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EU-OPEC Roundtable on Carbon Dioxide Capture & Storage.
Session 2: Prospects of CCS in OPEC Member Countries and the EU.

The In-Salah CCS experience Sonatrach, Algeria

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Sonatrach, Algeria

Sonatrach & Climate Change

Who is Sonatrach ?

- Created in 1963
- 232 Million TOE produced in 2005.
- Processing Capacity
  - Liquefaction of NG : 45 Mm^3/year
  - LPG Separation : 9.1 MT/year
  - Refining : 21.3 MT/year
- Transportation Network
  - 14 500 Km of oil, gas LPG and condensate pipelines

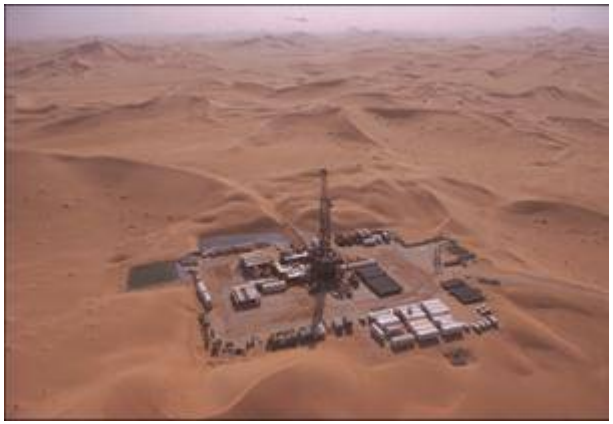
Who is Sonatrach ?

- Sonatrach is the Algerian National Oil & Gas company
  - 11th largest oil company
  - 1st African company
  - 3rd largest NG exporter
  - 1st largest LNG exporter

Environmental protection at Sonatrach

- Sonatrach adopted few years ago; an ambitious Heath, Safety & Environmental (HSE) Policy.

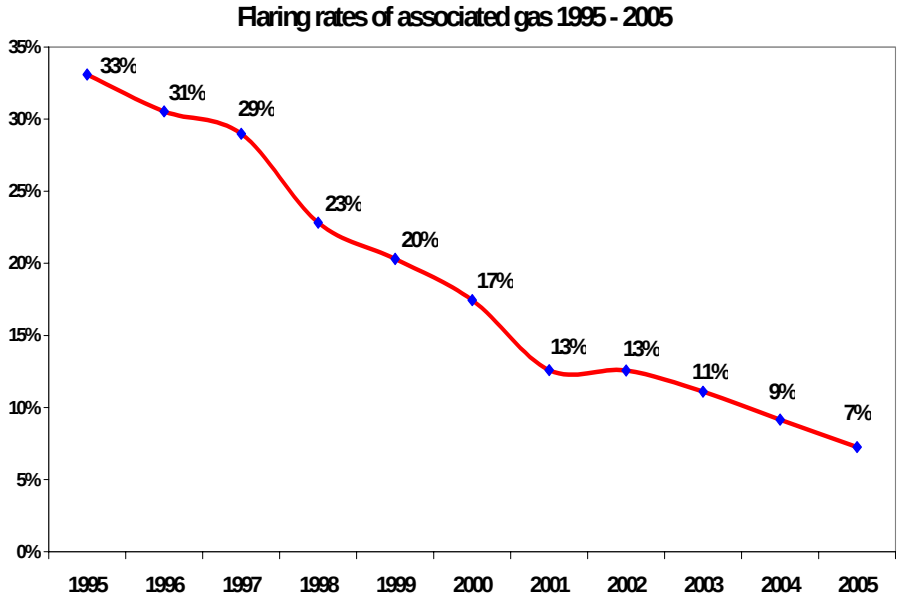
- It shows a strong commitment to protect the Environment and to contribute to the sustainable development effort of the country.



- One of the main environmental objectives of Sonatrach is reducing atmospheric pollution including greenhouse gases

Sonatrach's efforts to tackle climate change

- Associated gas flaring reduction program
  - Voluntary efforts since 1970
  - GGFR member (CDM project)
- Carbon Capture & Storage projects
- Voluntary projects
  - **First experience:** In Salah gas Project
  - **Second experience:** Gassi -Touil Integrated Project

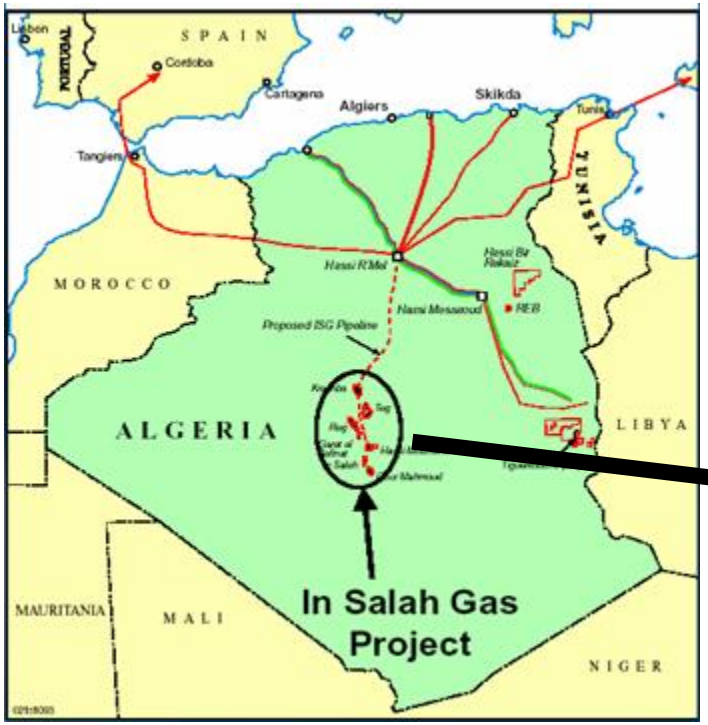


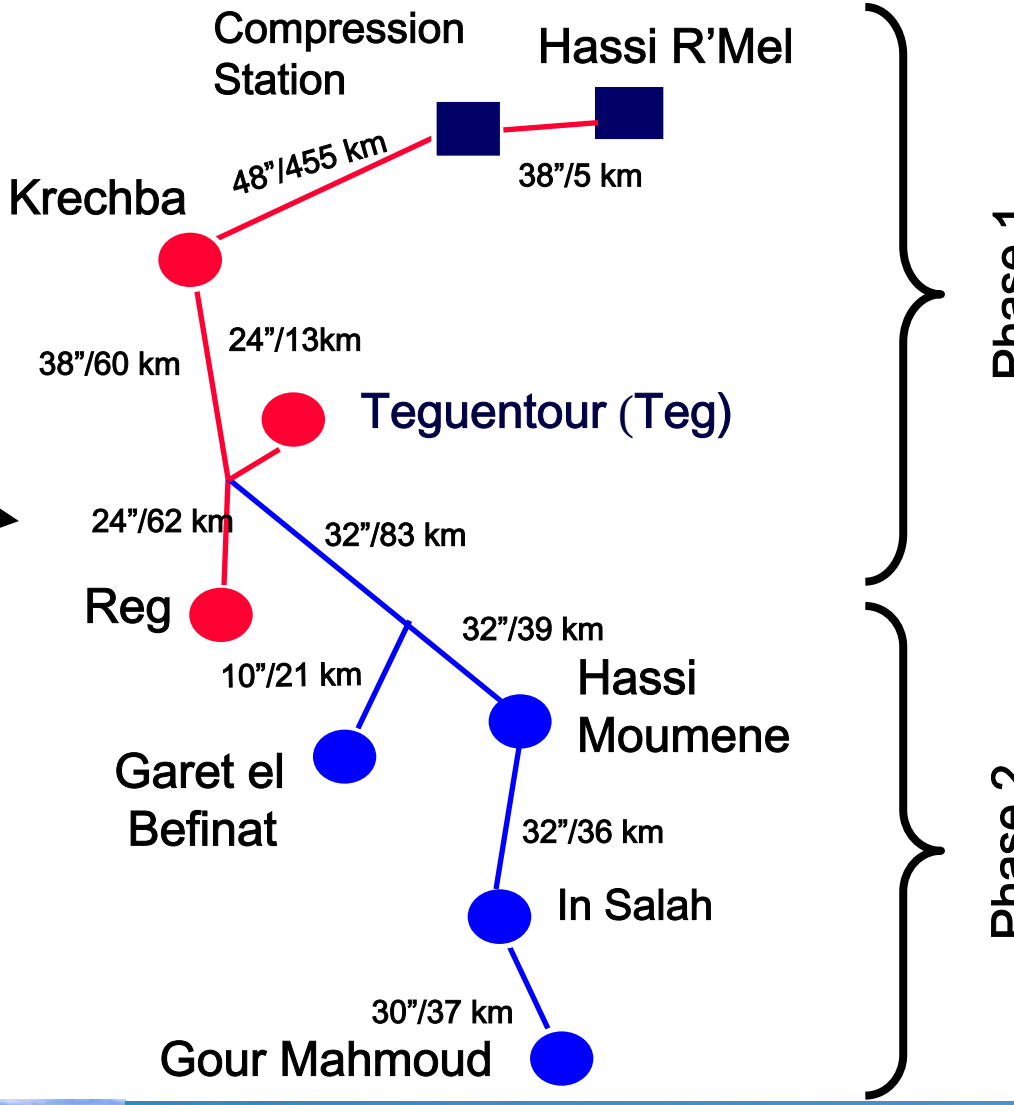
In Salah Gas Project

In Salah Gas Project

- In Salah Gas (ISG) is a Joint Venture between :
  - Sonatrach (35%),
  - BP (33%)
  - Statoil (32%).
- ISG Project involves the development of seven natural dry gas fields in the southern central part of Algeria (Sahara desert).

Project location



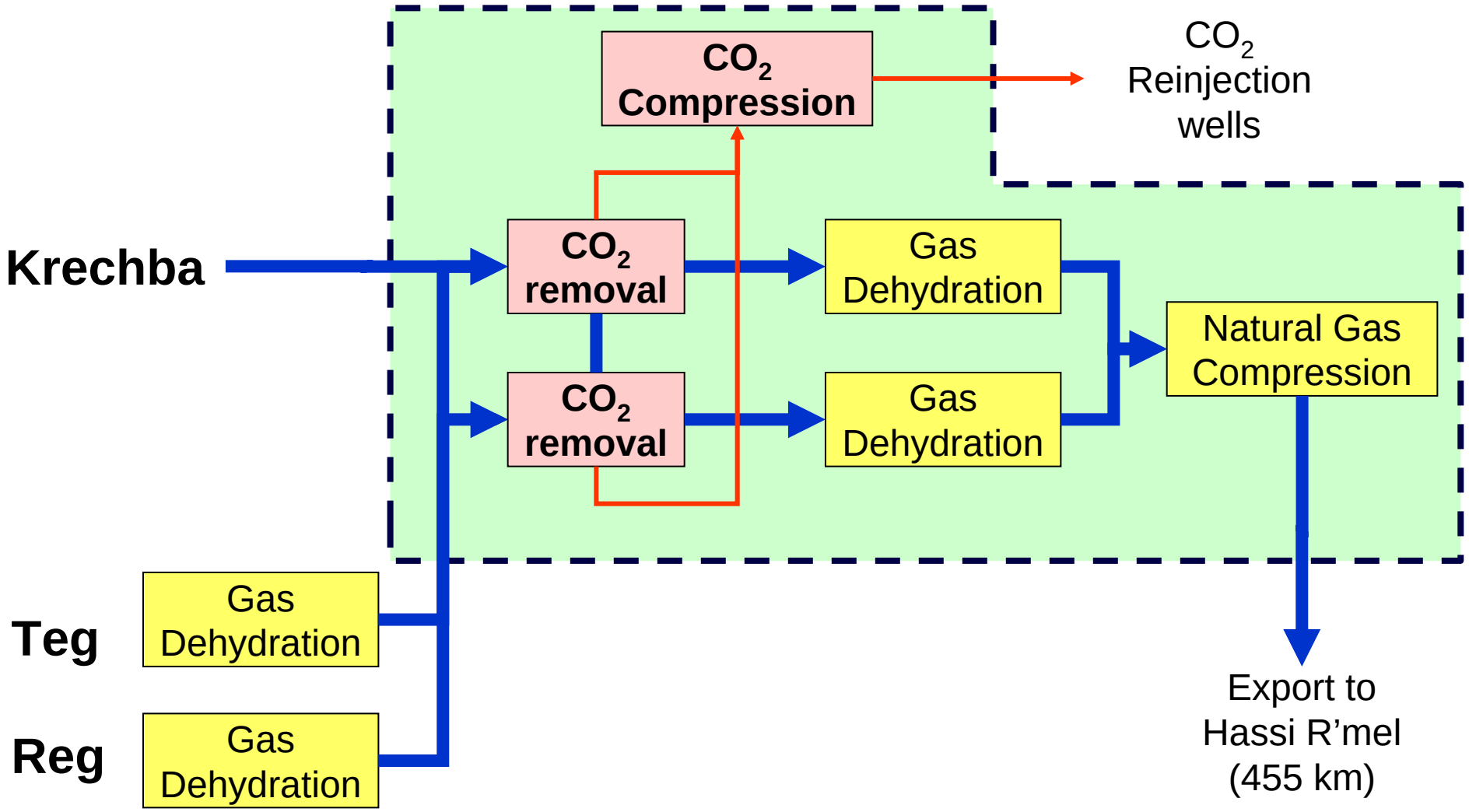


- **1st Phase :** Started in 2001, first gas produced in 2004)
- **2nd Phase :** after 2011

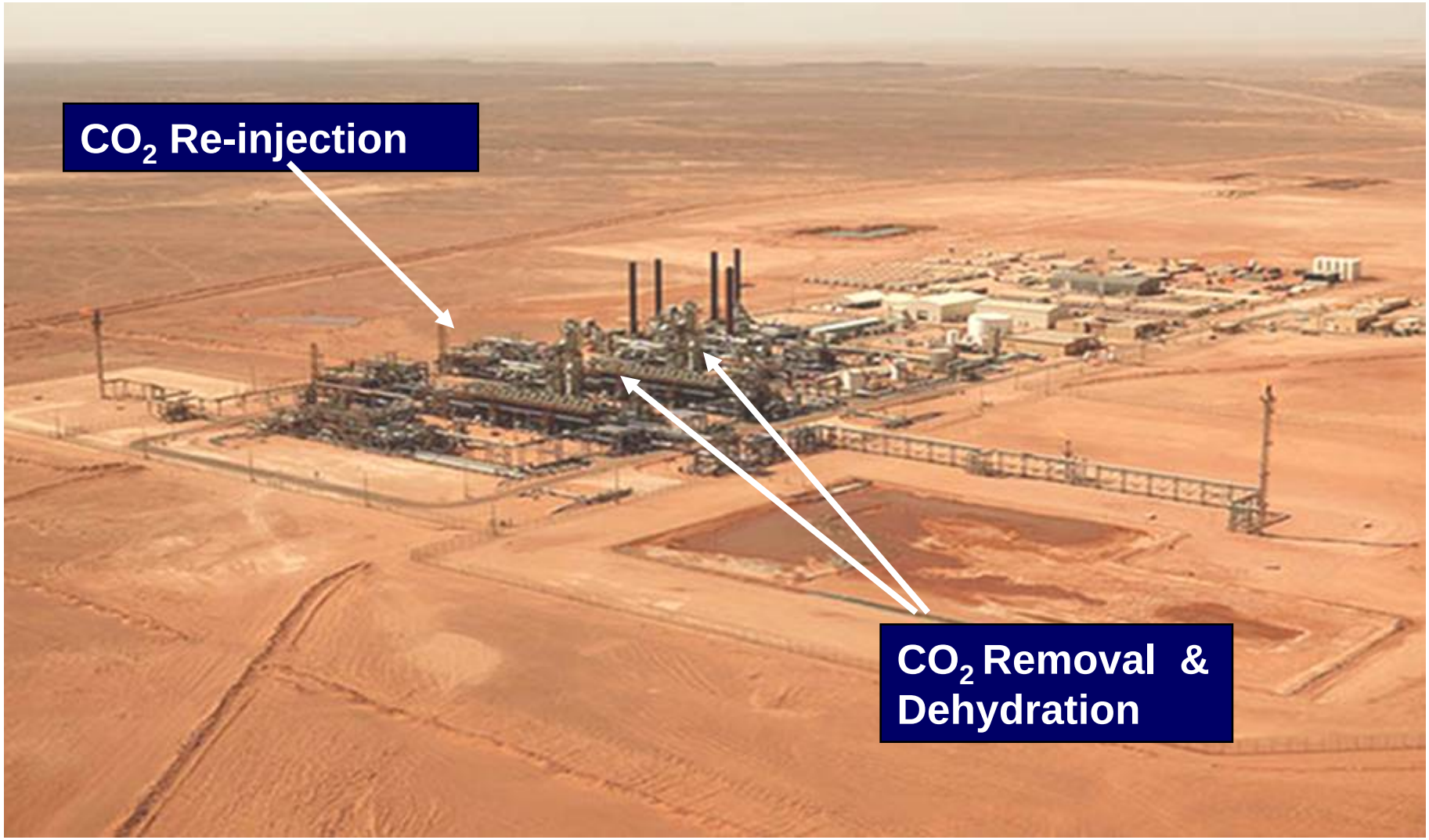
In Salah Gas Project

- The objectives of this JV are: Exploration, Appraisal, Development and Joint Marketing of natural gas produced.
  - First treated gas in July 2004,
  - Estimated gas reserves : 340 bcm (230 bcm recoverable).
  - Dry Gas production plateau : 9 bcm/yr for about 13 to 16 years
  - Contract duration : until 2027.
  - The global investment is around 2.7 billion US$ (1.7 billion US$ for Phase I).

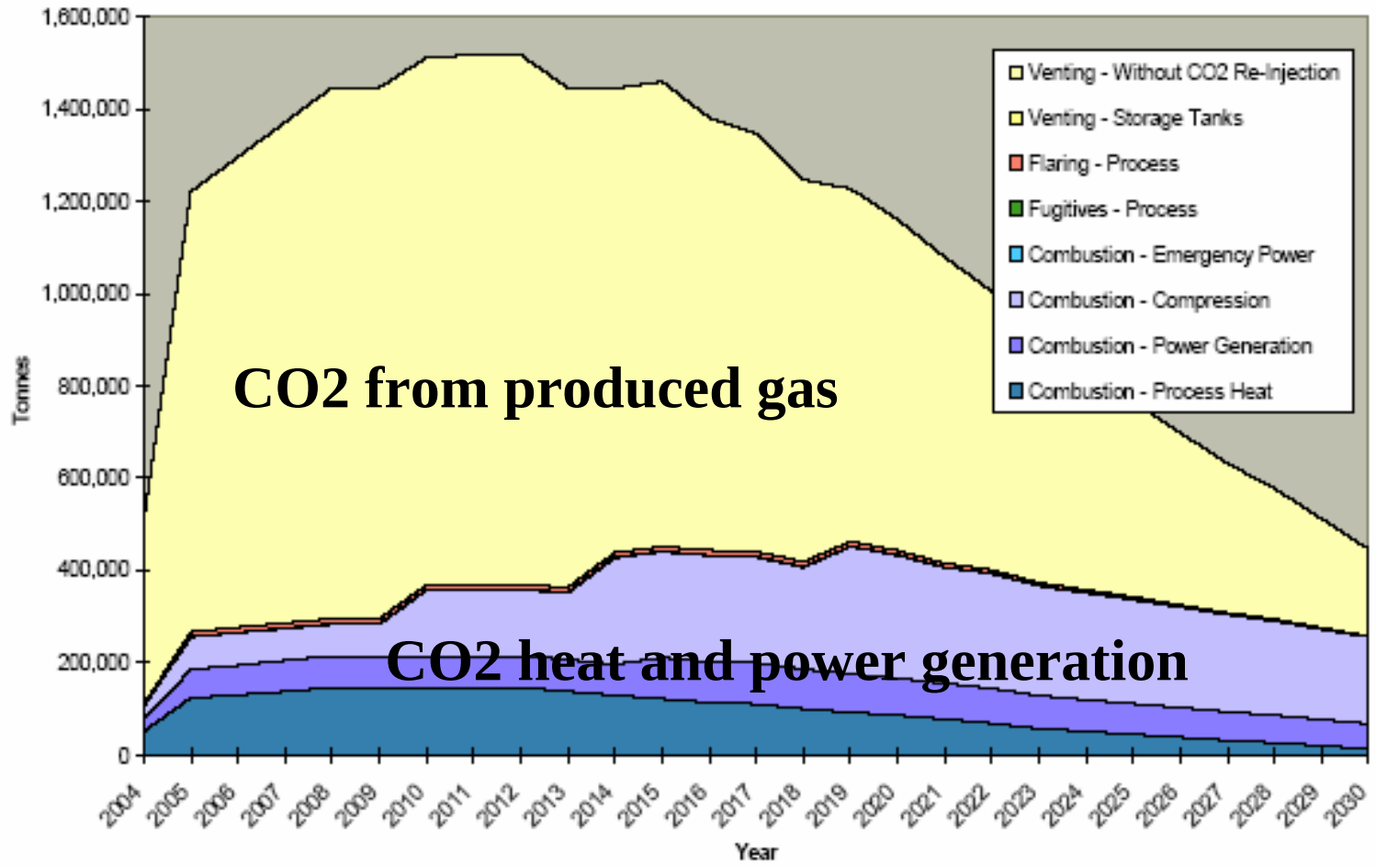
In Salah Gas Processing Plant



Krechba Processing Plant



In Salah Gas CO2 emissions by source



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

In Salah CCS project

CO_2 content for each reservoir

Fields	Reservoirs	CH_4 (%)	CO_2 (%)
Krechba	Tournaisian (Carboniferous)	91	1
	Gedinian (Devonian)	89	**9 to 10**
Teguentour (Teg)	Devonian	90	**8 to 10**
Reg	Devonian	94	2 to 4
Garet el Befinat	Emsian	94	2 to 4
Hassi Moumene	Emsian	94	4
In Salah	Devonian	94	4
Gour Mahmoud	Devonian	94	4

Why we remove CO2 from Natural Gas

- The carbon content in the natural gas produced from the In Salah project ranges between 4 – 9%.

- The target market for the Algerian natural gas is Europe, where the market requires incoming natural gas to contain no more than **0.3 %** CO_2.

- So, ISG is required to separate the carbon before export natural gas.

CCS, an alternative option to CO2 venting

- The industry business as usual practice is to first separate CO_2 from the natural gas and then vent it into the atmosphere.

- A commitment by the shareholders to manage down the emissions footprint of the project and not to employ atmospheric venting of the CO_2 stream resulted in a need to an alternative solution to be identified.

- So, rather than venting CO_2, the project compresses it and injects it into a large underground aquifer lower than the gas reservoir at 1,800 metres depth.

In Salah Gas CCS project – Key information

- ISG-CCS is an Industrial-scale demonstration of CO_2 geological storage
- 1 million tons per year of CO_2 will be geologically stored :
- About 17 million tons of CO_2 will be re-injected during the whole life of the project
- CCS reduce GHG emissions of the project by 60%. This is equivalent to :
  - To take 250 000 cars off road
  - Or, 200 km^2 of forests
- Project cost : **100 million US$**
- CO_2 capture & storage cost : **$6** per tonne

The overall objectives of In Salah Gas CCS project

- First, to demonstrate to stakeholders that industrial-scale geological storage of CO_2 is a viable greenhouse gas (GHG) mitigation option.

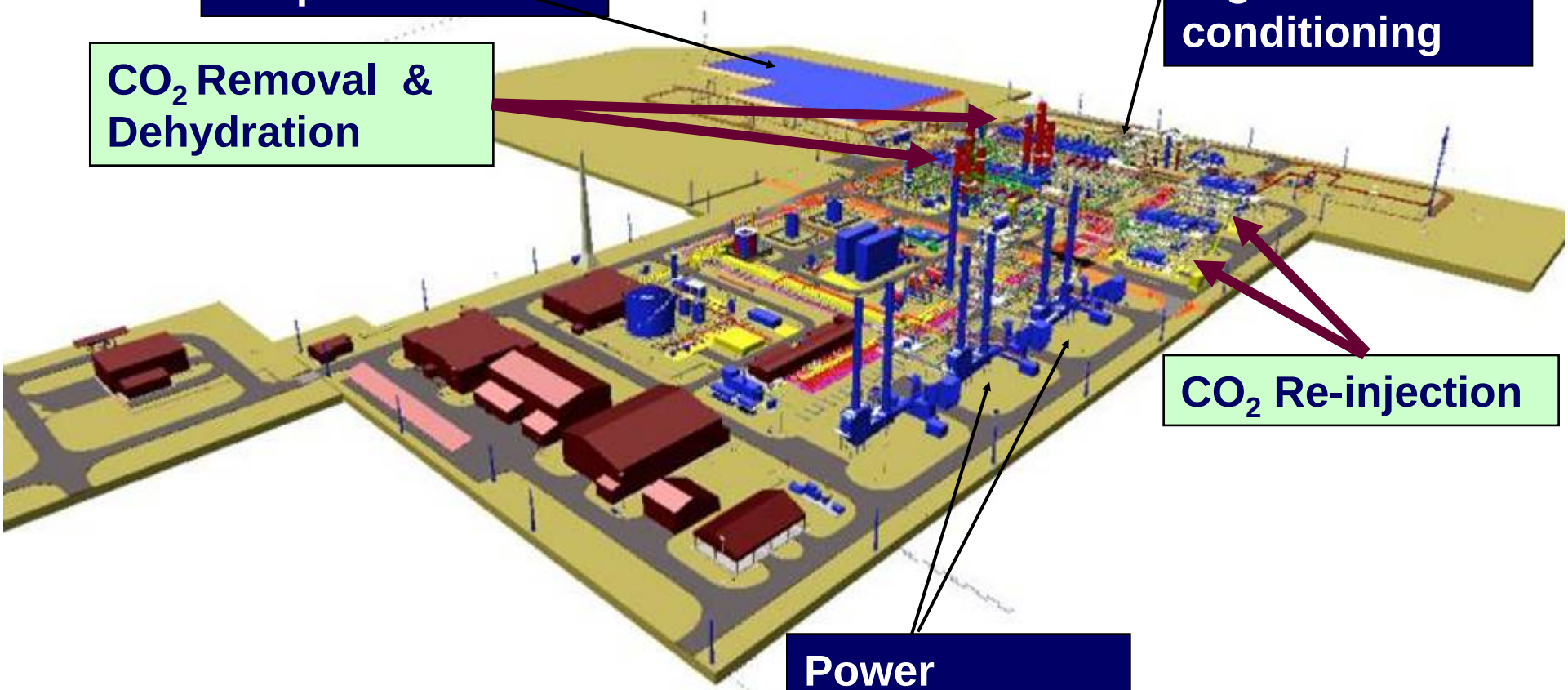
- Second, to assure people that secure geological storage of CO_2 can be cost-effectively verified and that long-term assurance can be provided by short-term monitoring;

- and third, to set precedents for regulating and verifying geological storage of CO_2 - ultimately to allow eligibility for Clean Development Mechanism (CDM).

CO_2 Removal and Compression

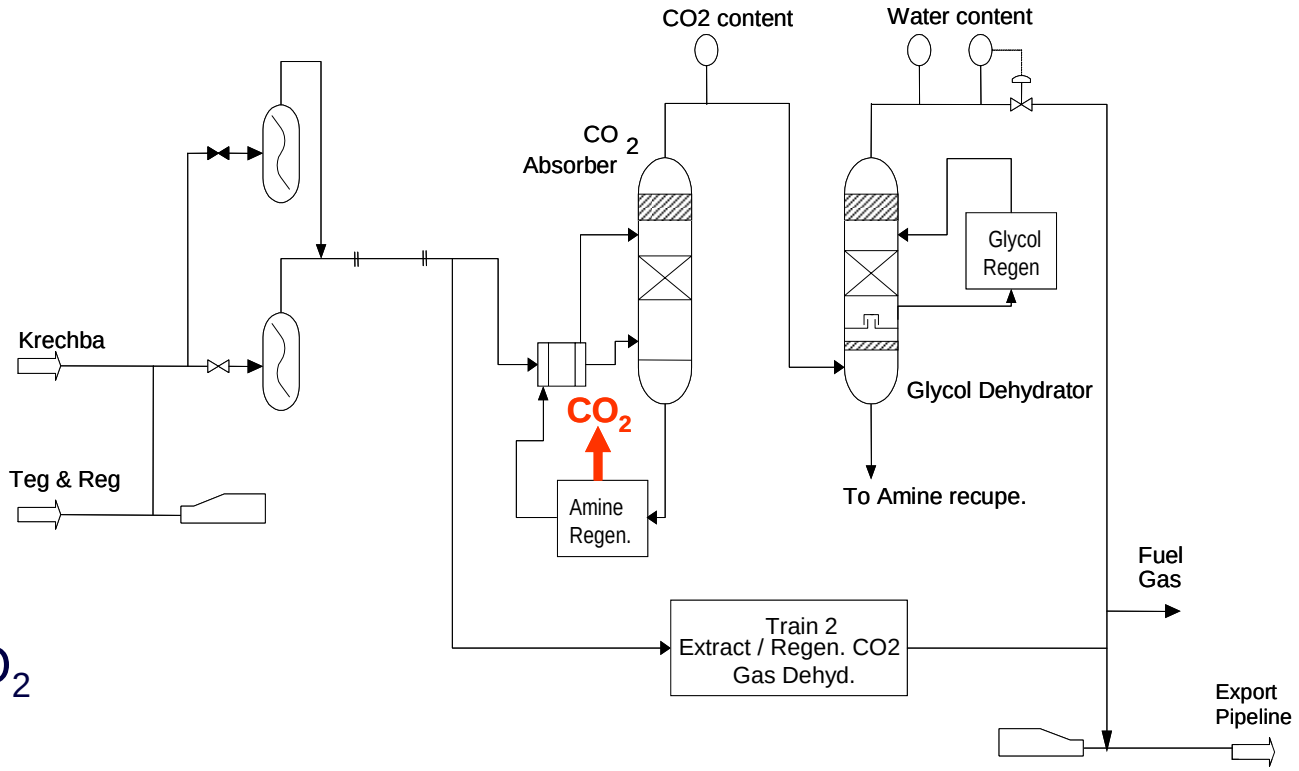
(CO_2 Capture)

Krechba Processing Plant



CO_2 Removal from natural gas

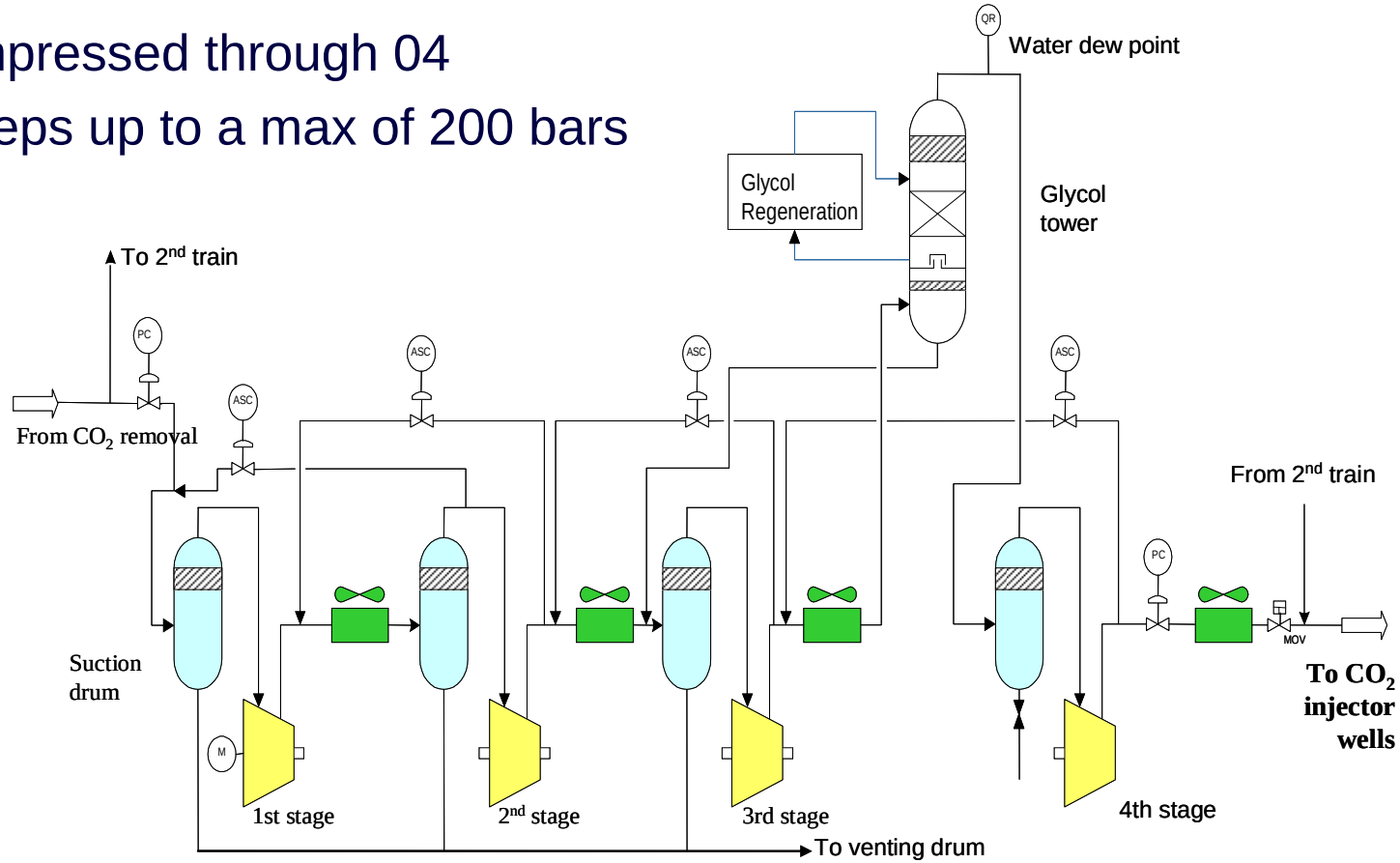
- For carbon removal purpose, two trains has been built,
- CO_2 is extracted by absorption using chemical solvent (Ethanol - Amino solution) .
- The solvent is then regenerated and CO_2 recovered.
- NG is then dehydrated by Glycol absorption



CO_2 compression & dehydration

- The CO_2 is compressed through 04 compression steps up to a max of 200 bars

- After the 3rd phase of compression, CO_2 is dehydrated by absorption using tri-ethylene glycol (TEG).



- CO_2 is cooled after each compression stage and before re-injection.

CO_2 Geological Storage

Injection site choice criteria

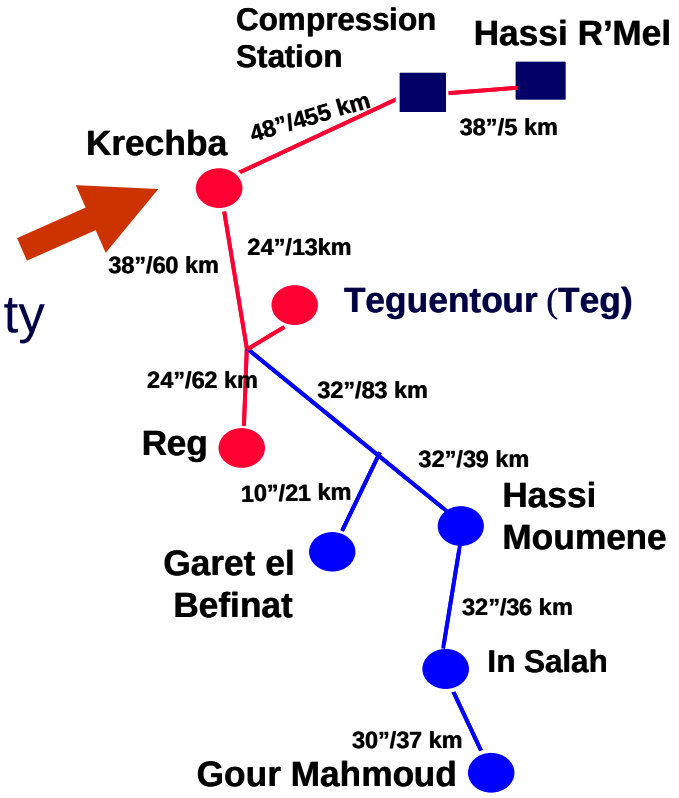
- The selection criteria considered to choose the injection site are :
  - A robust sub-surface storage sites close to the planned In Salah Gas process facilities.
  - A demonstrated reservoir cap seal integrity,
  - The availability of sufficient storage capacity to meet the predicted CO_2 volumes estimated at ~ 12 Standard Bcm,
  - A moderate to good storage reservoir properties (porosity, permeability…)
  - A reservoir pressure below 6000 psi.

Krechba, best option

- Several opportunities for storage were evaluated during the design stage and ranged from distributed storage at each field location, to a single centralised facility and storage site.

- The high cost and increased system complexity associated with distributed storage, primarily around the need to employ multiple CO_2 stripping units, precluded this as an option.

- So, a single facility was one preferred and **Krechba** field was selected to be the location.



Why Krechba reservoir ?

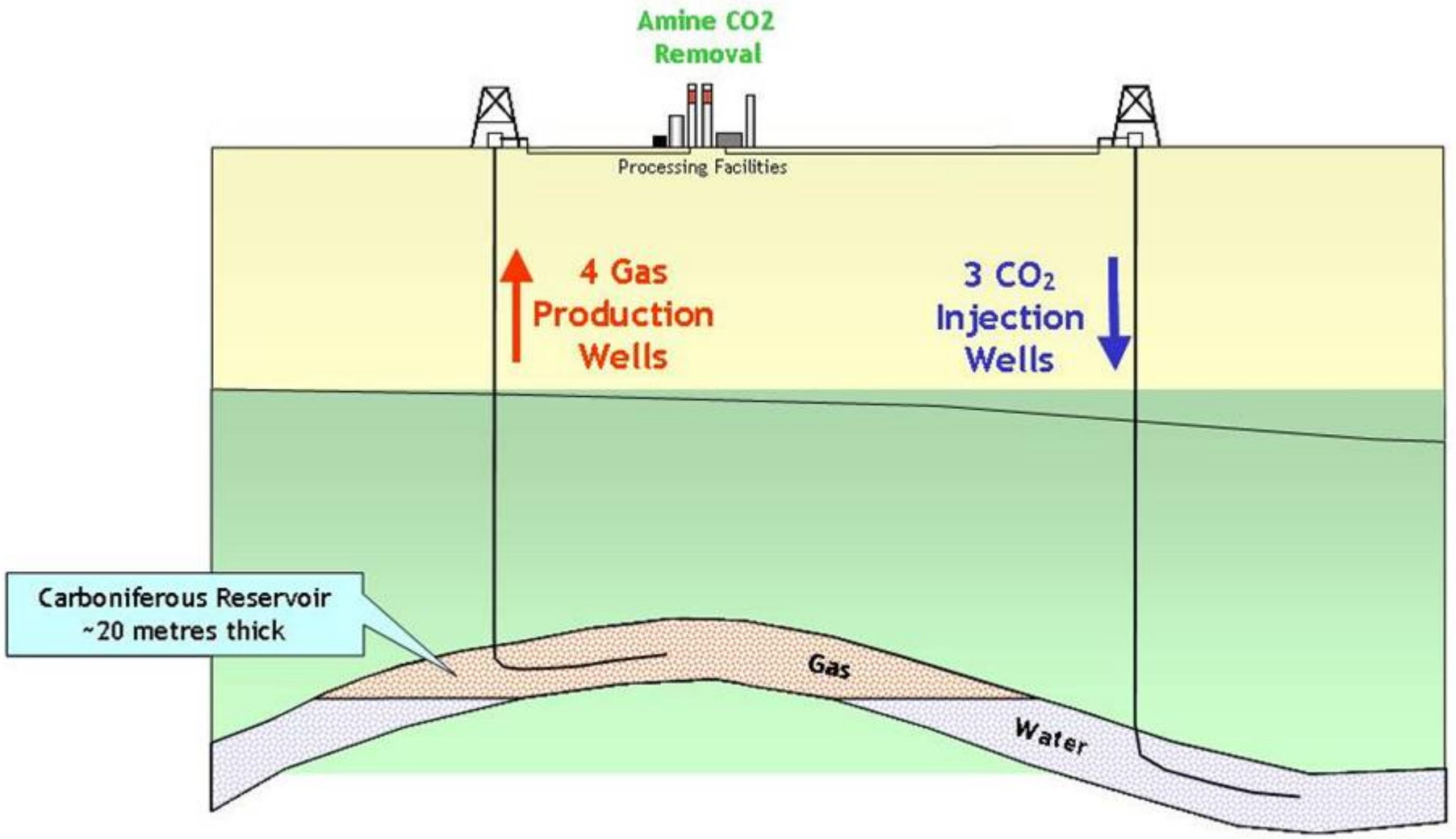
The need therefore was to identify subsurface CO_2 storage locations proximal to the Krechba field area.

A number of reservoir options for the CO_2 storage were investigated close to Krechba, taking in consideration both the shallow Carboniferous and the deep Devonian structures.

Why Krechba ?

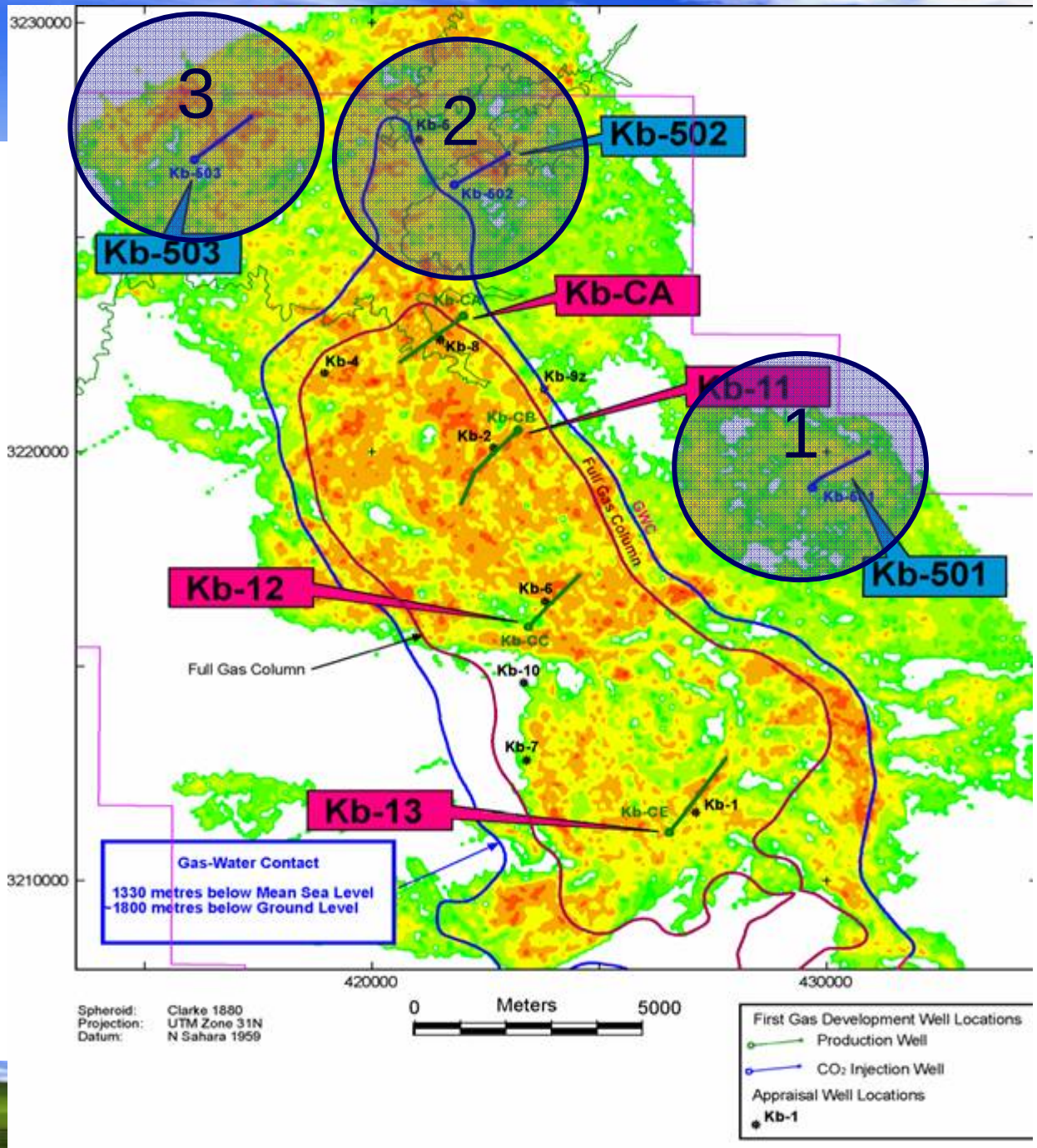
- All Processing facilities are located in one site,
- Seismic data available,
- Existence of exploration and appraisal wells,
- The shallowness of the Carboniferous structure,
- The reservoir has a big storage capacity with a good insulation.

CO2 injection

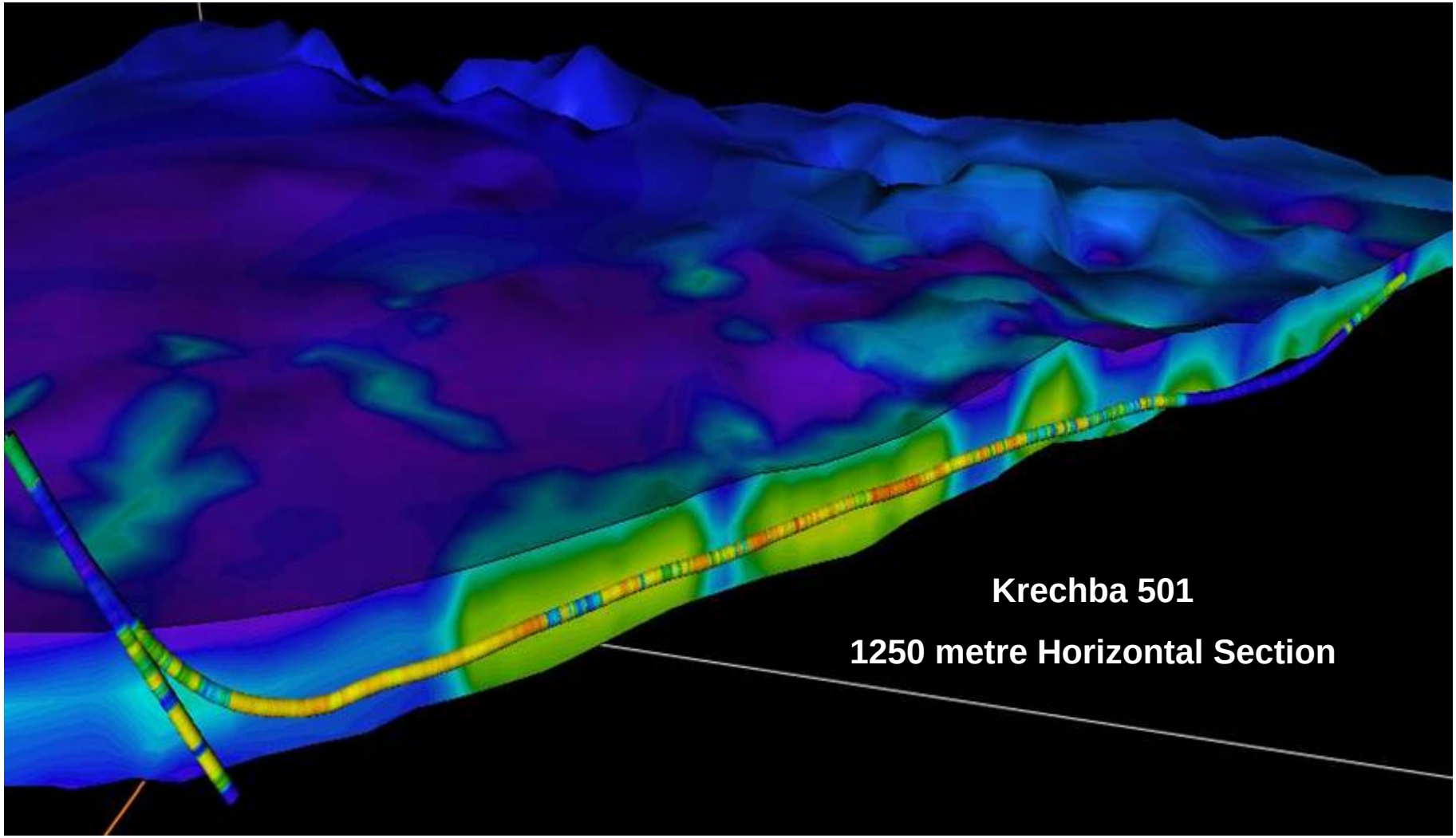


CO_2 injection wells location

3 peripheral injection wells were required to ensure that CO_2 is retained within the aquifer zone and does not enter the main field area until after it has been depleted and abandoned (after 25 to 30 years of production).



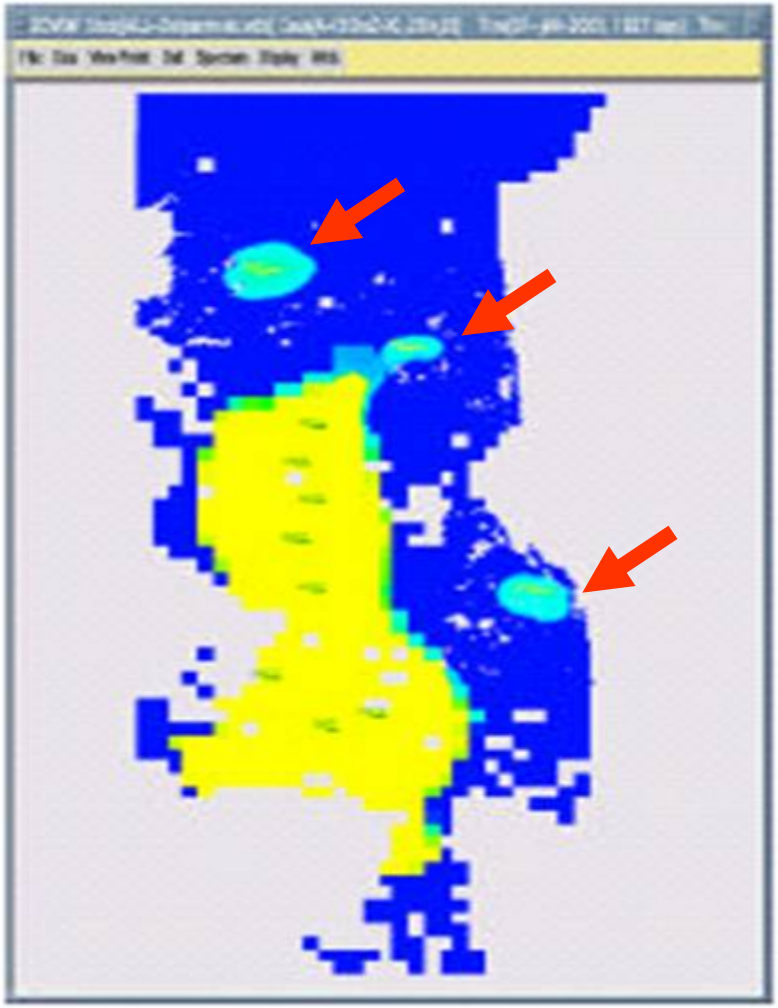
Injector well : Kb-501



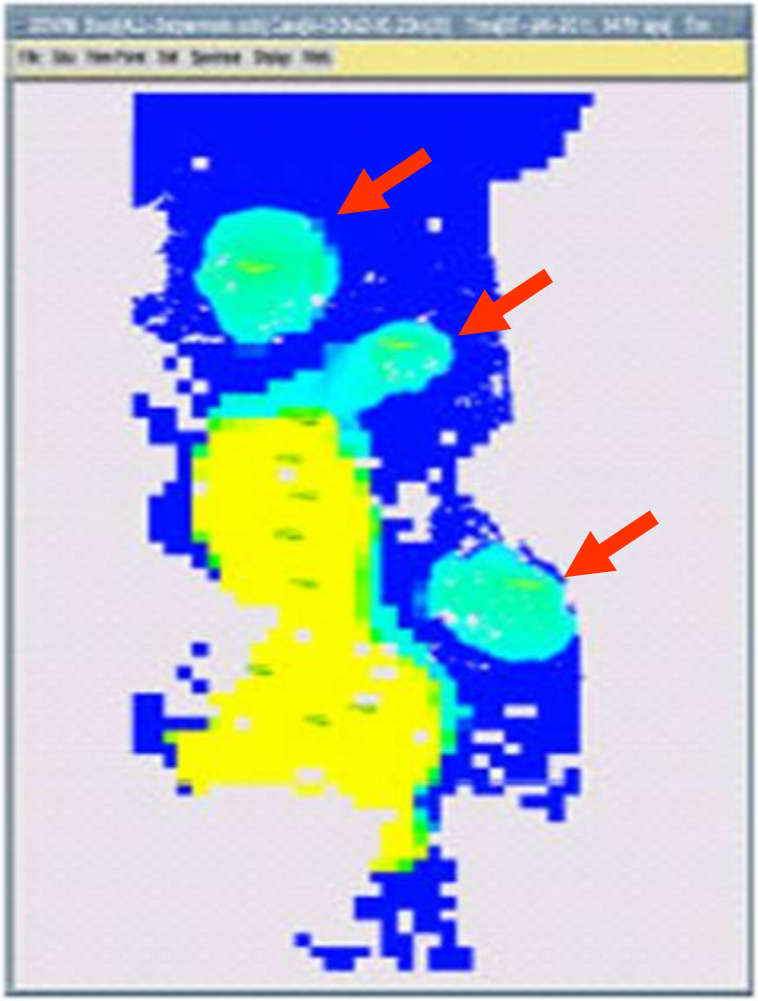
Future CO2 behaviour

- The studies demonstrated that the CO_2 stream injected into the aquifer zone of Krechba Carboniferous reservoir will over time migrate back towards the main Hydrocarbon accumulation and into structural trap.
- It is predicted that during the early years of injection (up to 10 years), the CO_2 will be retained within the aquifer zone near the injector locations.
- However, over the long term, as volumes build in the reservoir, the CO_2 will slowly migrate up-dip towards the structural crest of the main gas accumulation, moving into the main field area only after the field is depleted and abandoned.
- Prediction of the injected CO_2 behavior has been modeled both analytically as well as by numerical simulation.
- The results confirmed that CO_2 breakthrough into the main field area would not occur until after field abandonment (after 25 years of production)

Future CO_2 behaviour simulation



5 years



15 years

Conclusion

- In Salah gas project is one of the largest CCS schemes in the world.
- The project demonstrated that complexity and project size are not blockers to achieving the extraordinary outcome , with large scale atmospheric disposal of CO2 no longer seen as an acceptable option.
- ISG CCS project is expected to lead in setting precedents for monitoring, regulation and verification of geological CO_2 storage and establish CCS as eligible for Kyoto Protocol Clean Development Mechanism.
- The eligibility for CDM is very important to promote CCS in developing countries such as Algeria and OPEC members.
- Carbon Credits will enhance the project economy and help to achieve GHG mitigation at lower costs.

Thank you

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