THE DISPOSAL OF
LOW- AND INTERMEDIATE-LEVEL
RADIOACTIVE WASTE IN GERMANY

Dr. Enrique Biurrun
DBE TECHNOLOGY GmbH
1. Historical Outline
- Nuclear power research start in the fifties and sixties
- Kahl NPP (BWR, 16 MWe) starts operating in 1961
- Commercial nuclear power use since the late sixties
  - 1968 Obrigheim, (PWR, 357 MWe)
  - 1974 Biblis A, (PWR, 1225 MWe)
- 19 Commercial NPPs were built, ~ 22,000 MWe
- Nuclear Electricity in the Public Grid ~ 33% in 1998
Milestones in Waste Disposal

- 60’s: All waste must go to Deep Geological Repositories

- Asse Test Repository
  Commissioned in 1967
  Operational until 1978

The Worldwide First Deep Geological Repository

- 1979 Federal Council Decision on Waste Management:
  “Entsorgungsnachweis” Condition for NPP Operation
**Repository Development**

- **Morsleben**: Operational Waste (1980’s until 1998)
- **Konrad**: Non heat-generating waste, under construction
- **Gorleben**: Heat-generating waste, underground survey starts 1990’s
- **Asse** mine used only as URL since 1978, currently under decommissioning
2. Later Developments
Effect of the TEPCO Fukushima Daichi Incident

The TEPCO Fukushima Daichi NPP incident changed completely the view of nuclear power in Germany

- The incident received very high coverage in all media
- Media do not refer to the *Great Easter Japan Earthquake and Tsunami but to the Fukushima Catastrophe*
- After Fukushima all parties vowed to abandon nuclear power
  - 8 NPPs 8,846 MW were immediately ordered to stop
  - For the remaining 9 NPPs fixed phase out dates were ordered (12,696 MW)
**Phased Out Nuclear Power Plants**

1. **Biblis A and Biblis B**: RWE Power (1225, 1300 MWe)
   License appl. for decommissioning: August 6\(^{th}\), 2012

2. **Biblis B**: RWE Power (1300 MWe)
   License appl. for decommissioning: August 6\(^{th}\), 2012

3. **Brunsbüttel**: Vattenfall, E.ON, (806 MWe)
   Outage since July 2007, license appl. for decommissioning: November 1\(^{st}\), 2012

4. **Isar 1**: E.ON (912 MWe)
   License appl. for decommissioning: May 10\(^{th}\), 2012

5. **Krümmel**: E.ON, Vattenfall (1402 MWe)
   Outage since June 2007, license application for decommissioning pending
6. **Neckarwestheim 1**: EnBW (840 MWe)
   Phased out by direction of the Federal Government since March 16th, 2011

7. **Philippsburg 1**: EnBW – KKP-1 (926 MWe)
   Phased out by direction of the Federal Government since March 16th, 2011

8. **Unterweser**: E.ON (1410 MWe)
   E.ON declared in spring 2011 the phase out of the plant, license application for decommissioning pending
## Nuclear Power Plants Currently in Operation

<table>
<thead>
<tr>
<th></th>
<th>Plant Name</th>
<th>Power (MWe)</th>
<th>Shutdown Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Grafenrheinfeld</td>
<td>1345</td>
<td>2015</td>
</tr>
<tr>
<td>2.</td>
<td>Gundremmingen B</td>
<td>1344</td>
<td>2017</td>
</tr>
<tr>
<td>3.</td>
<td>Philippsburg 2</td>
<td>1468</td>
<td>2019</td>
</tr>
<tr>
<td>4.</td>
<td>Brokdorf</td>
<td>1480</td>
<td>2021</td>
</tr>
<tr>
<td>5.</td>
<td>Grohnde</td>
<td>1430</td>
<td>2021</td>
</tr>
<tr>
<td>6.</td>
<td>Gundremmingen C</td>
<td>1344</td>
<td>2021</td>
</tr>
<tr>
<td>7.</td>
<td>Isar 2</td>
<td>1485</td>
<td>2022</td>
</tr>
<tr>
<td>8.</td>
<td>Neckarwestheim 2</td>
<td>1400</td>
<td>2022</td>
</tr>
<tr>
<td>9.</td>
<td>Emsland</td>
<td>1400</td>
<td>2022</td>
</tr>
</tbody>
</table>
3. LILW Disposal in Germany
Two Repository Projects:

- one for LILW and one for HLW / spent fuel and

1. Konrad deep repository for non-heat-generating waste (LILW), fully licensed, under construction

2. Gorleben exploration mine and prospective repository for heat-generating waste (HLW), now in moratorium

and two special cases:

1. Morsleben deep LILW repository in the former East Germany, awaiting the license for decommissioning

2. Asse test repository mine (LILW), under decommissioning (not in the scope of DBE)
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965–1976</td>
<td>Iron ore production approx. 7 mil. t; Deposit: ~ 1.4 billion t</td>
</tr>
<tr>
<td>1975</td>
<td>Preliminary survey as candidate site</td>
</tr>
<tr>
<td>1982</td>
<td>Site Suitability statement and License Application submitted</td>
</tr>
<tr>
<td>09/92 - 03/93</td>
<td>Public hearing (75 hearing days)</td>
</tr>
<tr>
<td>14.06.00 / 17.07.01</td>
<td>Consensus Agreement - <em>Finishing licensing procedure</em> - <em>Withdrawal immediate enforcement</em></td>
</tr>
<tr>
<td>01.08.01</td>
<td>Radiation Protection Ordinance amendment</td>
</tr>
<tr>
<td>05.06.02</td>
<td>LICENSE GRANTED</td>
</tr>
<tr>
<td>2002-2008</td>
<td>Litigation</td>
</tr>
<tr>
<td>2008-2010</td>
<td>Start of Repository Construction</td>
</tr>
<tr>
<td>2013/2014</td>
<td>First Planned DISPOSAL START</td>
</tr>
<tr>
<td>2021</td>
<td>Currently Likely Disposal Start</td>
</tr>
</tbody>
</table>
Konrad Repository
Radioactive waste
- with negligible decay heat
- of national origin
- 303,000 m³ packaged waste
- $5.0 \cdot 10^{18}$ Bq $\beta$- and $\gamma$-emitter
- $1.5 \cdot 10^{17}$ Bq $\alpha$-emitter

Period of operation
- 30 to 40 years

Start of operation
- not before 2021

- waste packages with restricted masses and dimensions → max. 20 tons
- Delivery by road or rail
- Transport units
  → box-shaped Containers
  → pallets with 1 or 2 cylindrical containers
- annual average disposal rate → 10,000 m³ waste volume
Konrad Repository Equipment
Konrad Repository Shaft 2
Konrad Repository Disposal Sequence

Abwettersammelstrecke
Entladekammer
Einlagerung von Containern
Einlagerung von Rundgebinden
Herstellen einer Versatzwand
Pumpversatz

Einlagerungstransportstrecke
Sturzversatz

versetzte Einlagerungskammer

Dr. E. Biurrun Presentation at INAC 2013
Recife, November 25-29, 2013

DBE TECHNOLOGY GmbH
Shaft Station Construction (Konrad 2)
**Morsleben Repository**

1970 Bartensleben mine selected as repository
1971 Start of trial disposal (LLW)
1974 Approval of repository construction
1981 / 1986 1st and 2nd permanent operation licenses
10 / 1990 Morsleben repository a Federal Facility under BfS, operated by DBE
1991 Disposal stop, refurbishment
1994 Disposal restarted
09 / 1998 Waste acceptance interrupted
05 / 1999 Waste disposal terminated
Licensing procedure only for closure
11 / 2000 Advanced backfilling - repository closure to follow
2011 Public hearing
2015 License for closure?
Morsleben Repository
Morsleben Repository
4. Repository Projects outside Germans
Richard Repository (Czech Republic)
Mochovce Repository (Slovakia)
Mochovce Repository (Slovakia)

Kozloduy Repository (Bulgaria)
Kozloduy Repository (Bulgaria)
Thank you for your kind attention!