Large Scale CCS Demonstration – Status and Outlook of RWE's 450MW IGCC CCS Power Plant

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Sharp rise in coal consumption for power generation by 2050 – Only CCS can compensate additional CO₂ emissions

Business as usual => high additional global CO₂-Emissions due to electricity production

![Chart showing CO₂ emissions and efficiency improvements](chart.png)

New technologies for CO₂-reduction

Note: CCGT - combined cycle gas turbine; IGCC - integrated gasification combined cycle turbine; CCS - carbon capture & sequestration

Quelle: International Energy Outlook 2006; http://www.eia.doe.gov; BCG analysis
RWE’s Clean Coal Power Strategy

For today: Deployment of most advanced technology

- Construction of highly efficient power plants; 2,200 MW raw lignite, 3,200 MW hard coal

Power plant portfolio: continuous renewal

For tomorrow: Further efficiency increase

- Lignite pre-drying (WTA prototype)
- 700°C test plants

Commercial use

For the day after tomorrow: Implementation of CCS

- 450-MW IGCC CCS plant
- PCC development for conventional power plants
450 MW IGCC CCS plant: Main process features

- **Fuel:** Rhenish raw lignite
- **Coal drying & milling:** WTA technology plus roller mill
- **Gasification:** Quench gasifier (~ 1,000 MW\(_{th}\), 40 bar)
- **Gas treating:** Sour shift, H\(_2\)S/CO\(_2\) unit, Claus, CO\(_2\) compression
- **Gas conditioning:** Dilution with N\(_2\), H\(_2\)O
- **CCPP:** F class technology; diffusion burner

Most of the individual processes are proven technologies today. The demonstration of their interaction is decisive.
450 MW IGCC CCS plant: Key performance data

**Raw lignite 370 t/h**

- **Gas island**
- **Power island**
- **455 MW**
- **$\eta_{\text{gross}} = 48.5\%$ (LHV)**

**Gross capacity 455 MW**
- **ST (160 MW)**
- **GT (295 MW)**
- **Auxiliaries (135 MW)**

**Net capacity 320 MW**

- **ASU (49 MW)**
- **WTA (19 MW)**
- **Gas cleaning + comp. (21/30 MW)**
- **Others (16 MW)**

**$\eta_{\text{net}} = 34\%$ (LHV)**

- **Total CO$_2$ input based on coal**: 2.85 mill. t/a (7,500 h)
- **CO$_2$ captured**: 2.6 mill. t/a (92% capture rate)
- **CO$_2$ emitted**: 0.25 mill. t/a
- **Specific CO$_2$ emissions**: 107 g/kWh$_{\text{net}}$
450 MW IGCC CCS plant: Erection at the Goldenberg location near Cologne

> A location with a long tradition: 12 years of industrial-scale coal gasification / synthesis gas production (HTW\(^1\))
> Commitment to lignite – Connection to the opencast mines via railway
> Developed Infrastructure

\(^1\)High-temperature Winkler process
450 MW IGCC CCS plant: Carbon storage

> Screening of the onshore and offshore storage potential by RWE DEA completed.

> Suitable storage formations are located in the north-west and north-east Germany

> Max. storage potential: 20 Gt (BGR)

> The exploratory phase has started in March 2008 and comprises seismic investigations of preselected storage sites

> Start of exploratory drilling in 2009/10
450 MW IGCC CCS plant: CO$_2$ pipeline

- Pipeline length of 530 km (330 miles) required
- Initial pressure: 200 bar, no booster compressor
- Pipeline diameter: 16”-32”
- Use of an existing route corridor if possible
- Study verifies technical feasibility
- Communication concept developed

The risks of public acceptance call for a comprehensive communication concept.
450 MW IGCC CCS plant: Legal issues

The project urgently needs a specific regulatory framework

> The existing CCS directive by the EU is a positive basis for the next steps to be taken.

> The directive must be transposed into national law by mid-2009.

> Essential requirements from the operator point of view
  - Experience gained from demonstration projects have to be taken account of in the regulatory framework
  - Accelerated planning and building law for CO₂ pipelines
  - Financial guarantees for stored CO₂: adequate, risk-dependent, and time-limited
  - Financial support of the Federal Government in a pipeline infrastructure
450 MW IGCC CCS plant: Important steps for implementation

**Power plant (Gas island + power island)**
- At present: selection of contractors for PDP / FEED and suppliers of gasification and gas turbine.
- After FID: engaging of EPC contractors

**Pipeline:**
- At present: start of regional planning procedure (Raumordnungsverfahren)
- Subsequently: formal public planning procedure (Planfeststellungsverfahren) and construction

**Storage facility:**
- At present: seismic investigations
- Subsequently: exploratory drilling, approval, and construction

Commissioning at the end of 2014/the start of 2015 if a regulatory framework is developed in time and if the approval procedure duration is appropriate...
450 MW IGCC CCS plant: Capital costs

Overall plant €2,220 m

- Storage facility €180 m
- Pipeline €430 m
- Power island €480 m
- Gas island €1,130 m

Basis:
- Indicative quotations for plant sections
- 2008 price basis in nominal terms
- Accuracy of estimate: +/- 25%

Causes of the cost rises:
- Longer pipeline
- General market price development for equipment in the energy industry
The increase in capital costs of the project is in line with the global trend.
450 MW IGCC CCS plant: Electricity generation costs

> Confirmation of the typical “economic gap” of demonstration plants
> Prospect of bridging the gap in large-scale applications necessary
# 450 MW IGCC CCS plant: Cost reduction potential of future large-scale plants

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IGCC CCS plants: Commercial perspectives

Commercial CCS plants can become commercially viable. The high costs and risks of the demonstration plant require support.

Electricity generation costs in €/MWh*

**CO₂ avoidance costs**

\[
\frac{(80 - 5) - (81 - 41)}{(0.85 - 0.1)} \text{ €/MWh} = 46 \text{ €/t CO₂}
\]

First IGCC/CCS plant: approx. 35%

Future large-scale CCS plants:

Dry lignite-fired PP (700°C) without CCS:

Market perspective: 70 - 80

*) Discounted average costs in today’s monetary value (position: 2008)
450 MW IGCC CCS plant: Conclusions

RWE is working hard to promote the project in all fields.
The key factors for successful implementation are:

**Costs and profitability:**
> Commercial large-scale IGCC/CCS plants can be economically self-sustaining.
> The high costs and risks of the demonstration plant require financial support.

**Regulatory framework:**
> Viable regulations must be developed as quickly as possible

**Acceptance:**
> Public awareness and support require a comprehensive communication concept and political support.

We rely on the commitment of all those involved to demonstrate the climate-friendly use of coal.
THANK YOU VERY MUCH
FOR YOUR ATTENTION