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Site visit Garzweiler Operations
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### Agenda

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Paris Agreement on Climate Protection

For the first time ever, all parties agreed to:

- Peak global emissions as soon as possible and reduce then
- Keep global temperature rise "well below 2°C Celsius" above pre-industrial levels and "pursue efforts to limit the temperature increase to 1,5°C Celsius"
- Submit **Nationally Determined Contributions** (NDCs) every 5 years (as from 2020)
- Undergo a **global "stock take" =** measurement and reporting of emissions every 5 years (as from 2018)
- Fund climate projects in **developing countries** with 100 billion Dollars annually provided by developed countries

But they did not set up **any kind of sanction** in case of non-compliance with the NDCs...

Next steps:

- **Ratification** – minimum 55 countries accounting for 55% of global emissions
## EU Climate Policy Framework

<table>
<thead>
<tr>
<th></th>
<th>Greenhouse gas emissions</th>
<th>Renewable energy</th>
<th>Energy efficiency</th>
</tr>
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<tbody>
<tr>
<td>... until <strong>2020</strong></td>
<td>20 %</td>
<td>20 %</td>
<td>20 %</td>
</tr>
<tr>
<td>Reduction base year</td>
<td>1990</td>
<td>Share of energy consumption</td>
<td>Improvement as opposed to business as usual projections</td>
</tr>
<tr>
<td>... until <strong>2030</strong></td>
<td>40 %</td>
<td>27 %</td>
<td>27 %</td>
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<tr>
<td><em>(mandatory, national targets)</em></td>
<td>Reduction base year 1990</td>
<td><em>(mandatory, no national targets)</em></td>
<td><em>(indicative, no national targets)</em></td>
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<tr>
<td></td>
<td></td>
<td>Share of gross energy consumption</td>
<td>Absolute reduction compared to business-as-usual scenarios</td>
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- European Council agreed on new targets for 2030 / new European “Energy Union“ is based on these
- Emissions Trading Scheme (ETS) and national targets (“effort sharing“) have to be reformed accordingly
Impact of Paris Agreement on EU Climate Policy

The EU as forerunner!?  
- EU submitted target of at least 40 % CO2 reduction by 2030  
- Pushed for the 5 yearly review mechanism

What will come after COP21?  
- Debate on ETS reform is gearing up – fundamentals are questioned:
  - Increase ambition of CO2 reduction
  - Stronger call for protective measures (carbon leakage, exemptions for some countries)
  - Regular review and adjustment of ambition level

- So-called effort sharing has to be decided
  - Contribution for each Member State for the non-ETS sectors in the form of national binding targets
  - 2030 framework foresees variation from 0 - 40% emission reduction
The slump in prices on the German wholesale market is continuing – pressure on power plants persists
The German “Energiewende” - targets of the Federal Government

- Reduction in greenhouse gas emissions from 1990 levels
  - 2020: -40%
  - 2025 to 2050: -80 to -95%

- Reduction in electricity consumption from 2008 levels
  - 2020: -10%
  - 2025 to 2050: -25%

- Share of renewables in electricity supply
  - 2020: 35%
  - 2025: 40 to 45%
  - 2035: 55 to 60%
  - 2050: 80%
Promotion of renewables through the Renewable Energy Act (REA)

Fixed remuneration for feeding in renewable energy for the first 20 years of production

The grid operators are obliged to take all the renewable energy offered at once and with priority (§ 8 REA)

The plant operator is paid for the renewable energy by the local grid company at the REA feed-in tariff; the four German transmission system operators provide for the marketing of the power via the exchange at the market price, which is typically lower than the feed-in tariffs under the REA

The coverage gap (feed-in tariff less market price) is passed on by the sales companies to the consumers by raising an REA levy
Climate levy fended off, security stand-by agreed: Five 300-MW units will shut down in four years' time

<table>
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<th>Power-plant units in security stand-by</th>
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<td>01.10.2016</td>
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(x MW) in net capacity

Period of security stand-by

Time of shutdown

The shutdown of five lignite-fired units is a decisive turning point for RWE: decline of power generation based on Rhenish lignite by some 15%, as a result CO₂ emissions in the mining area will be reduced by about 12.3Mt (gross) in 2020
Overview – German electricity mix

Gross power production in 2015: 647,1 bn kWh

- Lignite: 24%
- Natural gas: 18.2%
- Nuclear: 14.1%
- Renewable: 30%
- Other/oil: 8.8%

Changes 2015/10 in bn kWh

- Nuclear: -49
- Renewables: 89
- Lignite: 9
- Hard coal: 1
- Natural gas: -32
- Other/oil: -4

Energy mix after 2022

- Renewables: 35%–45%
- Natural gas, coal: 55%–65%

Lignite is a mainstay of Germany's electricity supply

Lignite, hard coal and RES closed the capacity gap formed in 2015

Lignite will also be a mainstay of the energy mix of the future
Coal in Europe 2013
lignite production, hard coal production & imports

EU-28 million tonnes
- lignite 407
- hard coal 114
- imports 216

Source: EURACOAL members – * 2012 data
Note: bars show million tonnes of coal equivalent (Mtce) while figures at top of bars show millions of physical tonnes (Mt)
Germany has considerable lignite reserves even by international standards.
Power plant renewal progressing as planned
BoA* 1-3 make lignite fit for the future

- 3,000 MW in new-build units (BoA 1-3) started operation between 2003 and 2012; highest standard for lignite-fired plants world-wide
- All sixteen 150 MW units in the Frimmersdorf, Niederaussem and Weisweiler power plants were finally closed down 31/12/2012
- CO₂ savings of some 9 Mt/a

Approval procedure for BoAplus involving a further efficiency boost is underway

* Braunkohlekraftwerk mit optimierter Anlagentechnik
(lignite-fired power plant with optimised plant engineering)
We devise Climate Protection with Lignite

- By 2020 five power plant units will be in security stand-by
  - CO₂ emissions reduced by ~ 15%

- 2020 – 2030 further options to reduce CO₂ through:
  - Increase of efficiency by building BoAplus
  - Decrease of full load hours in power
  - Decommissioning of additional 300 MW units
  - CO₂ emissions reduced by an additional ~5-15%

- Around 2030 Weisweiler power plant will be taken off the grid, combined with the planned closing of Inden mine. After that, our power plants will be supplied from Garzweiler and Hambach mines
  - CO₂ emissions reduced by a further ~ 20%

- In total, CO₂ emissions from lignite will be reduced by 40-50% by around 2030
- Then a decrease of electricity generation depending on the future increase of renewables
- By the middle of the century electricity will be generated in BoA plants

Hence the use of lignite in the Rhenish area is in accordance with the national and European climate protection targets!
Flexible lignite-fired power plants

- **BoA 1-3 new-builds**

- **Planning and approval of BoAplus**

- **Modernisation of existing power plants**

Lignite is becoming a strong and reliable partner to renewables, balancing fluctuating PV- and wind-based power generation.
Regulating short-term fluctuations from energy generated by wind power - example Feb. 2015

- Flexibility proven (reduction/increasing of load)
- Grid stabilized by lignite fired power plants
- No interruption of heat supply
The refining business offers additional markets

Raw lignite input of ~ 15 Mt/a

- Refining to make pulverised lignite and fluidised-bed lignite, lignite briquettes and lignite coke of about ~ 5.5 Mt/a
- Generation and external marketing of ~1.1 TWh\textsubscript{th} heat/a
- Power generation (net) of 1.9 TWh/a

Refining offers opportunities for value creation outside the electricity market
Lignite can help replace gas and oil production of a wide variety of products. Example: CtL/CtG process.

Key technologies:
- Drying
- Gasification
- Gas treatment
- Synthesis

Alternative routes:
- Synthesis gas
- Ammonia
- Methane
- Methanol
- Basic chemicals*
- Motor fuels
- Waxes

Other energy sources:
- Option: H₂ use

* Naphtha, acetic acid, formic acid, carboxylic acid, hydrogen, …
Lignite - answers to the challenges of our time

In power generation and refining today:

- Lignite-fired power plants are as flexible as modern gas plants, which makes them an ideal partner to renewables
- As a domestic raw material, lignite reduces Germany's import dependence

As a carbon supplier in future:

- Raw material supply of the chemical industry is largely based on mineral oil and natural gas today
- Chemical industry can diversify its raw material base with lignite, with prices remaining stable over the long term

Outlook: Helping to overcome imbalance of soil fertility

- Blending liquid manure with lignite could help to reduce the problems of groundwater pollution

→ Rhenish lignite also offers options for replacing imported energy sources and for supplying the chemical industry with carbons in the long run
Rhenish lignite-mining area in 2015

Lignite system
- Output: some 90–100Mt/a
- Power generation: some 70–75TWh/a
- Upgraded products: some 5Mt/a for distributed use
- Some 10,000 employees

Unit class | Share
---|---
300MW | 1/3
600MW | 1/3
BoA | 1/3

Weisweiler/Inden stand-alone operation
- Weisweiler (1,800MW\(^{*\dagger}\))
- ~14TWh/a

Joint supply of power plants and upgrading facilities via North-South railway
- Some 8,100MW, output some 60TWh/a
- Upgrading: some 5.5Mt dry lignite/a

Mineral Output Reserves
- Garzweiler: 35–40Mt/a, 1.2bnt
- Hambach: 35–45Mt/a, 1.4bnt
- Inden: 20–5Mt/a, 0.3bnt

\(^{1)}\) NRW's share: 40%, Germany: 13%
Lignite is a major economic factor in the region

EEFA study: employment effects of Rhenish lignite

- Triggered employment effects
  (indirect, income-induced) factor about 2.11

- Jobs at RWE Power in lignite mining and power generation

2015 at a glance: data and figures on the Rhenish mining area

- Direct jobs
  ~ 10000

- Apprentices
  ~ 600

- Gross payroll
  (lignite) > € 800 Mio.

- Value of orders placed in the region
  (RWE Power to 3,500 contractors) ~ € 800 Mio.

Sources: own calculations; EEFA study: Importance of Rhenish lignite – sectoral and regional employment and production effects
Schematic diagramm of a lignite opencast mine in the Rhenish mining area

Bucket-wheel excavators extract overburden layers before mining coal.

Belt conveyors connect spreaders and coal bunkers.

Spreaders dump the extracted overburden and ensure the continuous rehabilitation of land.

Mine slewing around a centre ensures optimal deposit utilisation and keeps operational and impacted areas to a minimum.
Water management measures
Using more than 50% of the pumped water for ecological purposes

Power Plants: 45 m³/y
Dewatering: 110 m³/y
Infiltration: 60 m³/y
Dust Control: 5 m³/y
Recultivation in the Rhenish mining area is regarded as exemplary worldwide

In the Rhenish mining area, more than 22,000 ha have already been recultivated, including more than 8,600 ha for forests and green corridors.

Compared with the situation prior to the land being used for mining purposes, areas for industry, settlements and roads have been reduced; instead new, attractive recreational areas have been created.

Studies of flora and fauna have identified more than 2,200 animal and over 700 plant species in the recultivated areas, including 429 animal species threatened by extinction.
Relocation of the river Inde
Biodiversity-protection measures – examples

Silvicultural measures

Linking structures

Park-like, semi-open landscape

Measures in the open landscape
The future development of lignite calls for diverse activities to ensure public acceptance.

- **Recultivation**: Careful rehabilitation enables re-use for leisure, nature, agriculture and forestry.
- **New kinds of recultivation and promotion of structures**.
- **Coal information centre**: Research for more efficiency, cleaner power plants and avoiding CO₂ emissions.
- **Development of residential building land**: Innovative project development throughout the mining area.
- **Renewable energies in the Rhenish mining area**: Development of wind and photovoltaic projects.
- **Industry and SME**: Promotion of industrial and SME structures by relocation of jobs.
- **Wide range of information available**: Use of all media to inform about businesses and processes plus extensive opportunities for viewing.

Public acceptance depends on dialogue at all levels and highly visible projects and activities in the region.
Sustainable Recultivation
Industrial area „Mühlenerft“ – new landscape for new jobs
Recultivation Garzweiler
Current REA projects

RWE-Windenergie im rheinischen Revier

Freiland-Photovoltaikanlagen Kerpen-Buir und Hüth

- Investitionen: 2.5 Millionen Euro
- Leistung: 5 MW

<table>
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<tr>
<th>Daten und Fakten Windpark Königshoever Höhe</th>
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<tbody>
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<td>Baubeginn 1. Phase (12 Anlagen, 38 MW)</td>
</tr>
<tr>
<td>Inbetriebnahme 1. Phase</td>
</tr>
<tr>
<td>Baubeginn 2. Phase (6 Anlagen, 29 MW)</td>
</tr>
<tr>
<td>Installierte Gesamtleistung</td>
</tr>
<tr>
<td>Rechnerisch versorgte Haushalte jährlich</td>
</tr>
<tr>
<td>Investitionsvolumen</td>
</tr>
<tr>
<td>Windkraftanlagen</td>
</tr>
<tr>
<td>Nabenhöhe/Gesamthöhe</td>
</tr>
<tr>
<td>Vollamphöhe</td>
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Hambach forest: Attacks on employees and partner firms increasing

As regards the protests, RWE sets store by the safety of everyone involved!
RWE will not accept unlawful actions.
Lignite Mining Plan of Garzweiler II
A consistent mine concept forms the basis of review and approval by regional planning authorities

- Mining engineering
- Water management
- Relocation of roads
- Resettlements
- Recultivation

Key figures:

- Lignite deposit:
  - Field size: 48 km²
  - Lignite reserves: 1.3 bn t
  - Stripping ratio: 5 : 1

- Production:
  - Lignite production: 35 - 40 m t/y
  - approx. 1,725 employees / 150 trainees & apprentices

- Resettlement / relocation:
  - People: approx. 7,600
  - Townships: 13
Garzweiler II – the guideline decision process has entered the public consultation phase

Guideline decision on Garzweiler

- Draft guideline draft decision attests to the necessity of lignite for the energy supply after 2030
- But less so than before: the resettlement of the district of Holzweiler, the small settlement of Dackweiler and Hauerhof farm is no longer required
- Safety line extended to 400m

State of affairs:

- Guideline decision draft presented 29/09/2015
- Online consultation concluded
- Completion scheduled for spring 2016

Lignite remains an important part of our energy mix: we are holding on to Garzweiler and are proactively assisting with the process!
Garzweiler Opencast Mine

### Facts and figures

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<tbody>
<tr>
<td>Time of operation</td>
<td>until 2045</td>
</tr>
<tr>
<td>Employees</td>
<td>~ 1,500</td>
</tr>
<tr>
<td>Operating area</td>
<td>31 km²</td>
</tr>
<tr>
<td>Overburden (GRZ II)</td>
<td>6.5 Mrd. m³</td>
</tr>
<tr>
<td>Coal (GRZ II)</td>
<td>1.3 Mrd. t</td>
</tr>
<tr>
<td>O/C-ratio</td>
<td>5 : 1</td>
</tr>
<tr>
<td>Max. depth</td>
<td>210 m</td>
</tr>
<tr>
<td>Annual production</td>
<td>35 - 45 Mio. t</td>
</tr>
<tr>
<td>Resettlements</td>
<td>13</td>
</tr>
<tr>
<td>Inhabitants</td>
<td>~ 7600</td>
</tr>
<tr>
<td>residual lake</td>
<td>23 km²</td>
</tr>
<tr>
<td>End of refilling process</td>
<td>2080</td>
</tr>
</tbody>
</table>
Garzweiler Opencast Mine
Geological situation

1. West-East profile
2. North-South profile
Reconstruction of the A 44n
Mine position in 2017
Emission control
fighting dust and particulate matter
Thank you for your attention!