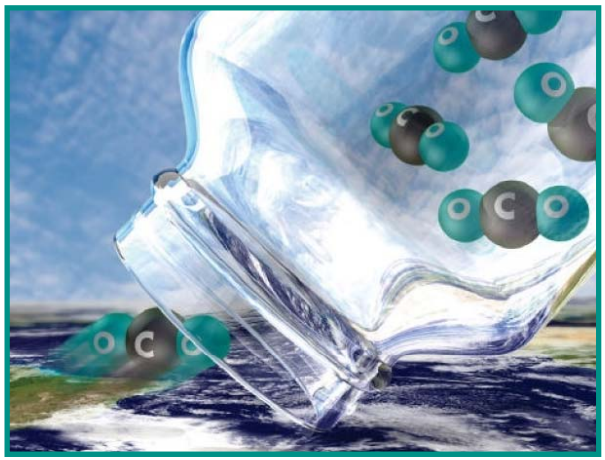
GDF SUEZ : building an intelligent user's position

International Energy Forum – Global CCS Institute
Symposium on Carbon Capture & Storage



Algiers 01-06-2010

R de Lannoy, CCS Program manager, Research & Innovation

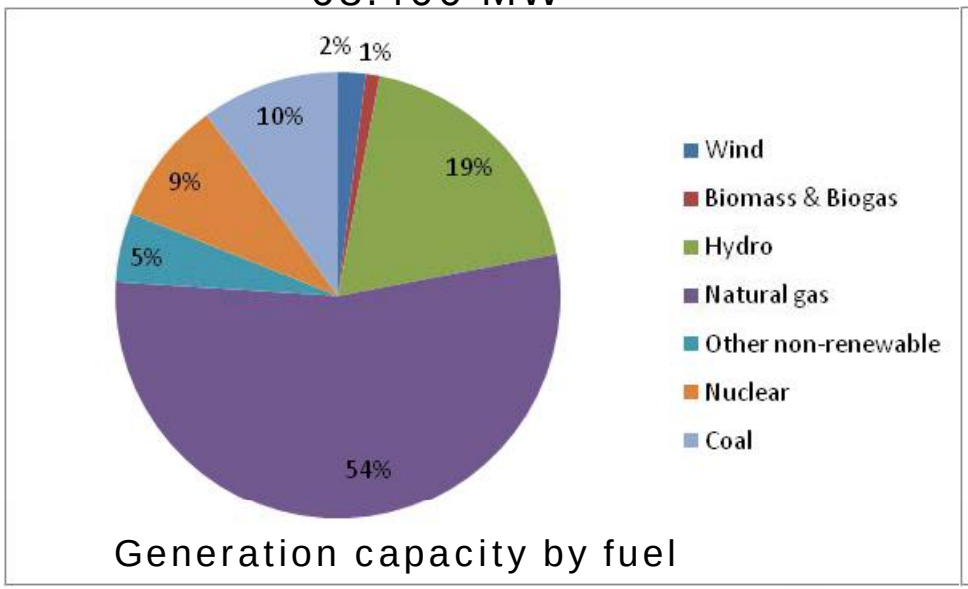
GDF SUEZ : a world leader in energy

- Diversified GAS supply portfolio : 1 235 TWh ≅ 110 Gm³

  with sourcing in > 10 countries

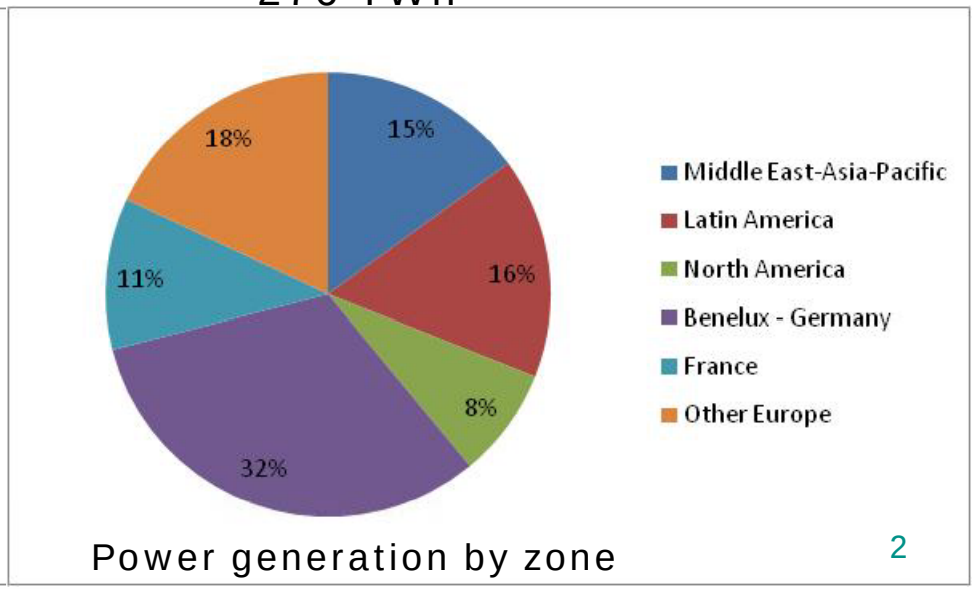
- Balanced POWER generation mix

68.400 MW



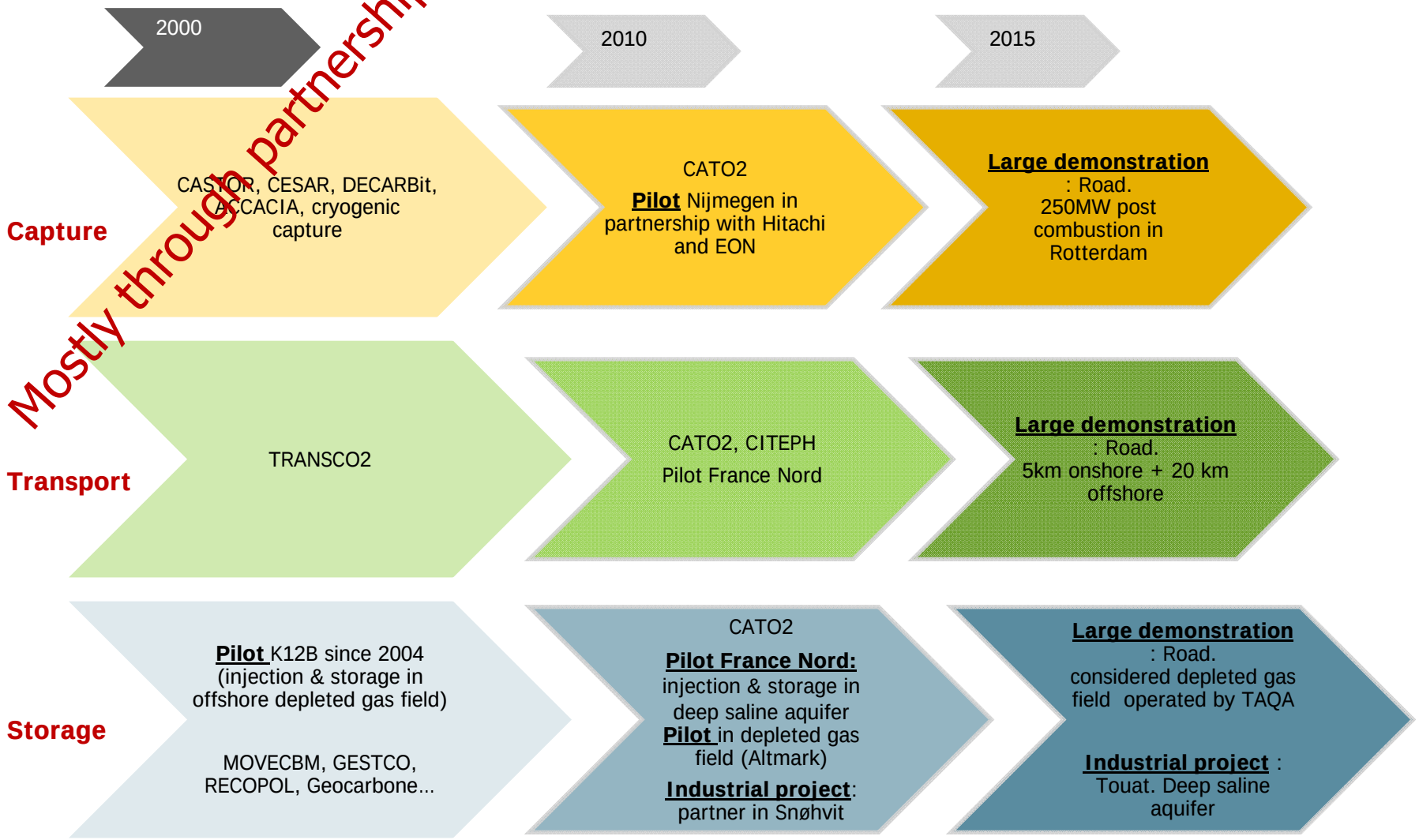
Generation capacity by fuel

276 TWh



Power generation by zone

Building a position of informed buyer / operator



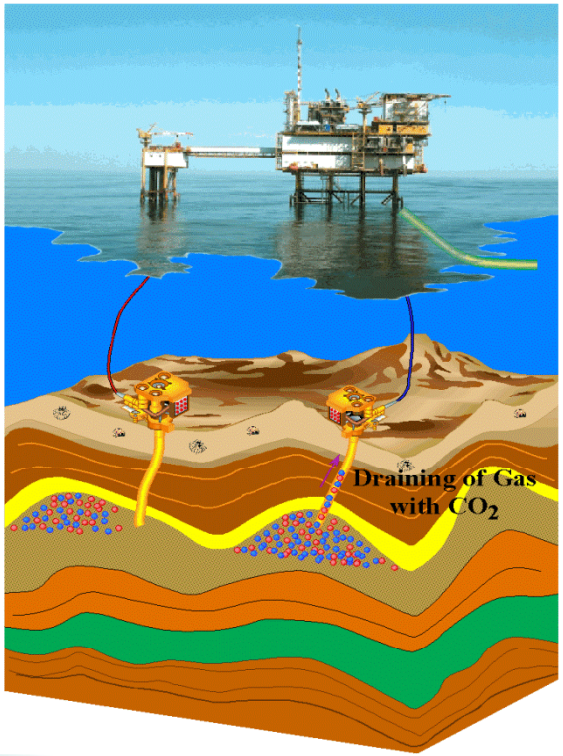
CO_2 injection & storage in K12-B (NL)
2004 - ongoing

Partners: Dutch Ministry of Economic affairs, TNO, GDF SUEZ - DEP

- Injection and storage in a nearly depleted natural gas field at a depth of almost 4000m
- Started in 2004 (CO_2 is separated from natural gas and used to be vented to the atmosphere before the injection project)
- Testing feasibility of CO_2 injection & EGR potential
- Studying well integrity & injectivity and CO_2 behavior in the reservoir,
- Monitoring & numerical simulation
- Since the start of the project, more than 80 000 tonnes of CO_2 injected in the reservoir

ENCOURAGING RESULTS

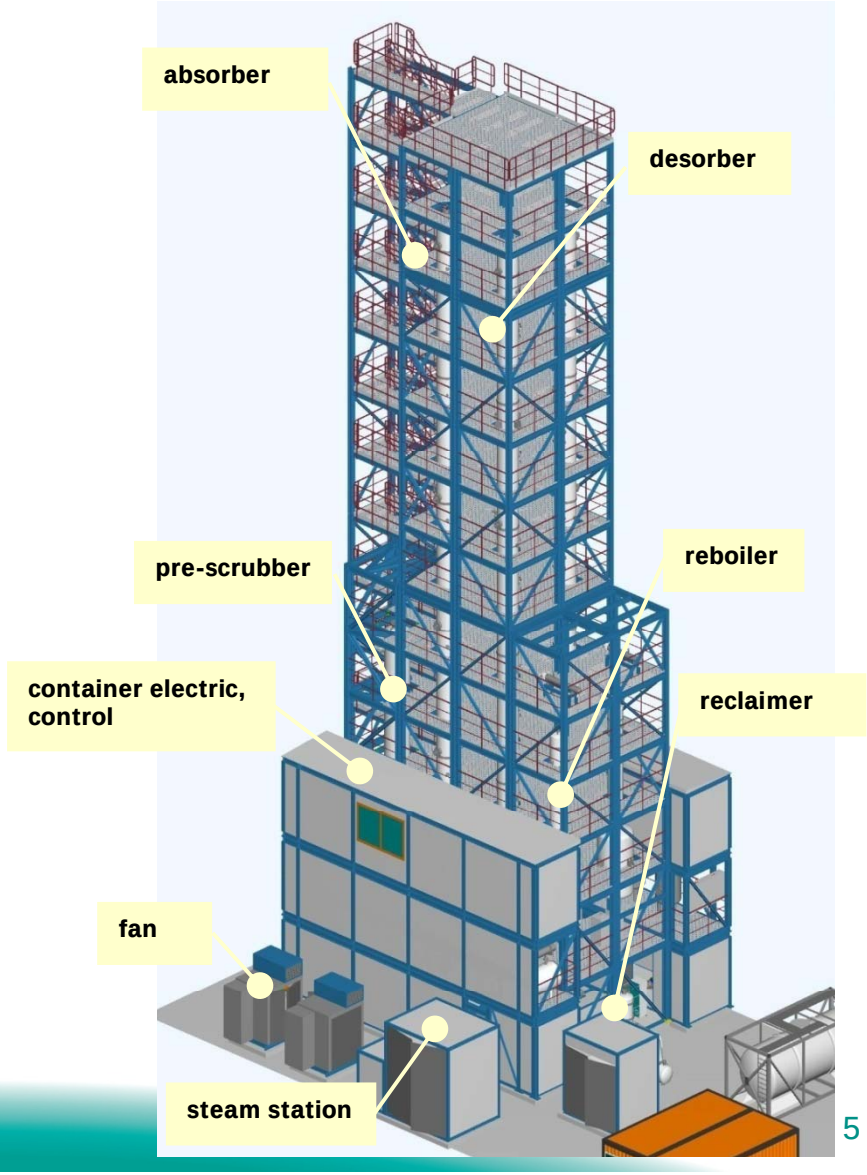
- Good injectivity despite relatively low permeability
- CO_2 injection without problems and as predicted
- Operational performances could be accurately modelled and understood
- EGR in terms of pressure support



Mobile pilot plant for CO_2 capture

Partners: HPE, E.ON, GDF SUEZ – Electrabel

- Design, build and operate a test facility to investigate the behaviour of different solvents in the process of CO_2 capture from flue gases
- Main objectives:
  - Acquiring operational experience
  - Lowering the energy consumption
  - Assessing the environmental impact
- Operational end 2010 → 2014
  at EBL and E.ON sites → mobile pilot plant
  First 2 years at EBL power plant
  in Nijmegen (NL)
- Real flue gas conditions:
  5000 Nm^3/h ~ 5 MW_{th} (≈ CASTOR)



EEPR proposal Rotterdam

Electrabel / E.ON - “ROAD” 2015

CAPTURE

Post combustion capture unit **250 MWe** equivalent

Captured CO_2: **1,1 Mton/y** (90% capture rate)

Power output penalty: aprox. **65 MW**

- 2010: Substantial commitments
- 2015: Whole chain operational (capture, transport, storage)
- Feed studies ongoing

TRANSPORT

GDF Suez E&P Nederland is preferred sub contractor for the pipeline

- 16” pipeline (4 km onshore and 21 km offshore)
- Transport capacity is 5 Mton/yr (dense CO_2)
- Pipeline design:
  - Operating pressure 20 – 150 bar
  - Operating temperature 20 – 110 °C

STORAGE

TAQA is preferred sub contractor for storage.

Storage capacity in the P18/A field estimated at ~ 25 Mton

- Fields at a depth of 3500 m
- Original pressure 350 bar, pressure after gas production estimated 30 bar
- No EGR foreseen

Challenges

1. Partnership are valuable & necessary to share costs and risks

2. High CAPEX & OPEX while :

   a) Uncertainty on future cost of CO2
   b) Impact of renewable on the Power Plants merit order

3. Public perception will be determining for the deployment: impact of the first demonstration projects

4. How will the supplier's market keep the momentum while buyers await the results of the first demonstration projects?

Success factors

A stable, long-term framework must be in place to create strategic alignment for CCS(*)

Key requirements for the development and implementation of CCS are:

- Suitable geological conditions for CO_2 storage
- Implementation of the Storage Directive in Member States
- A sound business case
- Public and political support

Industry is willing to develop and implement CCS as a critical carbon mitigation technology if <u>all</u> requirements are fulfilled

(*) source ZEP Working group

CONCLUSIONS

- CCS is **promising technology (for 60 – 100 yrs, during energy transition towards post fossil fuel)** to efficiently combat climate change

- GDF SUEZ will continue its efforts in **R&D and pilot projects** in order to assess and improve technical and economic feasibility of CCS, and in particular to lower energy penalty

- **Demo projects** are necessary to test technologies at industrial scale: GDF SUEZ welcomes EU and MS initiatives and is assessing at present its possibilities to participate in demo program

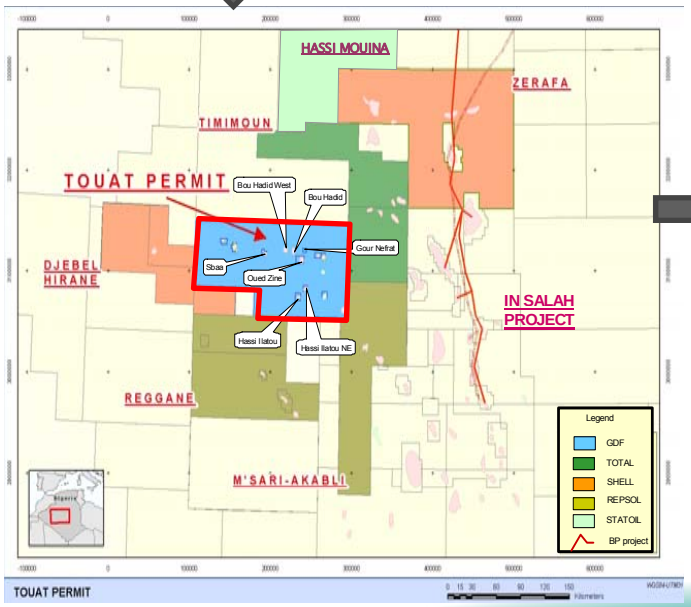
- GDF SUEZ is committed to **assess feasibility of CCS for its new fossil fuels fired power plants,** to take adequate measures (capture readiness) if appropriate and under specific circumstances considers the technical and economic feasibility of CO2 storage for its E&P activities : e.g. TOUATGAZ

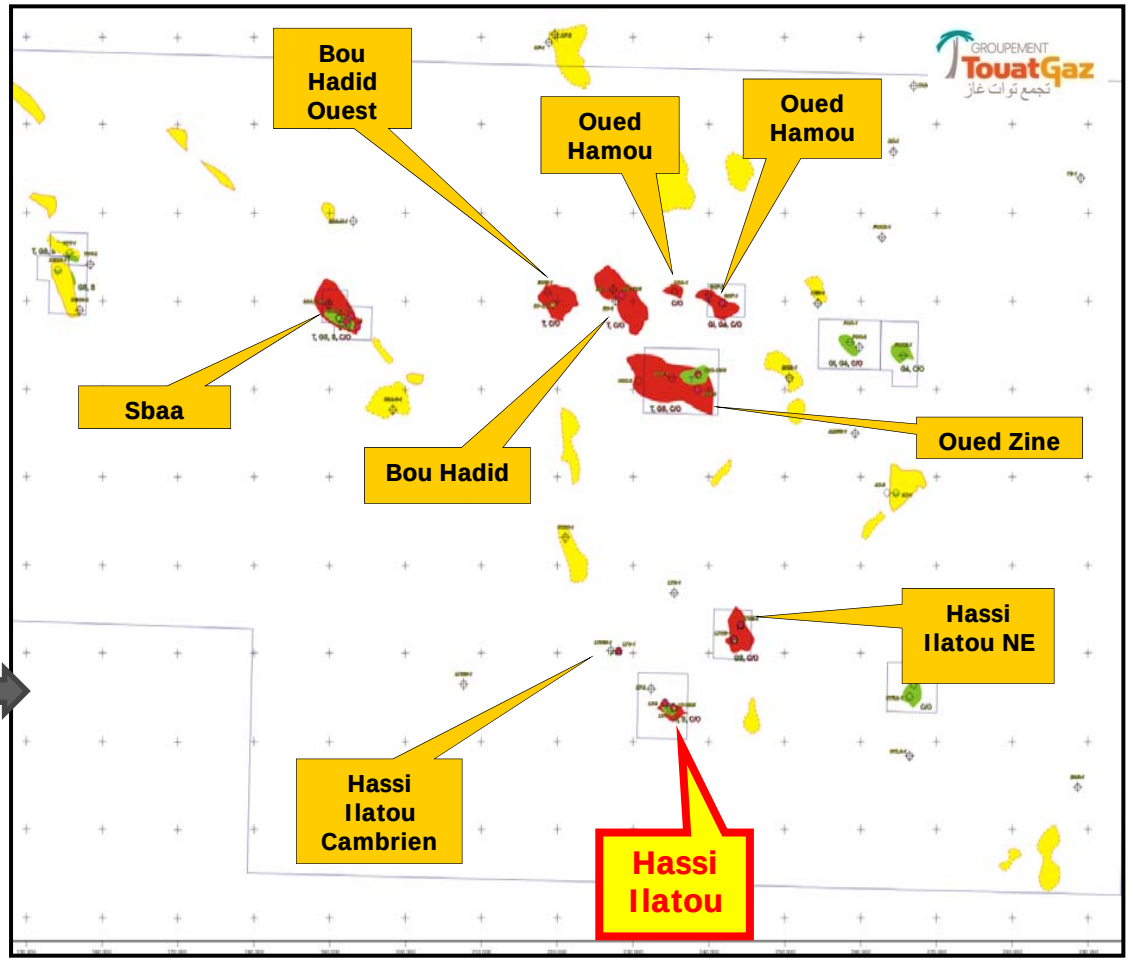
TOUAT / HASSI ILATOU
CO2 INJECTION/STORAGE PROJECT

Groupement Touatgaz

JV between GDFSUEZ and SONATRACH

TOUAT PERMIT LOCATION





TOUAT project : Project Timeline

- Exploration period from 28th January 2003 to 2007, GDFSUEZ as operator.
- Participation interest: GDFSUEZ 65% - SONATRACH 35%
- Commerciality declaration 26th January 2009
- Production licence from ALNAFT the 22th June 2009
- Exploitation phase duration 30 years
- Exploitation will be performed by the Groupement Touatgaz
- Drilling spud is planned in 2011 with the first CO2 injector well

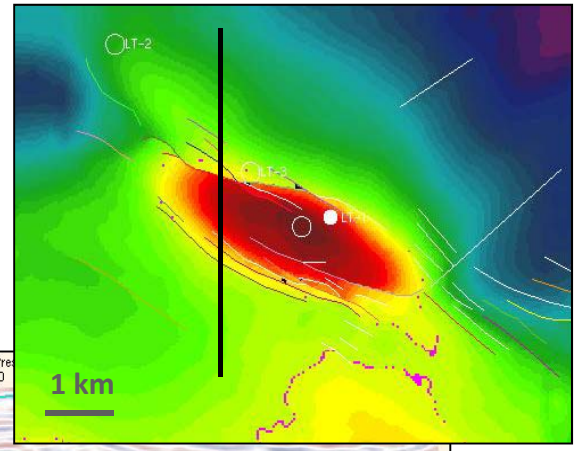
TOUAT project : Why re-injecting CO2 underground ?

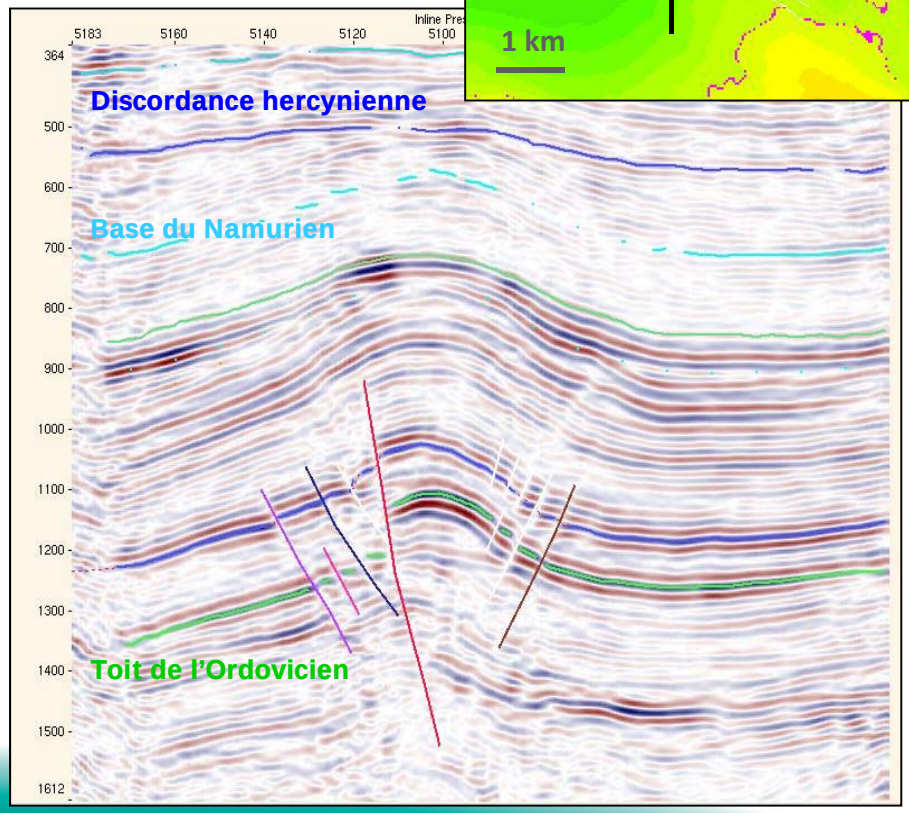
- CO2 content : average ca. 7% mol.
- Sales gas specification requires 2% max of CO2 content
  ➔ CO2 need to be removed from raw gas
- CO2 may be vented to atmosphere or re-injected underground
- No regulatory requirements to inject CO2 underground.
- However, for obvious environmental reasons and in the frame of the sustainable development policies of GDFSUEZ and SONATRACH, the TOUAT development plan includes underground CO2 sequestration as a clear objective...
- ... But it is subject to technical and economical feasibility!

Hassi Ilatou Field (LT) Structure

Field screening: selection of LT field

- Best candidate characterisation:
  - 300 meters closure
  - Cambro-Ordovician reservoir
  - Gas bearing field
  - Intercalation in-between of a local seal (Lower Ordovician shale)





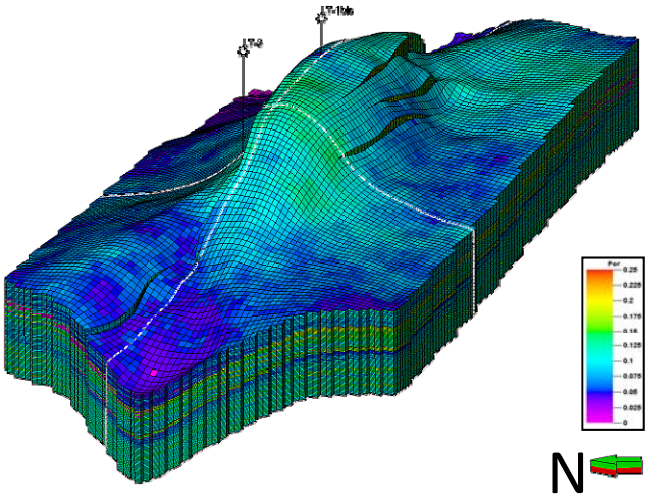
Hassi Ilatou – CO2 Sequestration Main steps

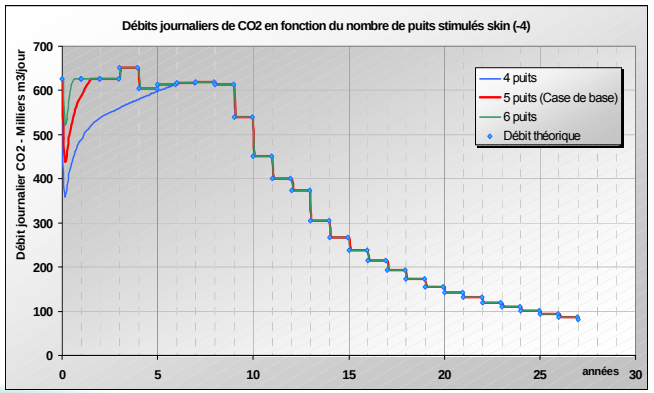
OBJECTIVE : To re-inject within the Hassi Ilatou field the equivalent of 80% at least of 3.56 Bcm of CO2 (daily rate of 1200 t/d).

Main steps

- Sensibility studies and feasibility (2008-2010)
  - Sensibility studies
  - Reservoir Simulations (LT)
- Preparation stage (2010)
  - Pilot well program
  - Well preparation et acquisition program
- DRILLING OF PILOT WELL (2011)
- Pilot well evaluation & conclusions
  - Pilot Evaluation
  - G&G models
  - Update CPF+ cost → DECISION

Porosity Distribution





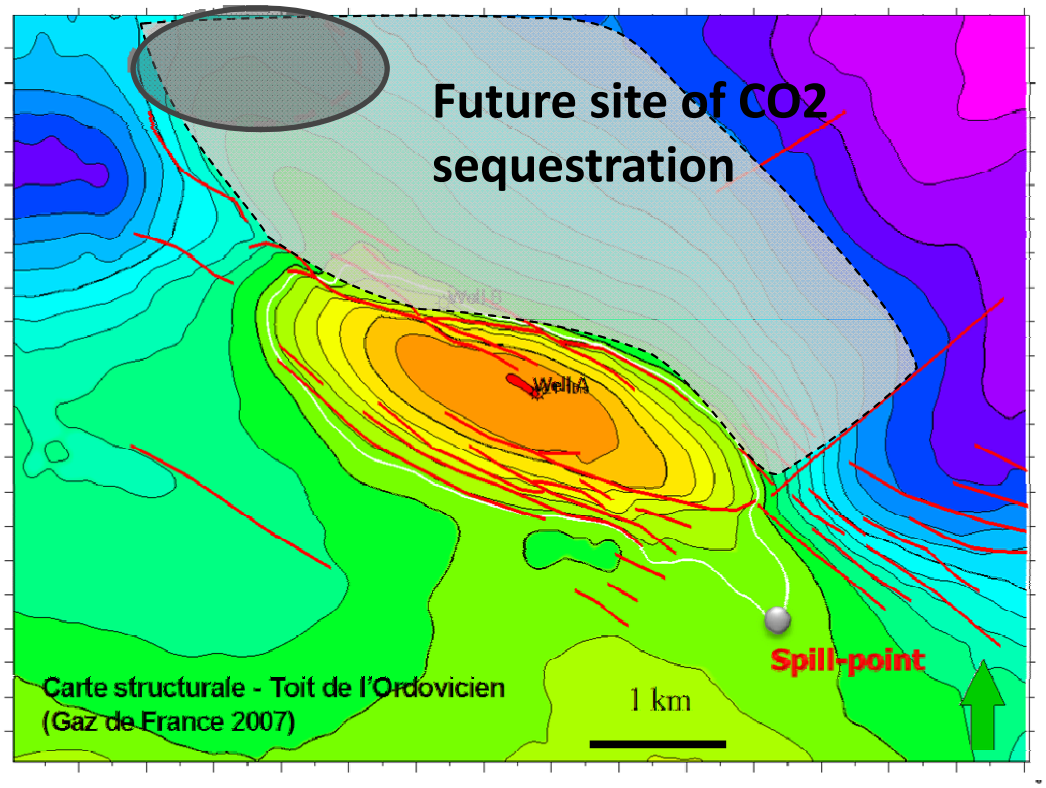
Hassi Ilatou – CO2 Sequestration Main technical options (1/2)

- Rate : 1200 t/d of hypercritical CO2, over 30y (eq 3.56 Bcm)

- Site: Northern flank (opposite of spill point), downdip of the main gas accumulation, within aquifer leg

- Wells: 5 vertical, hydraulically fractured

- FWHP max: 270 bars



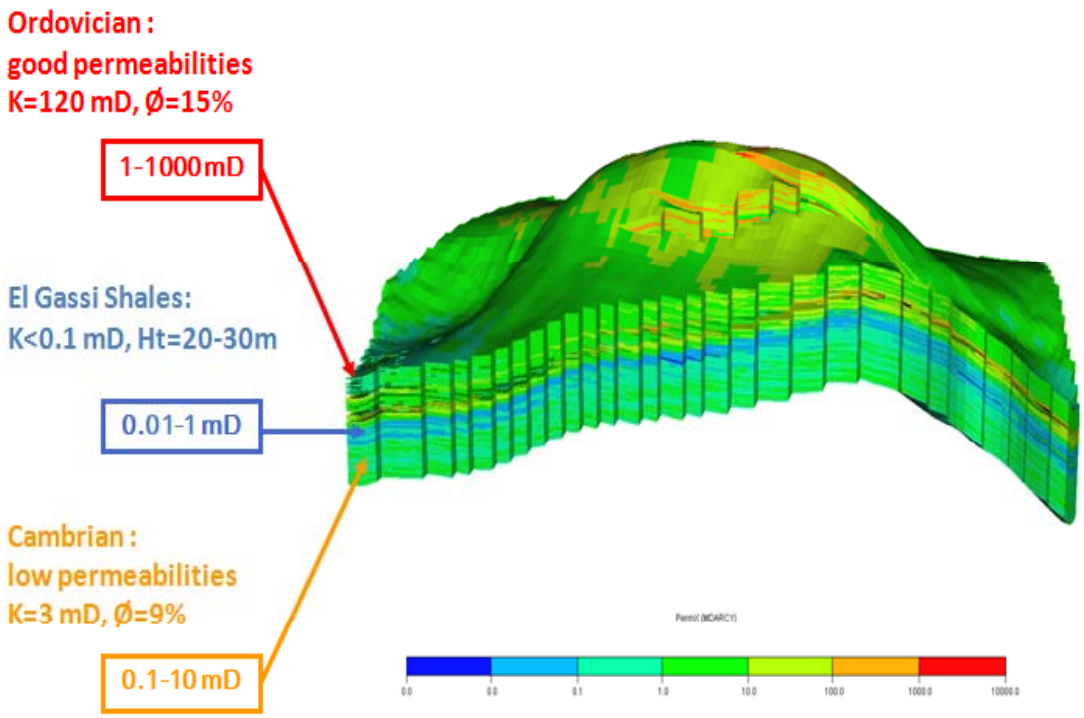
Hassi Ilatou – CO2 Sequestration
Main technical options (2/2)

- <u>Reservoir Target:</u>

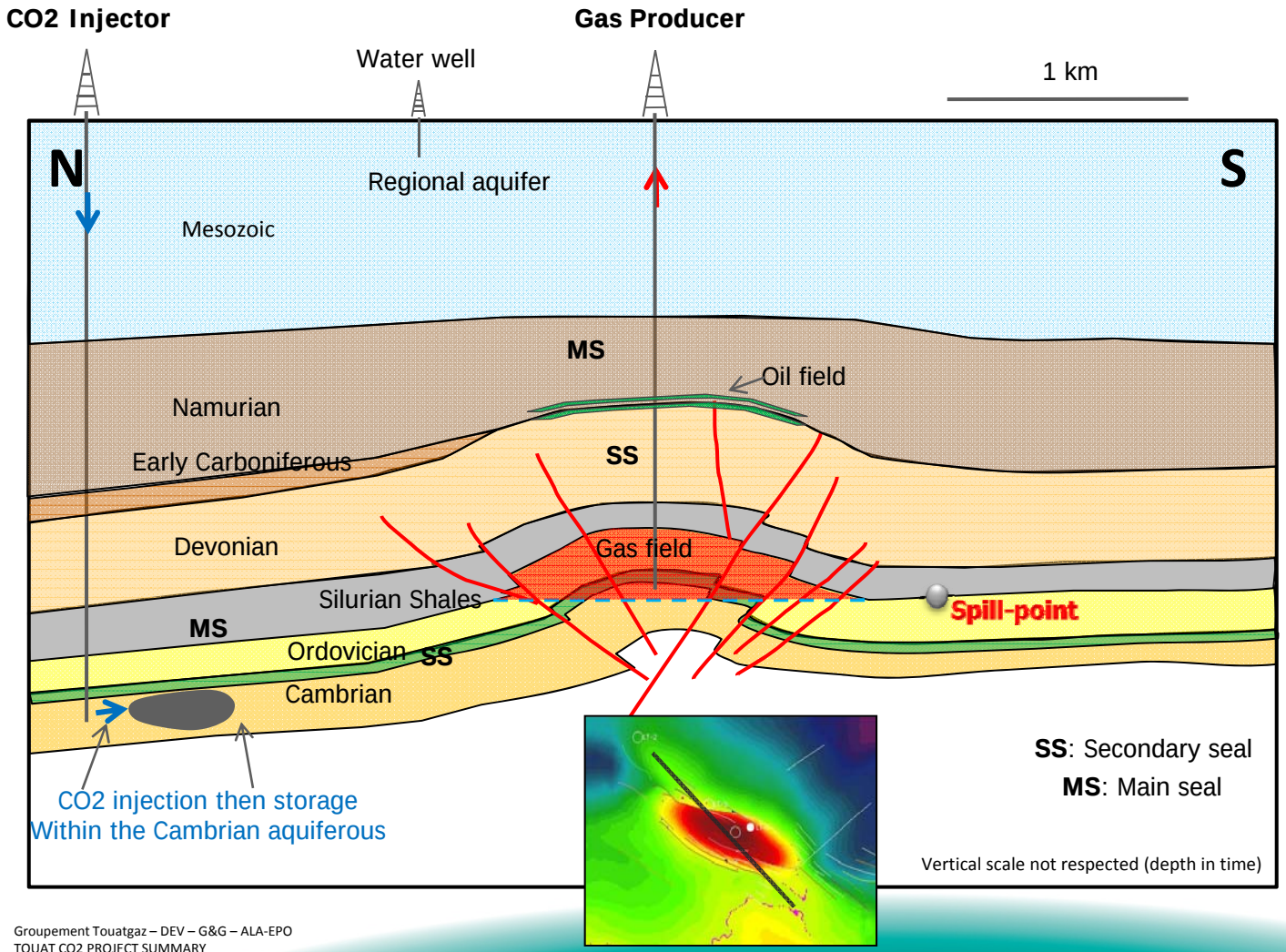
Cambrian, 1-10mD perm, 6-12 pu porosity, 9 pu in avg, 500m thick

- Associated Seal: Unit III-1 (eq. El Gassi Shale, L.Ordovician).

- <u>Main seal:</u> Silurian, 300m thick + Devonian & Namurian



Hassi Ilatou – CO2 Sequestration Concept



INTEGRITY & CONFINEMENT:

- **Injection far from main seal (Silurian) → protection of Mesozoic regional aquifer**
- **Opposite of Spill point**
- **Proven cap rock (gas field)**
- **Local confinement of CO2 plume due to low permeability & intermediate vertical flow barrier …**

…But

- **Well stimulation compulsory**

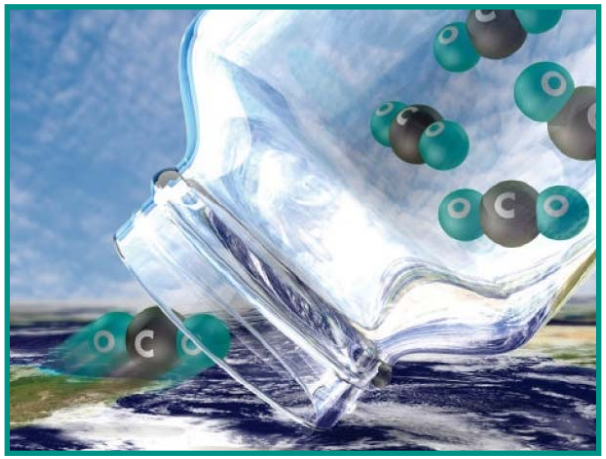
Touatgaz CO2 project : Results & conclusions

- **Expected CO2 underground performance** (simulations)
  - CO2 well confined within Cambrian
  - No breakthrough to LT gas field after 150y
  - Between 70 to >90% of CO2 re-injected according to sensitivities
- **Main uncertainties**
  - Well injectivity (stimulation, reservoir properties)
  - Aquifer mobility
  - Well performance sustainability

GDF SUEZ

Research & Innovation

Improving the present
& Preparing for the future



Thank you for your attention