RWE´s IGCC CCS Project
Zero-CO$_2$ Fossil-Fired Power Generation

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Power Generation of RWE Power

Market shares in European power generation (EU-25)
- E.ON 7%
- EdF 20%
- ENEL 7%
- Vattenfall 5%
- RWE 8% (RWE Power 6%, npower 1.7%)
- Other 55%

Power generation capacity of RWE Power* (35 GW)
- Lignite 31%
- Hard coal 28%
- Gas 12%
- Nuclear 18%
- Hydro/other 11%

incl. electricity purchased from third parties; *as of 31/12/2004

RWE is No. 2 in Europe with a wide energy mix.
RWE´s Clean Coal Power Strategy

Horizon 1

Applying worldwide highest standards for power station renewing

(Further) developing advanced power plant technology

Horizon 2

Efficiency enhancement for CO₂ reduction (primary measure)

Horizon 3

Bringing the CO₂-free Power Plant and storage to technical maturity

CO₂ capture and storage (secondary measure)
Innovation lines of RWE´s Clean coal Power Strategy

for today
- Efficiency increase via new built power plants recent BoA 2/3, HC Twin Unit

Power Plant Fleet: Permanent Renewal

for tomorrow
- WTA-Prototype
- 700 °C-Test Units
- First dried lignite fired PP
- First CO₂-free IGCC
- 700 °C Demo-PP

for the day after tomorrow
- New Project: 450 MW ZEIGCC with CO₂-capture
- New Project: Post combustion CO₂-Capture
- First Retrofit/ New Building with CO₂-Capture
RWE strengthens its technology leadership and sets trend in zero-CO$_2$ power plant technology

Decisions dealing with CCS

1. RWE Power develops and builds a zero-CO$_2$ 450 MW coal-fired power plant based on IGCC technology incl. CO$_2$ transport and storage; commissioning is scheduled for 2014.

2. In parallel, RWE will develop the technology of CO$_2$ scrubbing for future advanced coal-fired steam power plants and as a retrofit option for modern installations.
   - RWE Power with focus on CO$_2$ scrubbing for lignite
   - RWE npower with feasibility study for a clean coal 1,000 MW hard coal-fired plant in Tilbury and CO$_2$ scrubbing tests for hard coal.
The RWE project of a zero-CO₂ 450 MW coal-fired power plant with CO₂ storage

- Basic technology: IGCC
- El. capacity: 450 MW\(_{\text{gross}}\) 360 MW\(_{\text{net}}\)
- Net efficiency: 40 %
- CO₂ storage: 2.3 mill. t/a
- CO₂ storage in depleted gas reservoir or saline aquifer
- Commissioning: 2014
- RWE budget: approx. € 1 billion
RWE´s IGCC - CCS Project
Overall concept

Essential Features
- Fuel: Rhenish lignite, ~ 350 t/h
- Single train concept
- Capacity: 450 MW gross (F-class GT) / ~360 MW net
- CCS design, with option to run without capture
- Gasification: preferably entrained flow technology, HTW as backup option
- Total investment costs including storage : ~ € 1.0 bn
For RWE IGCC is the most attractive Route to the CO₂-free Power Plant

- High Efficiency
- High technical Maturity
- High Product Flexibility

\[ \text{Gasifier} \rightarrow \text{Gas treatment} \rightarrow \text{CO₂ capture} \rightarrow \text{CCGT} \]

Fuel flexibility
- Gas
- Coal
- Biomass
- Waste

Product flexibility
- CO₂
- Electricity
- Heat
- \( \text{H₂} \)
- Synthesis gas (CO+\( \text{H₂} \))
- SNG
- Methanol
- Motor fuels

IGCC opens up additional options for portfolio optimization.
CO₂-freies IGCC-Kraftwerk mit CO₂-Speicherung

Vergasung → Wasserstoff → Gas- und Dampfturbine → Strom

Kohle
ca. 100 – 1.500 m

CO₂
ca. 1.000 – 3.000 m

Aquifer, alte Öl-, Gaslagerstätte (Norddeutsche Tiefebene)

H₂O

450 MW_{brutto}
Development of CO\textsubscript{2} storage site
Tasks and current status of work

- **Phase 1: Selection of storage site (2006-2008)**
  - Setting up the storage site portfolio
  - Analysing basic methods for evaluating storage potentials
  - Detailed feasibility study for 2-3 selected sites

- **Phase 2: Evaluation of storage sites (2008-2010)**
  - 3D seismics of potential storage sites
  - Exploration drilling, formation tests
  - Selection of a storage site, application + approval

- **Phase 3: Construction of storage facility (2011-2014)**
  - Production drilling
  - Trial operation, if appropriate
  - Surface facilities, pipeline
Research and implementation of CO₂ storage is the critical element of CCS success

Storage site development is new ground in many aspects. Potential storage sites are depleted gas reservoirs and deep saline aquifers in Germany.

Technical challenges
- There are no recognized methods for the identification and suitability evaluation of storage sites and, in particular, their long-term tightness.
- High uncertainty as regards costs and time needs due to geological imponderabilities.
- Injection of 2 mill. t CO₂/a would currently be the largest volume world-wide.

At present, there are no legal bases for CO₂ storage
- Applicable rule of law is unclear and regulatory framework below the law level is lacking.
- Fundamental rules are open, e.g. right of access to storage site, liability issue….,
- Consideration of CCS in the CO₂ regulatory framework required after 2012.

⇒ • Development of storage standards throughout the project by review with power generators, oil and gas industry, politicians and authorities.
  • In-depth work in bodies on national and EU levels.

Public acceptance must be reached.
⇒ • Develop a communications and acceptance strategy.
  • Seek division of work between politicians, authorities, companies and NGOs.
RWE’s IGCC - CCS Project

Time Schedule

Power plant

- Preselection of Technology
- Fixing of location
- Project development
- Engineering, approval procedure
- Approval
- Decision to build
- Construction, commissioning
- First grid connection
- Start commercial operation
- Test operation
- Test operation
- Start commercial operation
- Approval

CO₂ storage

- Screening, exploration, approval procedure
- Construction, commissioning
- Test operation

Timeline:

- 05/2006: Preselection of Technology
- 08/2007: Fixing of location
- 08/2008: Project development
- 12/2010: Engineering, approval procedure
- 10/2014: Approval
- 09/2015: Decision to build
- 08/2008: Start basic engineering
- 12/2010: Approval
- 09/2015: Construction, commissioning
- 09/2015: Test operation
- 09/2015: Start commercial operation
RWE’s IGCC - CCS Project

Climate Change is a global problem

- Full scale commercial projects must be brought on track to promote a rapid deployment of Zero Emission technologies.

- RWE has decided to take the leadership and realize a CO₂-free IGCC Power Plant in a commercial scale being commissioned in 2014.

- With focus on the IGCC project RWE Power appreciates any kind of support by R&Ds and integration of national and international projects for those tasks that are not on the critical path.

- As a prerequisite for the deployment of the technology, the missing legal basis for CO2 Transport and Storage, must be established on national and EU level soon.