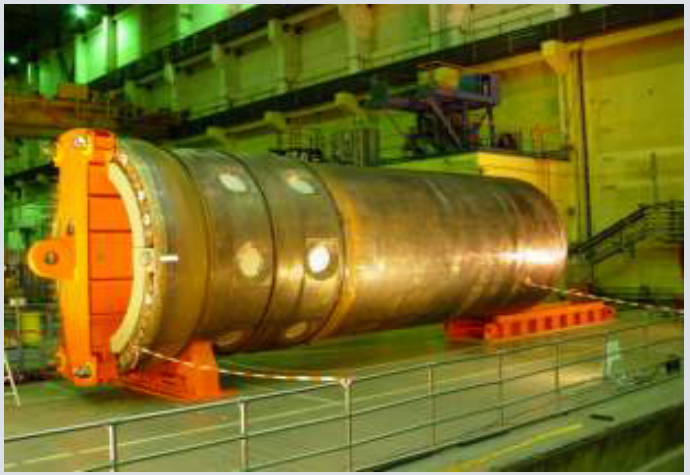
➔ Cutting the internals, but disassembly the vessel as large component (reactor 5)

Transport to ZLN



key data

- Length: approx. 12 m
- Diameter: approx. 4 m
- Weight: 214 Mg
- Total activity: 2.4 E+12 Bq
- Average specific total activity: 1.2 E+04 Bq/g

Changing strategy again for dismantling of reactor 3 and 4

➔ **Disassembly of the vessel with its internals as one large component**

Advantage:

- Economy of dismantling time
- Contamination minimization
- Using the vessel as shielding for the highly activated internals during storage at ZLN

Total Quantity of large EWN components at ZLN

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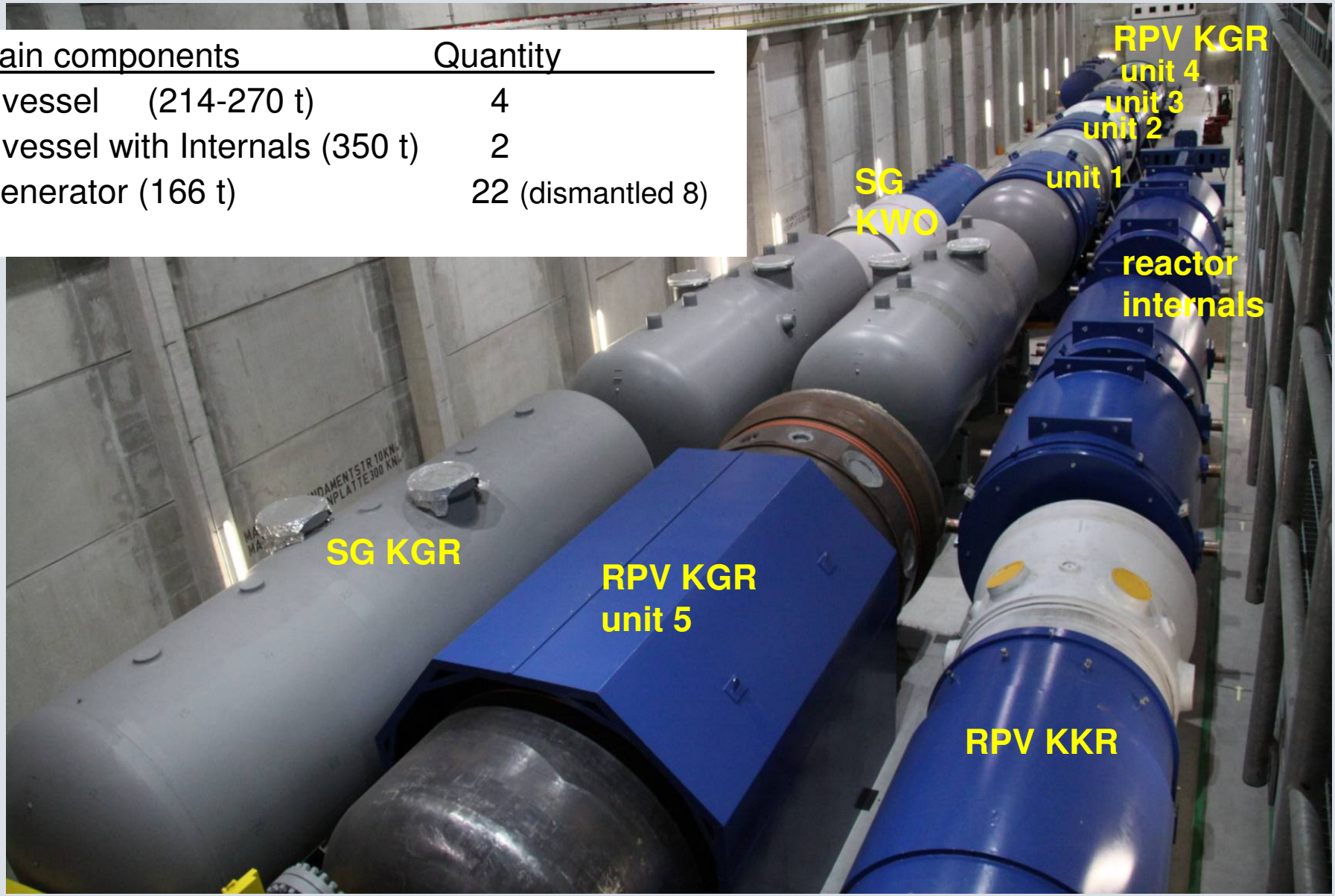
Large main components	Quantity
Reactor vessel (214-270 t)	4
Reactor vessel with Internals (350 t)	2
Steam generator (166 t)	22 (dismantled 8)



Waste management strategy in general

- Free release as much as possible (also burnable waste)
- Disassembling of components as large as reasonable possible to decoupling dismantling and waste treatment
- Quick completion of decommissioning work inside the reactor building and providing jobs at waste treatment facilities for many years
- Decay storage before treatment
- Decay storage of overload KONRAD containers
- Decay storage before free release (also building structure)

Application of know how: Management of decommissioning Russian's nuclear submarines

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Main goal: Safe and long term storage of 120 reactor compartments at Saida Bay and further treatment

Starting with the project 2003 at **Murmansk**

Expansion: Waste Managament Center (completion 2014)

Application of know how: Dismantling of Obrigheim NPP Reactor and Waste Management

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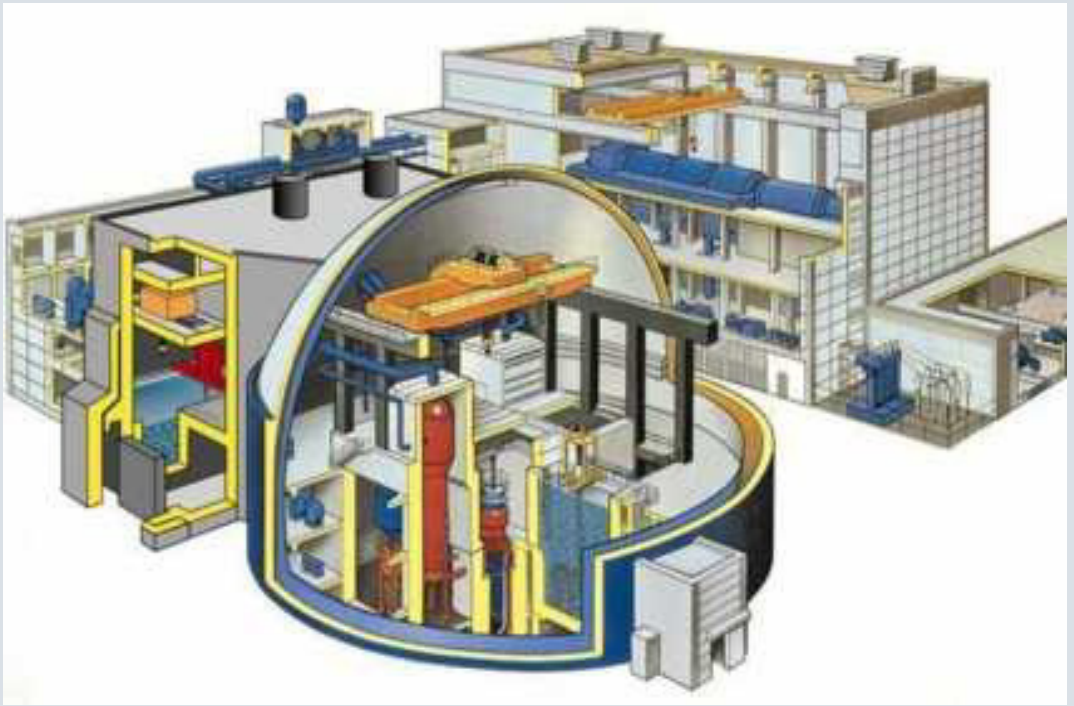
KWO – Kernkraftwerk Obrigheim

EnBW Owner:

Operation time: 1968 – 2005

Decommissioning since: 2008



Lessons learned (I)

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Important factors for decommissioning strategy

- radiological factors (dose rate, main nuclides, activation or contamination)
- geometrical factors (free space inside facility, structural calculation of the building, crane capacity)
- Existence of waste treatment and storage facilities
- Existence of repository requirements
- Existence of transport and/or storage casks

Important factors for saving money during decommissioning

- ☺ You can save **money** with the right choice of dismantling tools
- ☺ You can save **much more money** with the right choice of waste strategy

Lessons learned (II)

Important rules during decommissioning

- Waste management begins in the decommissioning planning stage, not after production of waste drums
- First question should always focus on **what kind** of waste you want to generate
- Second question is **how** and **where** to generate this waste (dismantling strategy, cutting methods and tools)
- If you already have a contaminated containment, cut the waste there
- If you have a rather clean containment, plan your decommissioning with the aim to generate and handle the waste with the lowest contamination dispersion and transport it to a waste treatment facility

Lessons learned (III)

Concrete structure decontamination and demolition

- Deep Penetration of contamination up to impact to static
- First performance parameters (0.2 m²/Mh) and surface area to be managed (105.000 m²/unit) show a 4 (!) times higher workscope than the workscope for dismantling the controlled area (without reactor)
- Same experience at EWN and WAK (Example: Remote controlled dismantling of the processing cells of reprocessing plant takes 2-3 years, decontamination and free measurement takes about 16 years)

➡ The often made statement “We are 90 % ready” after dismantling of the activated and contaminated components is not true!
With respect to the activity YES, but not with respect to the time schedule.

Common Challenges

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- **Missing final repositories in Germany**
  - has consequences to decommissioning strategy, dismantling sequences and waste management
  - leads to long term interim storage of fuel and substantial cost increases at all storage sites in Germany

- **Long time schedule of decommissioning projects** leads to
  - Needs of generation change management including know how transfer
  - Expensive facilities refurbishment due to new security requirements
  - Additional costs for prolongation/ adaptation of licenses

Thank you for your attention

Safety and Responsibility.
For Decades.