CO2 Geological Storage: Lesson Learned from In Salah (Algeria)

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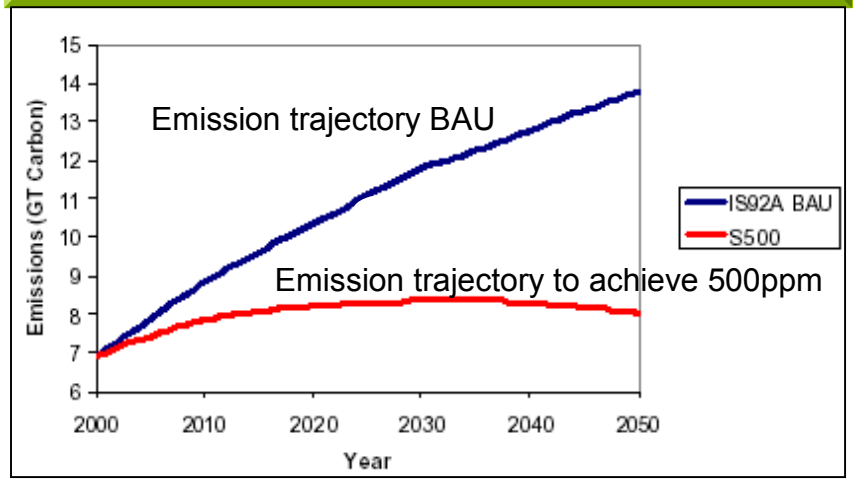
SBSTA Meeting Bonn May 20th 2006

Agenda

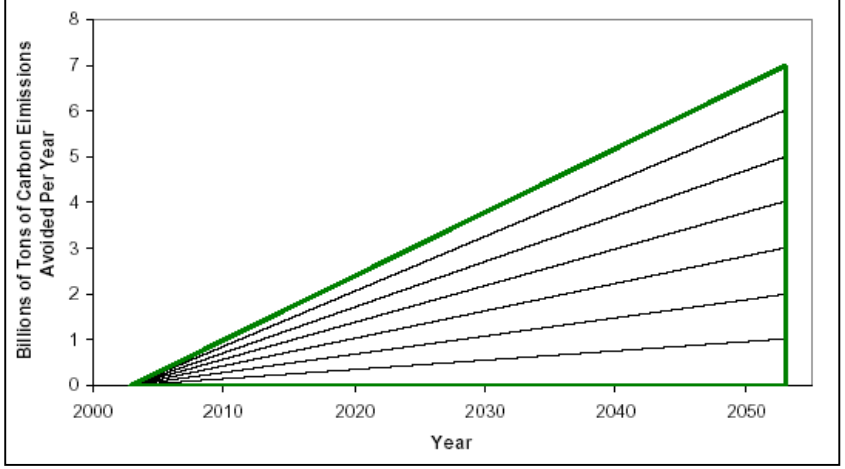
- CCS Benefits
- CCS Challenges
- The In Salah Project (Algeria)
  - How In Salah is addressing the challenges
- Summary

Technology Options for Stabilization

The Stabilisation Wedge



1 GtC Slices of the Stabilisation Wedge



Examples of Lower Carbon Slices	Scale for 1GtC Reduction b 2050
Increased **energy efficiency** across the economy	'Emissions/$GDP' increased
Increased **energy efficiency** (e.g. vehicles only)	2 billion gasoline/diesel cars achieving 60mpg
Fuel switching natural gas displacing coal for power	1400GW fuelled by gas instead coal
Solar PV or **wind** replaces coal for power	1000x scale up PV; 70x scale up for wind
Biofuels to replace petroleum based fuels	200x10^6 ha growing area (equal US agricultural land)
Carbon Capture and Geological Storage	CO_2 captured from 700 1GW co plants; storage = 3,500x In Salah/Sleipner
Carbon Free Hydrogen for Transport	1 billion H_2 carbon free cars; H_2 from fossil fuels with CO_2 captu & storage or from renewables o nuclear
Nuclear displaces coal for power	700 1GW plants (2x current)
Biosequestration in forests and soil	Increase planted area and/or reduce deforestation

CCS 2006: Key Challenges

1. **Reducing the Costs**
   - Mainly Capture, Capital Cost and Efficiency
   - Target: $20-30/t CO_2
2. **Is it Legal?**
   - Long-term Storage Integrity
   - Legal & Regulatory Frameworks
3. **Can you get Paid?**
   - Policy Frameworks
   - Market Eligibility (CDM,ETS)
4. **Public Acceptance**

} In Salah CO_2 Joint Industry Project (JIP)

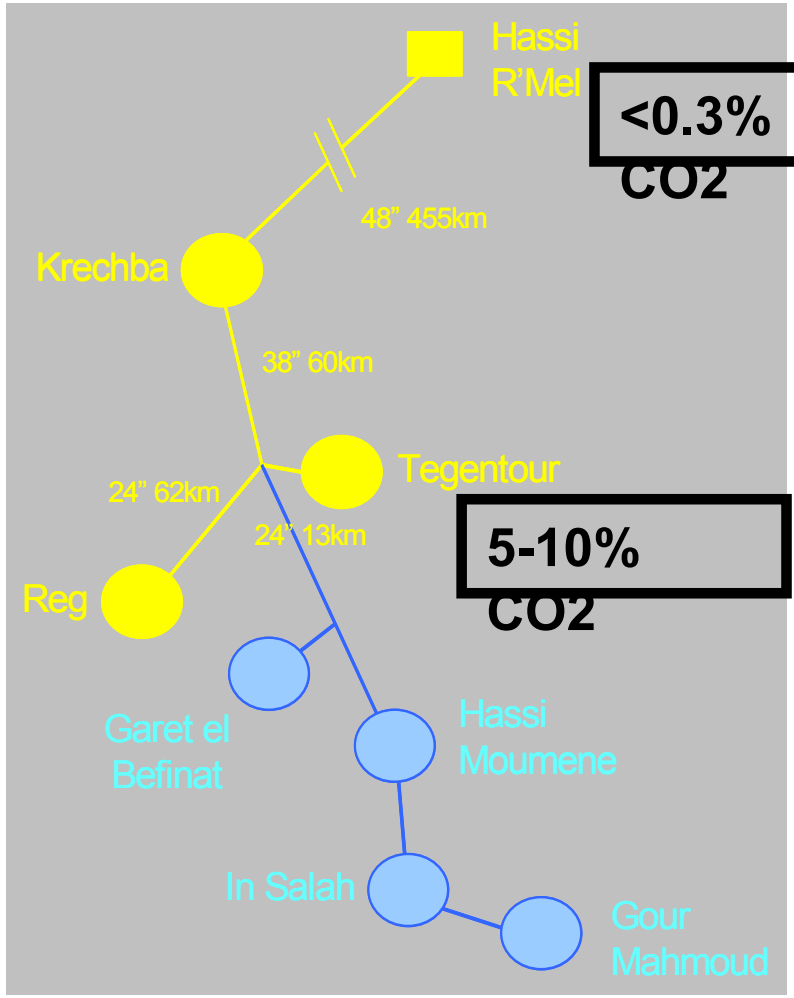
Three Projects at In Salah

- **In Salah Project(s) Overview**
  - **In Salah Gas Development (1bcf/d $2,000 million)**
  - **In Salah CO_2 Storage (1mmtpa $ 100 million)**
  - **In Salah CO_2 Assurance R&D (CSLF & EU $ 30 million)**

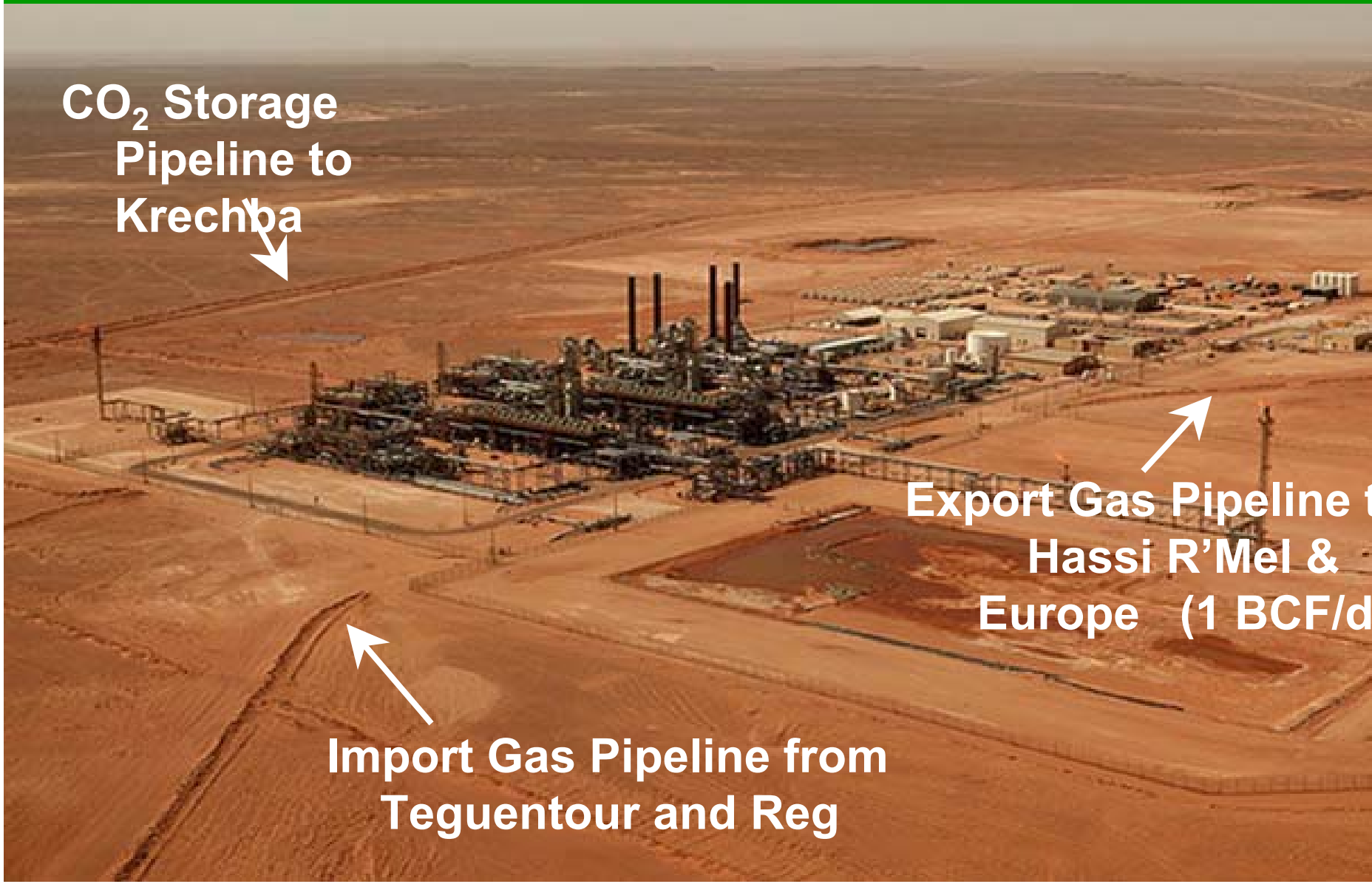
– In Salah Gas Development

- (1bcf/d $2,000 million)

In Salah Gas Project



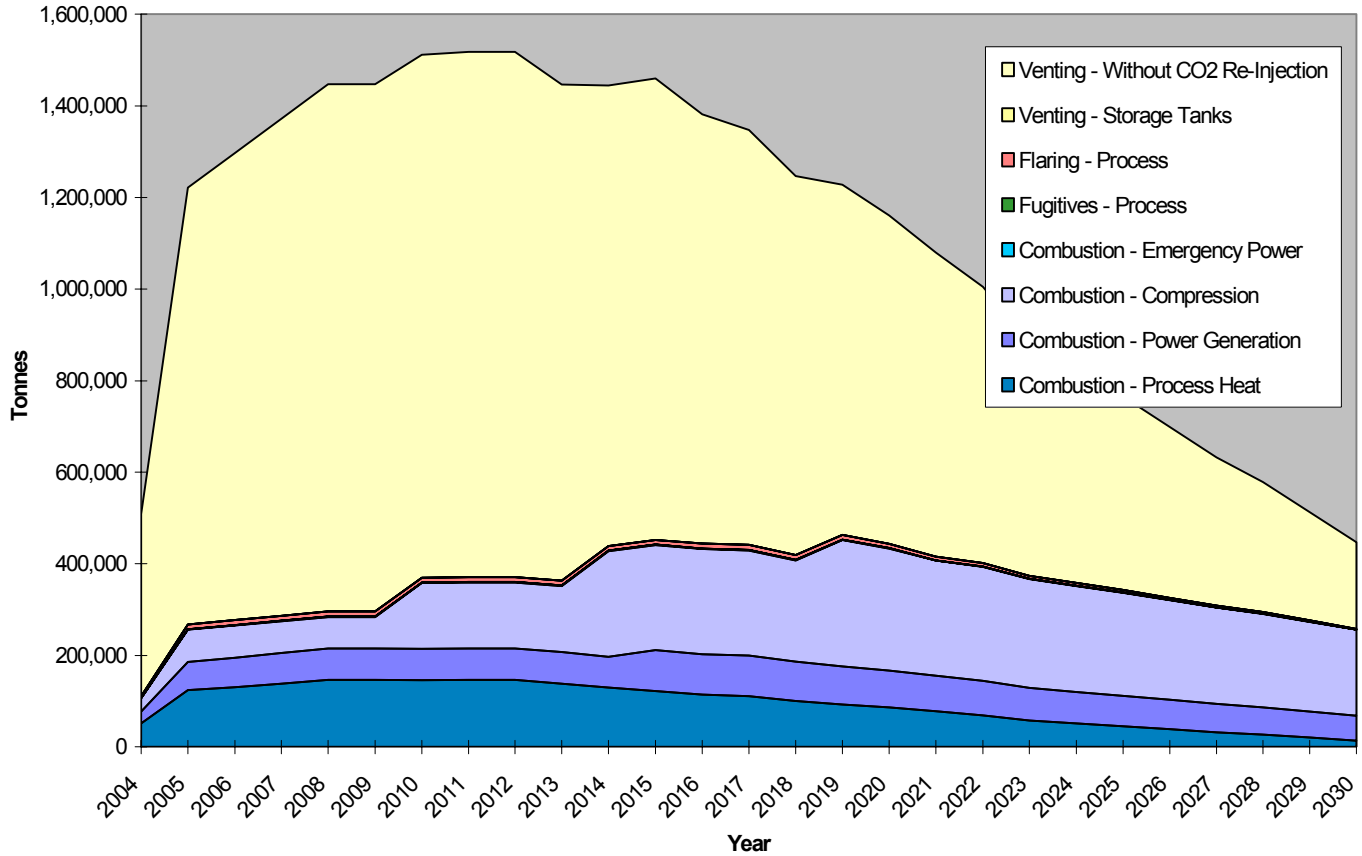
In Salah Gas Processing Plant



– In Salah CO_2 Storage

- 1mmtpa $100 million

In Salah: 25-Year CO_2 Profile

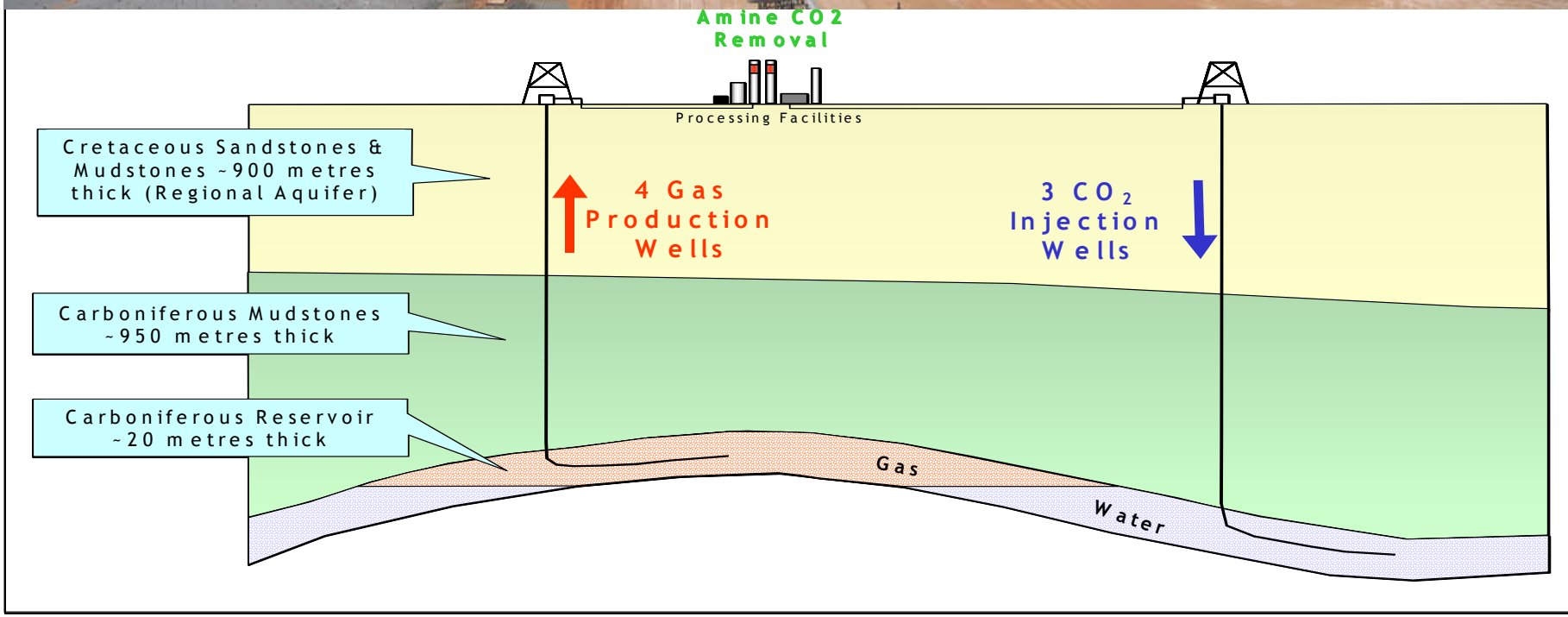


- **Only the separated (yellow) CO_2 will be stored – the combustion CO_2 (blue) will be vented**

In Salah CO_2 Storage

- Industrial Scale Demonstration of CO_2 Geological Storage (Conventional Capture)
- Started Storage in August 2004
- 1mmtpa CO_2 Stored (17mm tonnes lifetime)
- $100mm Incremental Cost ($6/tCO2)
  - No Commercial Benefit
- Test-bed for CO_2 Monitoring Technologies

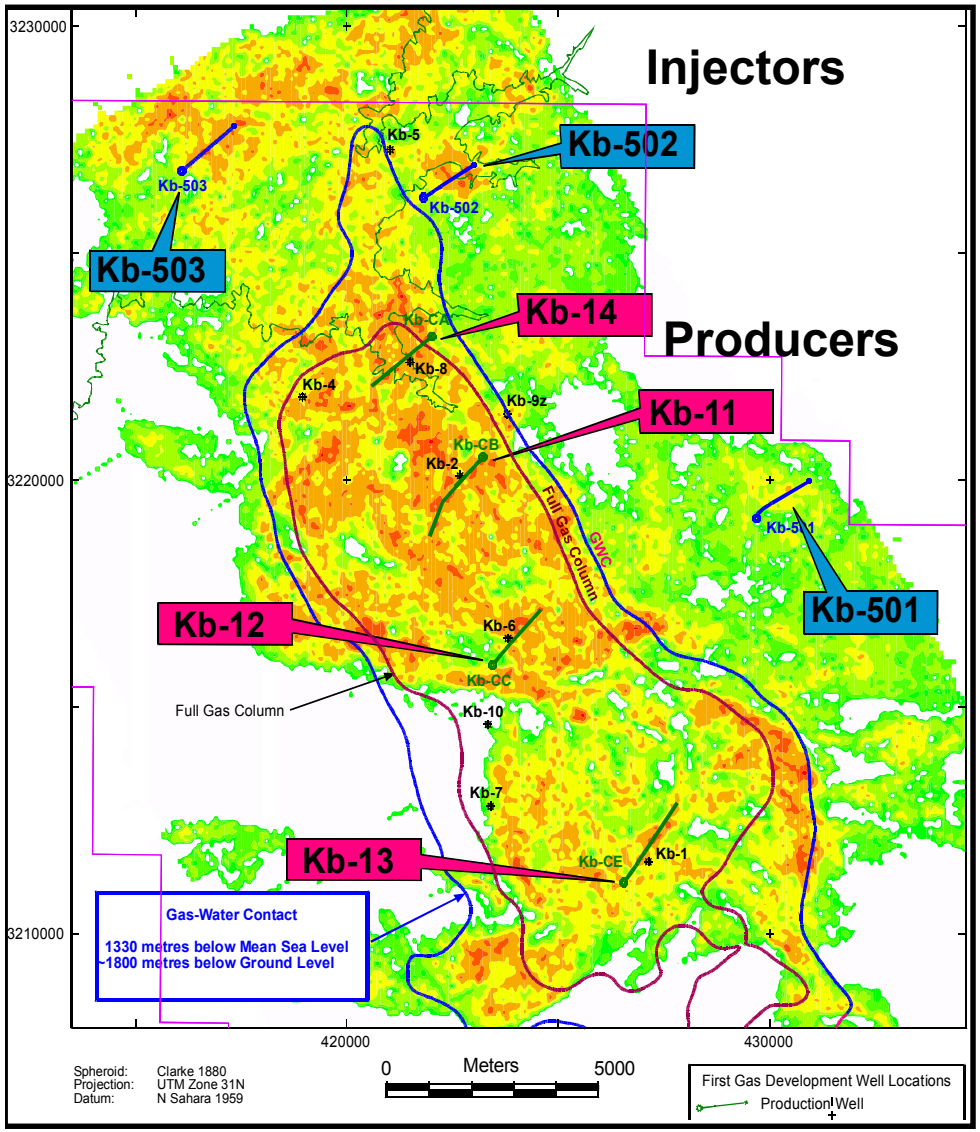
In Salah CO_2 Storage Operation

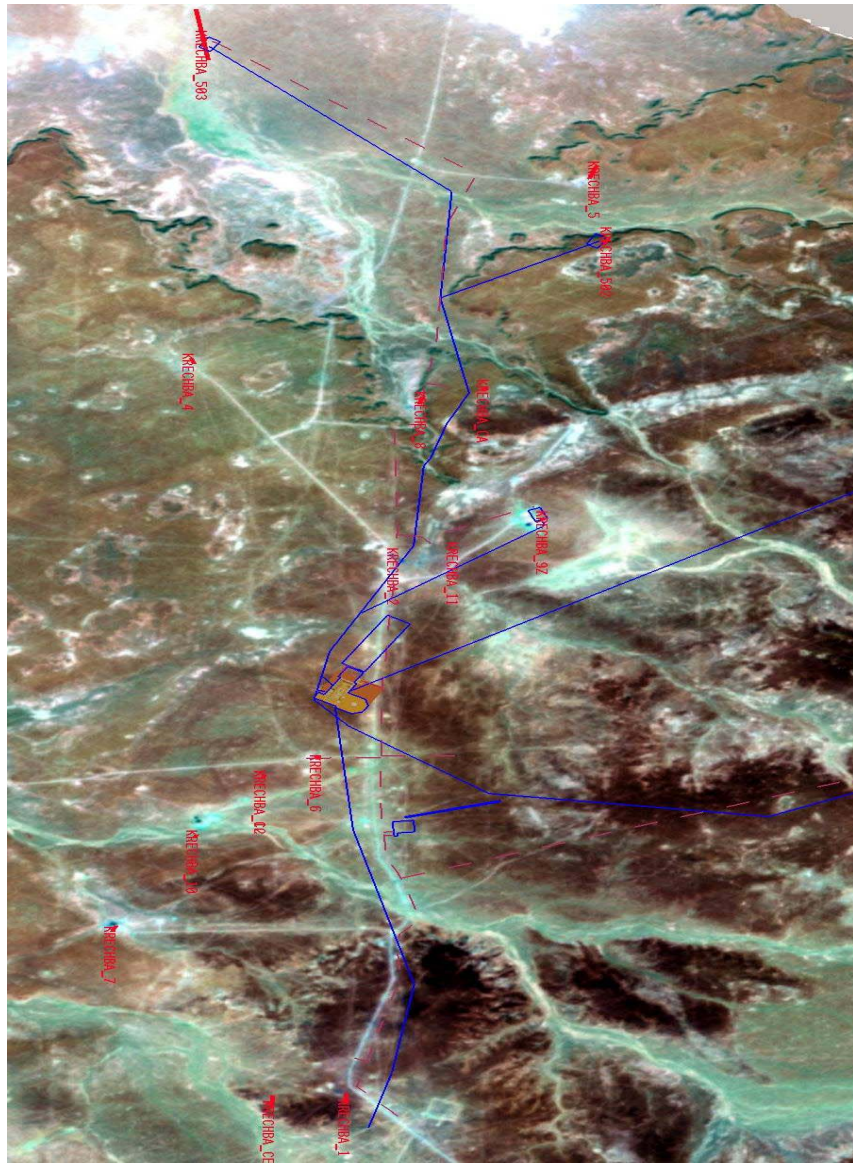


Krechba Field

Reservoir

Surface





CO2 Storage Infrastructure

50mmscf/d CO_2

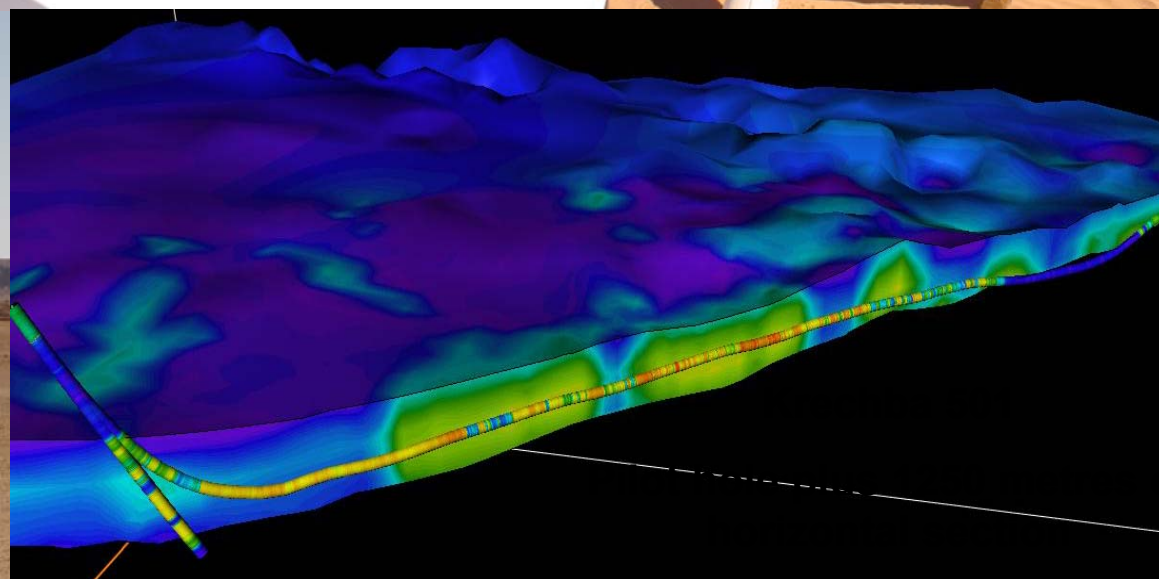
(1mmtpa)

Compression

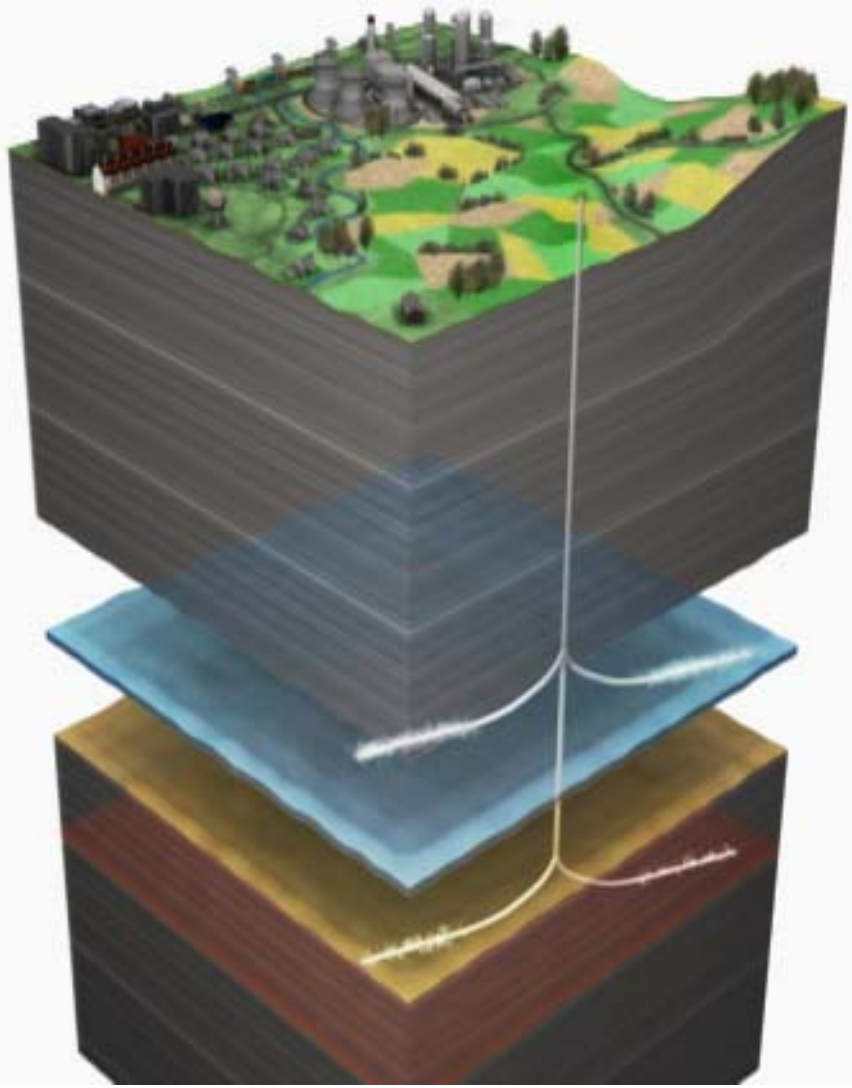
Transportation

Injection

Storage



Power Plant with CCS



–In Salah CO_2 Assurance

- R&D (CSLF $30 million)

Joint Industry R&D Project

Objectives (2004-09)

1. Provide assurance that secure geological storage of CO_2 can be cost-effectively verified and that long-term assurance can be provided by short-term monitoring.
2. Demonstrate to stakeholders that industrial-scale geological storage of CO_2 is a viable GHG mitigation option.
3. Set precedents for the regulation and verification of the geological storage of CO_2, allowing eligibility for GHG credits

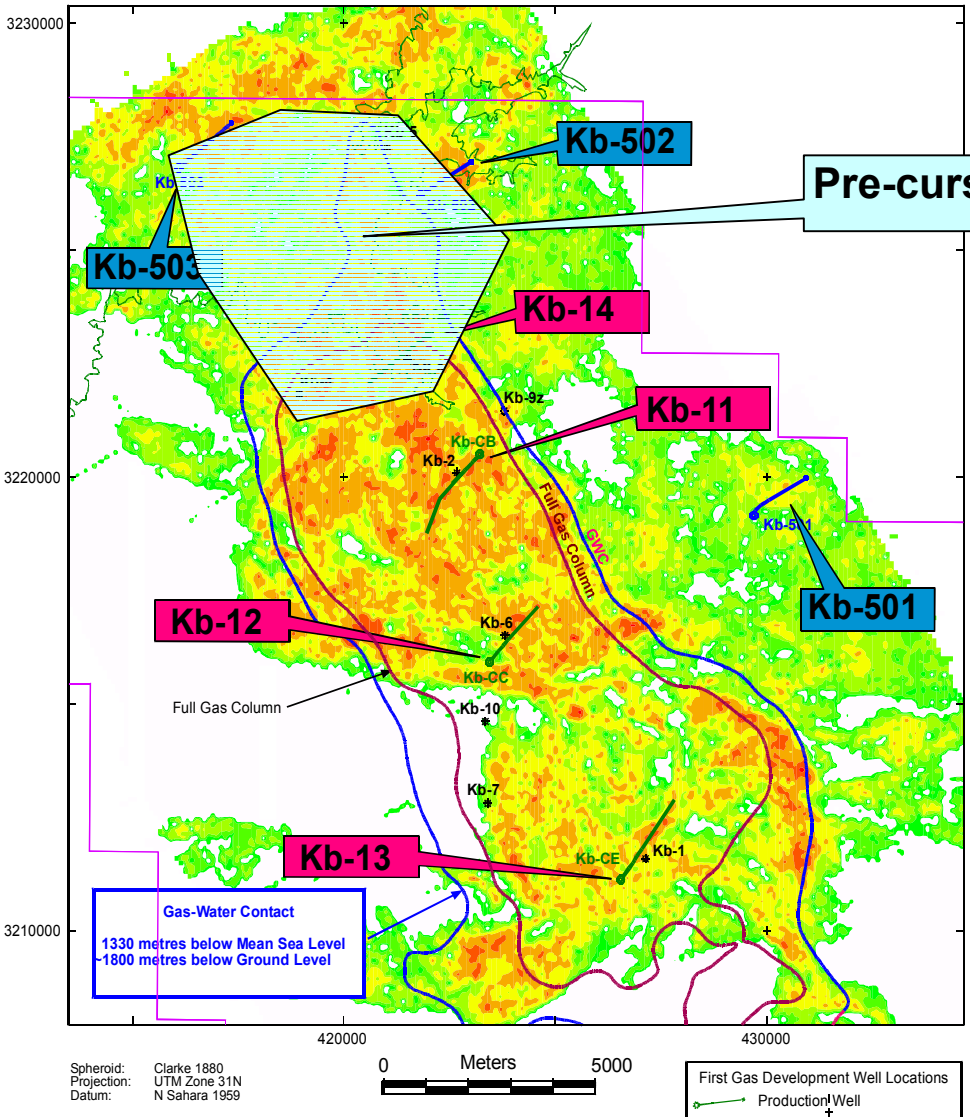
Why Monitoring?

- Need more cost-effective tools to demonstrate long-term storage integrity
- Oil & Gas Industry already has most of the tools required, but has never had a commercial reason to develop them
- Mother Nature made all geological formations different
  - Monitoring technology that works in one location may not work in another
  - Need to develop a pool of knowledge
  - Need to set standards for site certification

In Salah Monitoring: Status

Technology		Status
4D Seismic/VSP		Programme recommended – KEY TECHNOLOGY
4D Gravity		Modelling completed – marginal response
Tracers		Due to commence 1Q2006
4D Electrical/EM		Initial modelling suggests no response
Dynamic modelling		Building new model in Eclipse
Flow meter surveys		Reviewed and Not Recommended
Wellhead CO_2 Monitoring		Sampling programme ongoing
Formation water chem.		Analyses incorporated in Shared Earth Model
Injection monitoring		Ongoing by JV
Rock-fluid/Pressure Interactions		Studies ongoing in Norway
Specialist CO_2 modelling		Part of geochemistry studies ongoing in Norway
Microseismic		Programme recommended- awaiting info on access to suspended wells

Seismic Array Location



In Salah CO_2 Summary

- Industrial Scale Demonstration of CO_2 Geological Storage (Conventional Capture)
- Excellent Analogue for other Countries:
  - China, Europe, North America
- Started Storage in August 2004
- 1mmtpa CO_2 Stored (17mm tonnes lifetime)
- $100mm Incremental Cost for Storage ($6/t$CO_2$)
  - No commercial benefit
- Test-bed for CO_2 Monitoring Technologies
  - $30mm Research Project