

Overview about the RWE CCS- Strategy and the IGCC-CCS Project

**Wadden Sea Forum
26.11.2009
Climate House Bremerhaven**

Siegfried Vennekate
RWE Dea (CO₂ - Project Coordinator)

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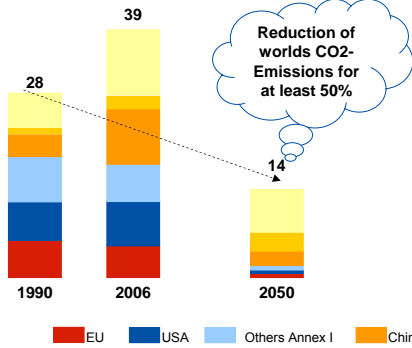
Outline

- Introduction: What is CCS and Why?
- Situation World and Germany
- RWE's CO₂ Mitigation Strategy
- PCC and IGCC Power Plant
- Pipeline planning and experience
- Storage evaluation & mechanism
- R&D Activities
- Preconditions for timely Realization

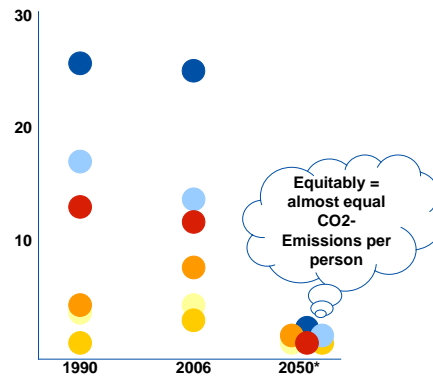
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Climate Change - a huge challenge for the energy industry

Worlds-CO₂-Emissions
[Bn. Tons]



CO₂-Emissions per person
[Tons per residence and per year]



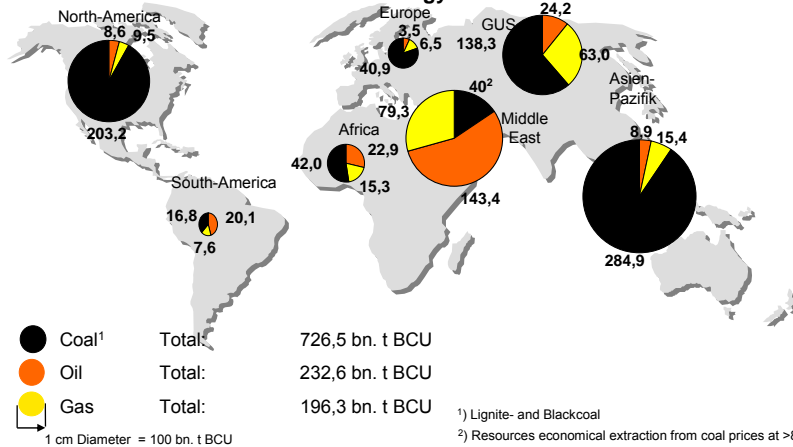
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Sources: UNFCCC, US Census Bureau, RWE

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Coal is the worlds main Energy Resource and has a nearly worldwide Availability

Allocation of fossile energy resources in Bn. t BCU



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Courtesy: BMWi Energiedata, October 2007

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Many Scientists with high international Reputation support CCS-Technology



„...without CCS, global climate protection might be hardly possible...“
 Dr. Edenhofer, Co-Chairman of Work Group III of the International Panel Climate Change (IPCC), 29.6.2009



„... whoever ignores CCS, does not act in a liable way regarding climate protection...“
 Dr. Matthes, Coordinator Energie und Klimaschutz Öko-Institut, 2.7.2009



„...ambitious international climate protection without CCS is not possible...“
 Prof. Dr. Schellnhuber, Director of the „Potsdam-Institutes für Klimafolgenforschung“, 23.1.2009



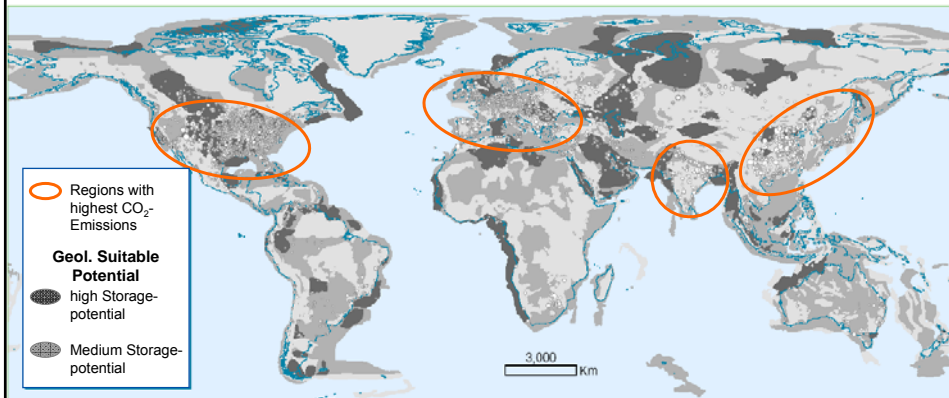
„...if we face the challenge of climate change, every measure, every technology we can achieve has to be taken and has to be brought to an applicable and commercially reasonable state...“
 Dr. Pachauri, Vorsitzender des Weltklimarates (IPCC), 7.5.2008

Courtesy for Graphics: Deutscher Bundestag, Öko-Institut, PIK, IPCC

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Allocation of CO₂-Emissions



Courtesy: IEA GHG

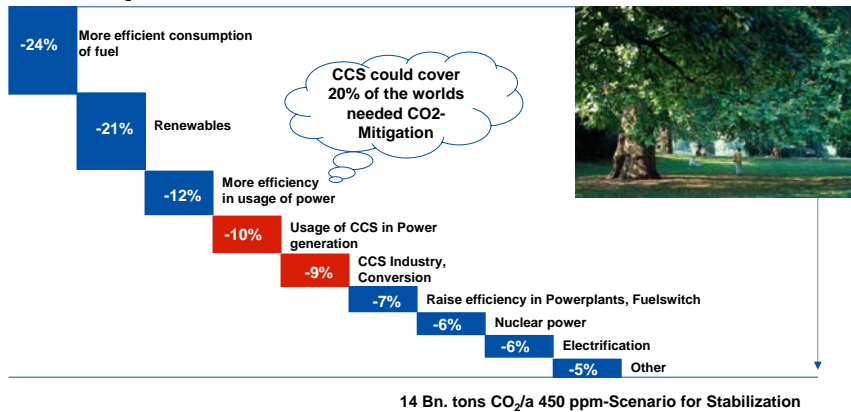
Well applicable Storage Potential is allocated worldwide.

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CCS - an essential pillar for climate protection

62 Bn. tons CO₂/a Baseline-Scenario for 2050 = 100%

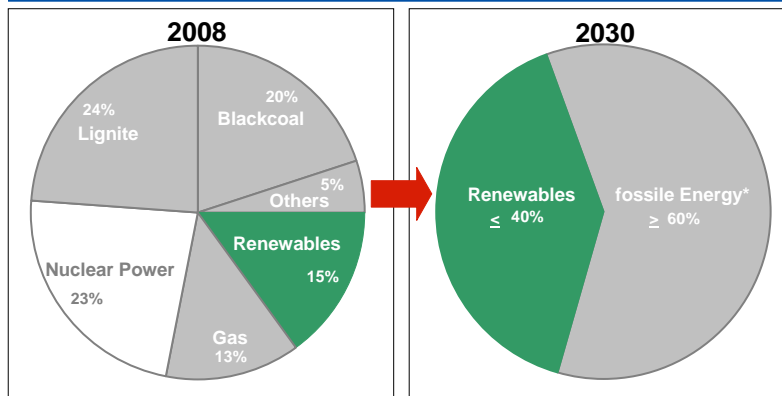


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In Germany Coal will play a mayor Role in Energy Production for the next decades

Percentage from different types of Resources regarding german Power Production today and tomorrow



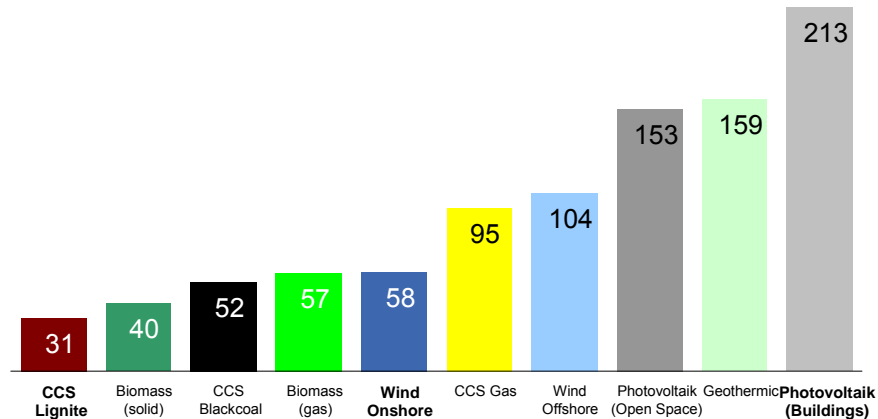
* Including the fuel switch from nuclear power to other alternative energy resources

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CO₂-Abatement Cost 2020 for Power Technologies from a global economic view

in €/t CO₂

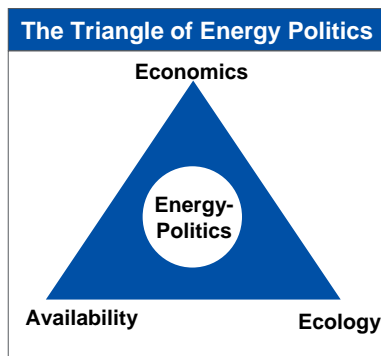


Courtesy: McKinsey & Company, Costs and Potentials in Abatement of Green House Gas in Germany, Section Energy, Berlin September 2007, Pg 48 and 55

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The basic political Parameters for Energy Production became massiv declined







Frameset
Increasing Demand on Energy
Scarcity of resources
Increasing Prices for Energy
Expanding dependancy from Import
Climate Change

Sustainable Energy Politics is always engaged to the triangle of conflict:
Economics – Availability - Ecology

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Three equitable Columns of sustainable Power Generation

	<ul style="list-style-type: none"> > Renewable Energy is not concerned to price fluctuations on international Energy markets > Inexhaustable Resource > Economics and reliability are increasing 	 <p>Onshore-facilities including grid connection</p>						
	<ul style="list-style-type: none"> > Lignite is the most important Energy resource in Germany > Lignite is proved in economic competition, base-loadable and stable regarding prices > Available for a very long range 	<p>Availability until:</p> <table border="1"> <tr> <td>geological</td> <td>> 400 years</td> </tr> <tr> <td>commercial producible</td> <td>> 200 years</td> </tr> <tr> <td>approved + developed</td> <td>~ 40 years</td> </tr> </table>	geological	> 400 years	commercial producible	> 200 years	approved + developed	~ 40 years
geological	> 400 years							
commercial producible	> 200 years							
approved + developed	~ 40 years							
	<ul style="list-style-type: none"> > Requirement for fuel mass very low due to high energy density > Source markets politically stable Outreach: > 200 years > Very low influence on Power Generation Costs (3-5%) 	<p>Energy density uranium</p> <table border="1"> <tr> <td>1 kg natural uranium</td> <td>—</td> </tr> <tr> <td>≈ 12.600 l petroleum</td> <td>—</td> </tr> <tr> <td>≈ 18.900 kg black coal</td> <td>—</td> </tr> </table>	1 kg natural uranium	—	≈ 12.600 l petroleum	—	≈ 18.900 kg black coal	—
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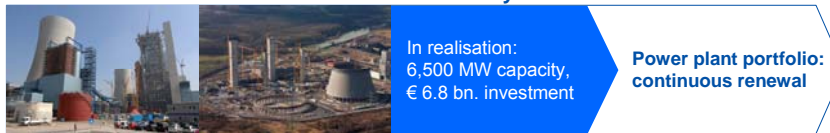
Courtesy: BGR, Deutsches Atomforum; dena

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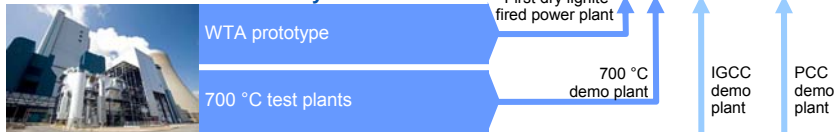
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RWE's CO₂ Mitigation Strategy for Power Plants

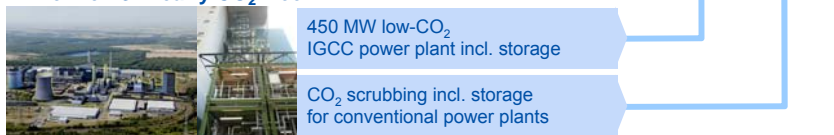
■ Horizon 1: Modernisation to increase efficiency



■ Horizon 2: Further efficiency increase



■ Horizon 3: Nearly CO₂-free



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Pilot Plant Niederaussem – PCC: Key Figures



- CO₂-capture rate 90 %
- app. 7.2 t per day
- Height: app. 40 m
- Skid mounted design
- Commissioning: July 2009
- Budget RWE Power: 9 Mio. €
- 40% Funding by the Federal Ministry of Economics and Technology

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RWE Demo-Power Plant with CO₂-Capture & Storage in Hürth-Knapsack near Cologne

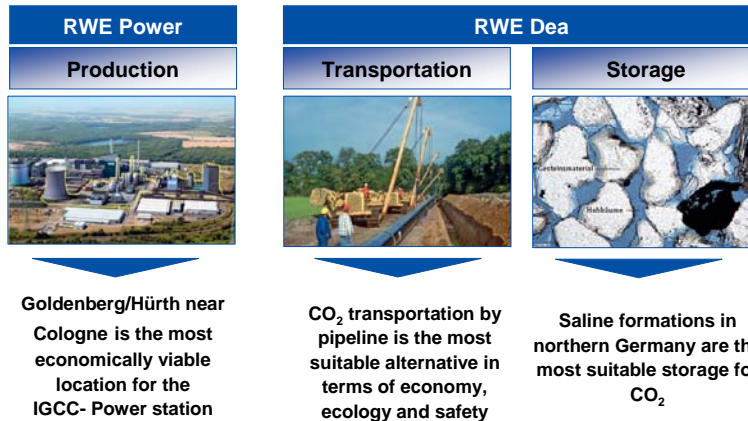


- Gas Treatment
CO₂ Capture
- Gasification
- WTA-Coal-Drying
- Gas- and
Steam
Turbine
Generator

- Base Technology: **IGCC** (Integrated Gasification Combined Cycle)
- Electric Power: 450 MW_{gross}, 315 MW_{net}
- Capture Rate: ~ 90% of CO₂
- CO₂-Storage: ~ 2,6 Mm. t/a in DSF North Germany (Sum: 100 Mill. t over 40 years)
- CO₂-Pipeline: ~ 600 km from Power Plant to Storage
- Investment: ~ 2,2 Billion €
- Commissioning: By end 2015 with optimal Framework (Legal and Puplic)

RWE Power has ist expertise in Gasification- and Power Plant Construction.
RWE Dea has ist expertise in Gas Storage and Pipeline Transportation.

IGCC-CCS: Project planning and tasks within the RWE Group



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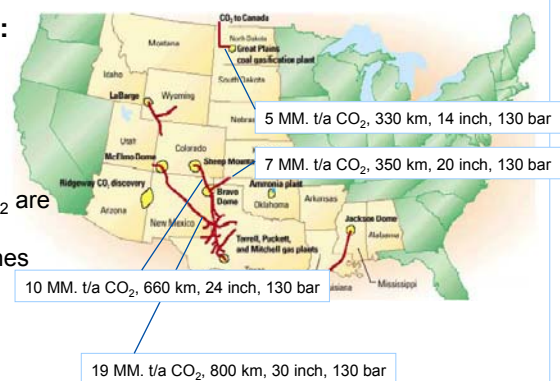
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CO₂ Pipeline Experiences in EOR in the USA

CO₂-Pipeline-Experiences:

Since early 70s in the USA CO₂ is used for enhanced oil recovery.

Therefore approx. 35 MM t CO₂ are transported safely through the states. Over 3000 km of pipelines are already installed.



Pipelines are the most secure option to transport CO₂ over distance.

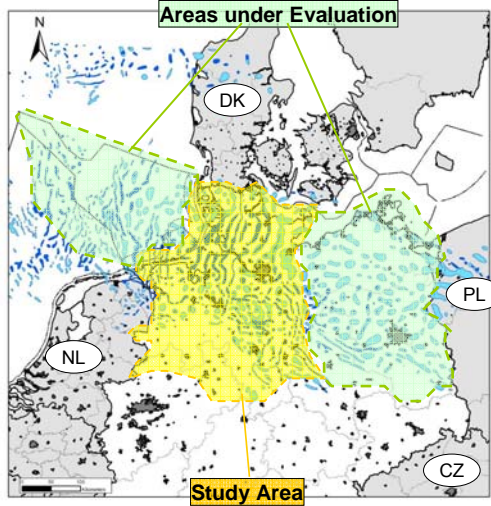
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Deep Saline Formations: Selection Criteria and Assessed Potential

- > Depth = 1000..4000 m
- > No faults in area, halite or clay as seal preferred
- > Capacity Factor:

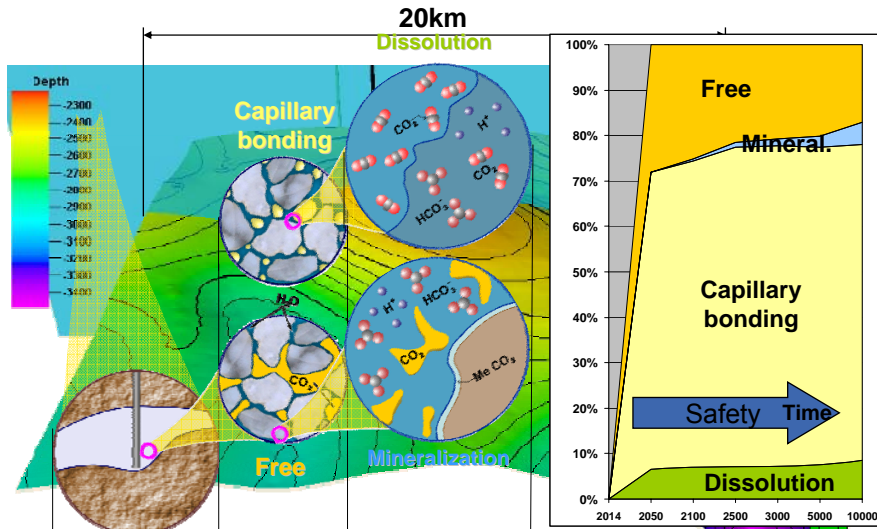
Anticlines	30%
Synclines/Flat areas	20%
- > Preferred System: Anticline/Syncline - Combination
- > Single local Capacity $\geq 100 \text{ Mt CO}_2$
- > Pore Volume
Injected $\leq 0.1 - 0.7\%$ of the hydraulic system
- > Intermediate result of potential approx. 3.8 Gt storage in NW-Germany (Study area onshore)



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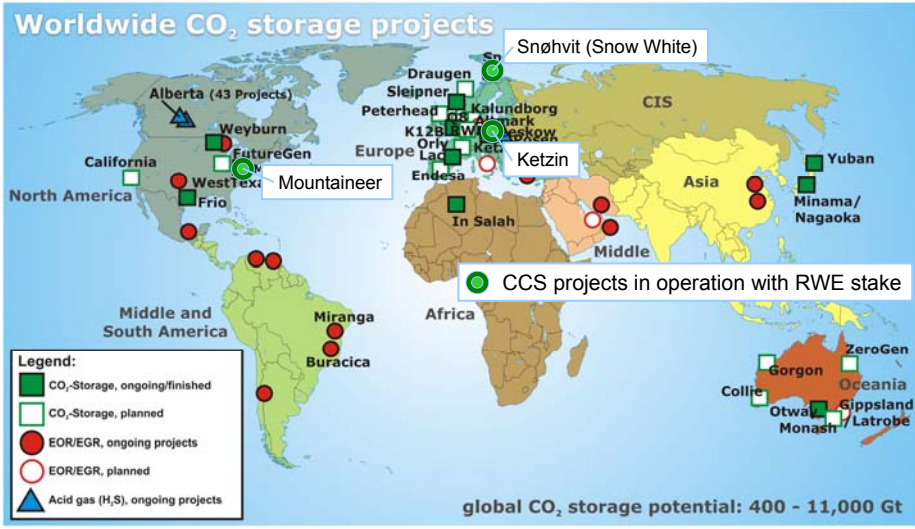
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Carbon Storage Mechanisms



CO₂ can be stored underground over the long term!

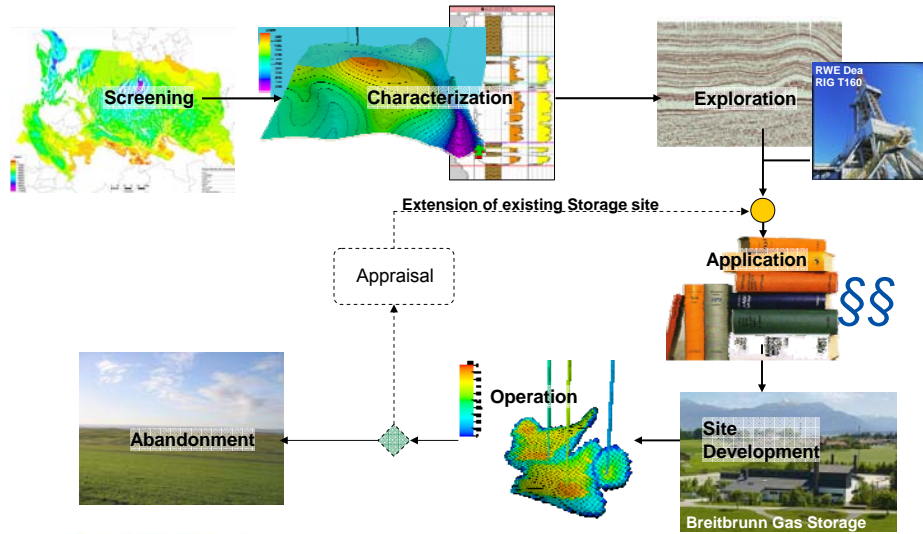
Worldwide CO₂ storage projects



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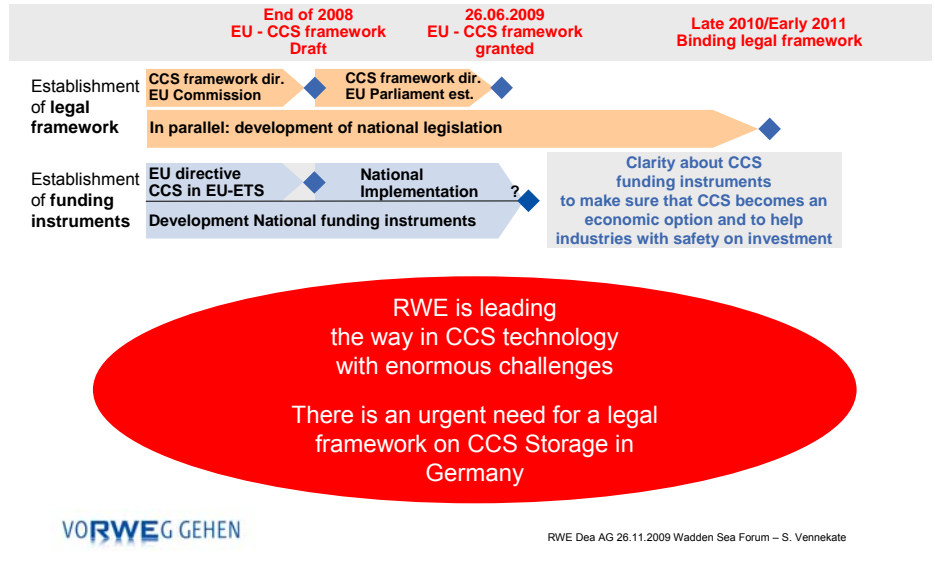
Life Cycle of an Industrial CO₂ Storage Site



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Legal and Regulative Preconditions for timely Realization of the IGCC CCS Project



Thank you for your attention!

Any questions ?

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