

The experience of Lacq industrial CCS reference project

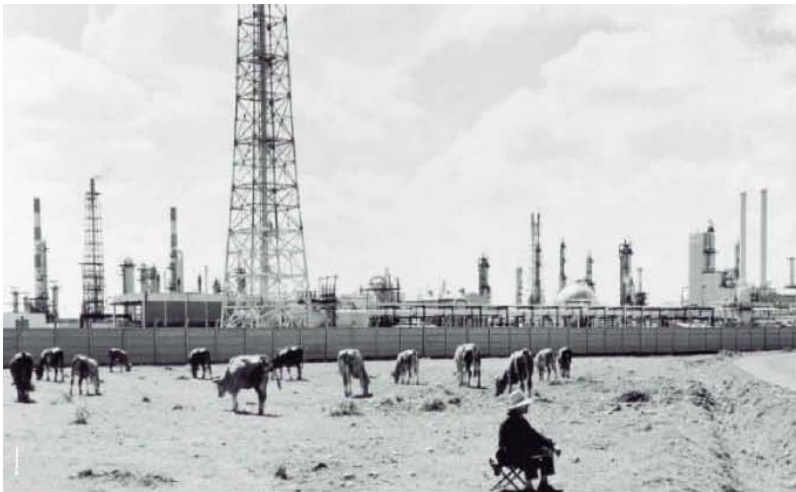
Carbon Sequestration Leadership Forum

Lacq, France - March 17th 2010

Nicolas AIMARD – Total CCS R&D Program Manager and Lacq CCS Project Manager



Total Exploration & Production France

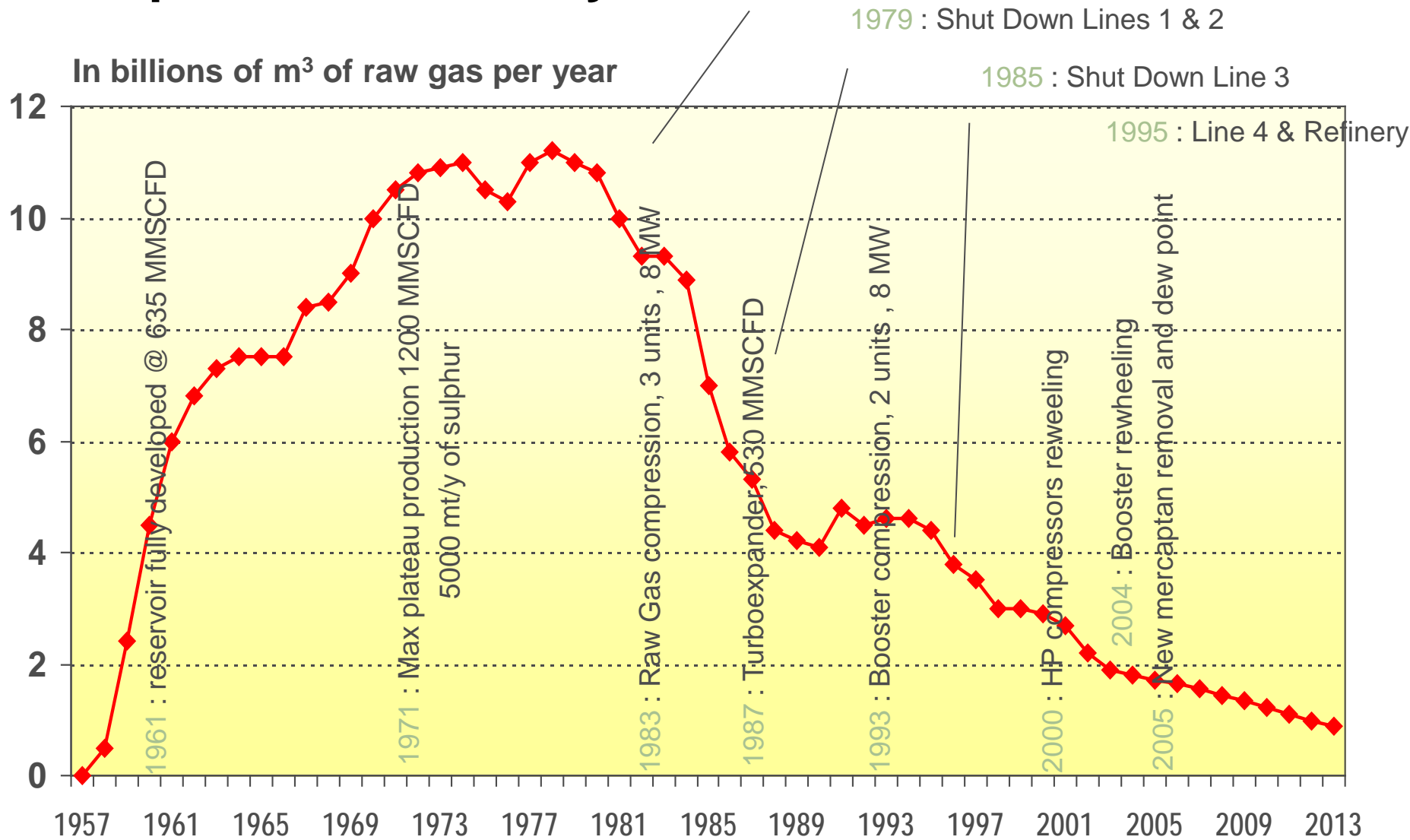


BASSIN AQUITAIN

- Champ d'huile
- Champ de gaz
- Stockage gaz commercial
- Oléoduc

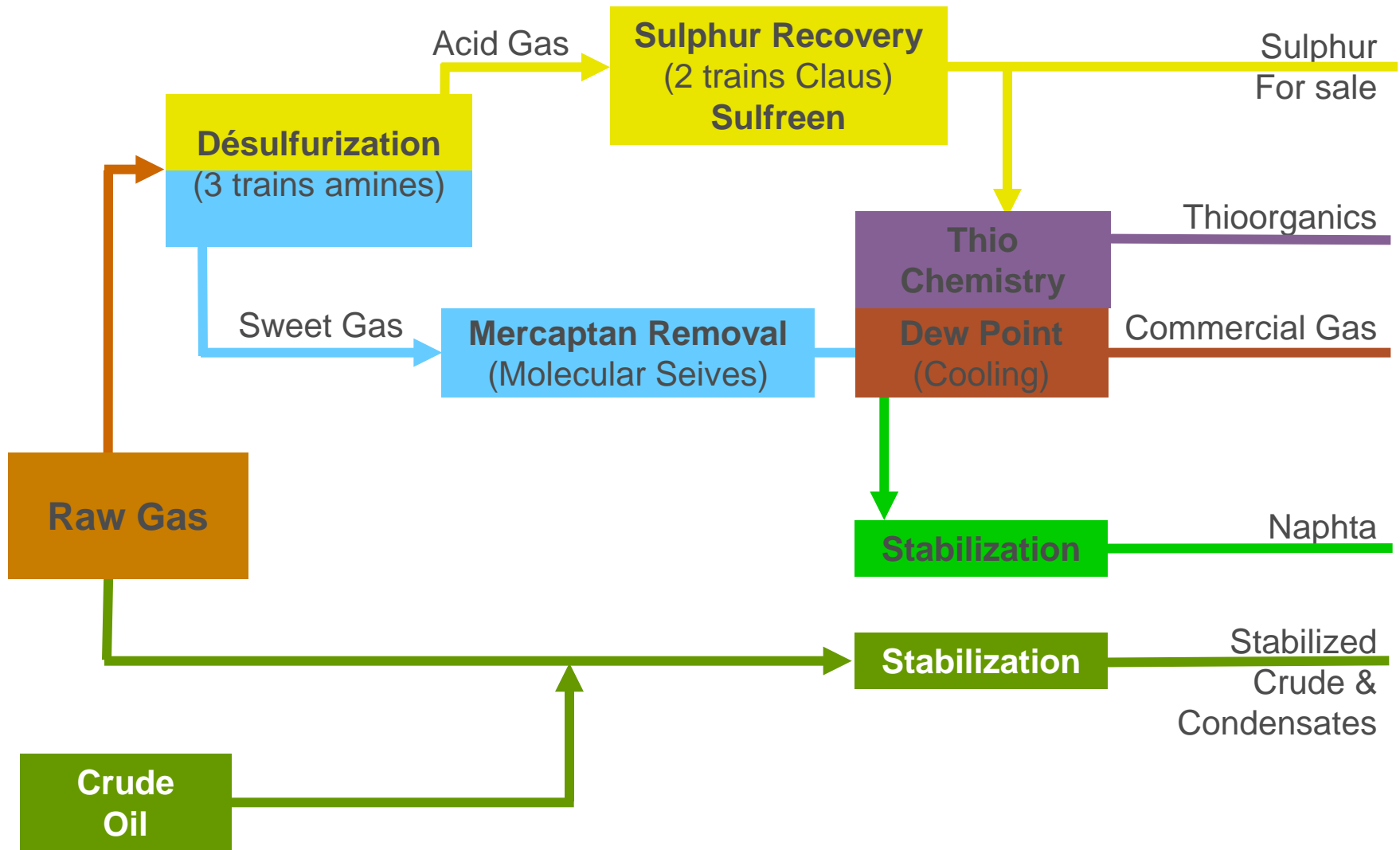


Gas production history – Forecast

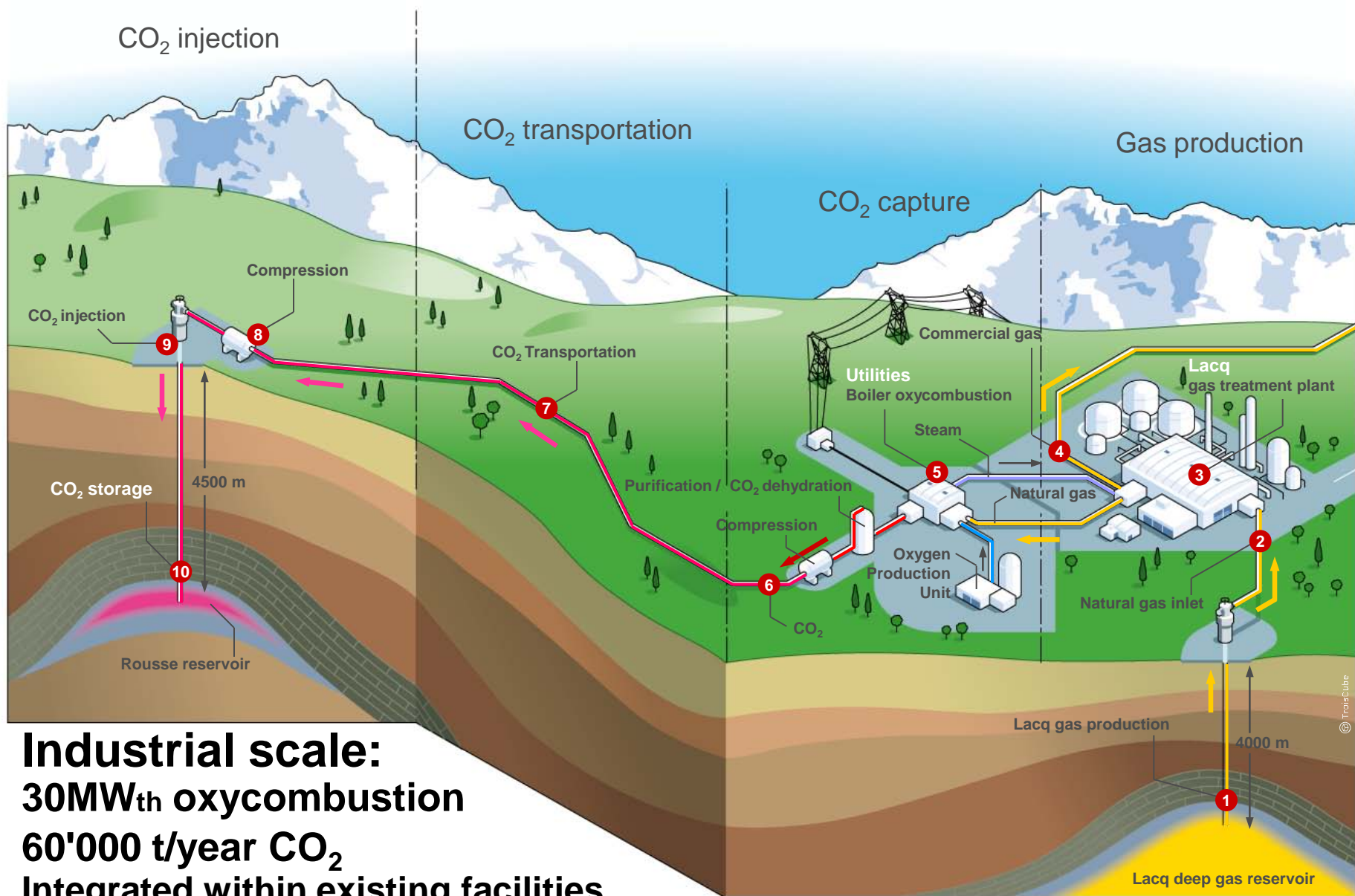


97 % recovery factor

Lacq Plant – General Flow diagram

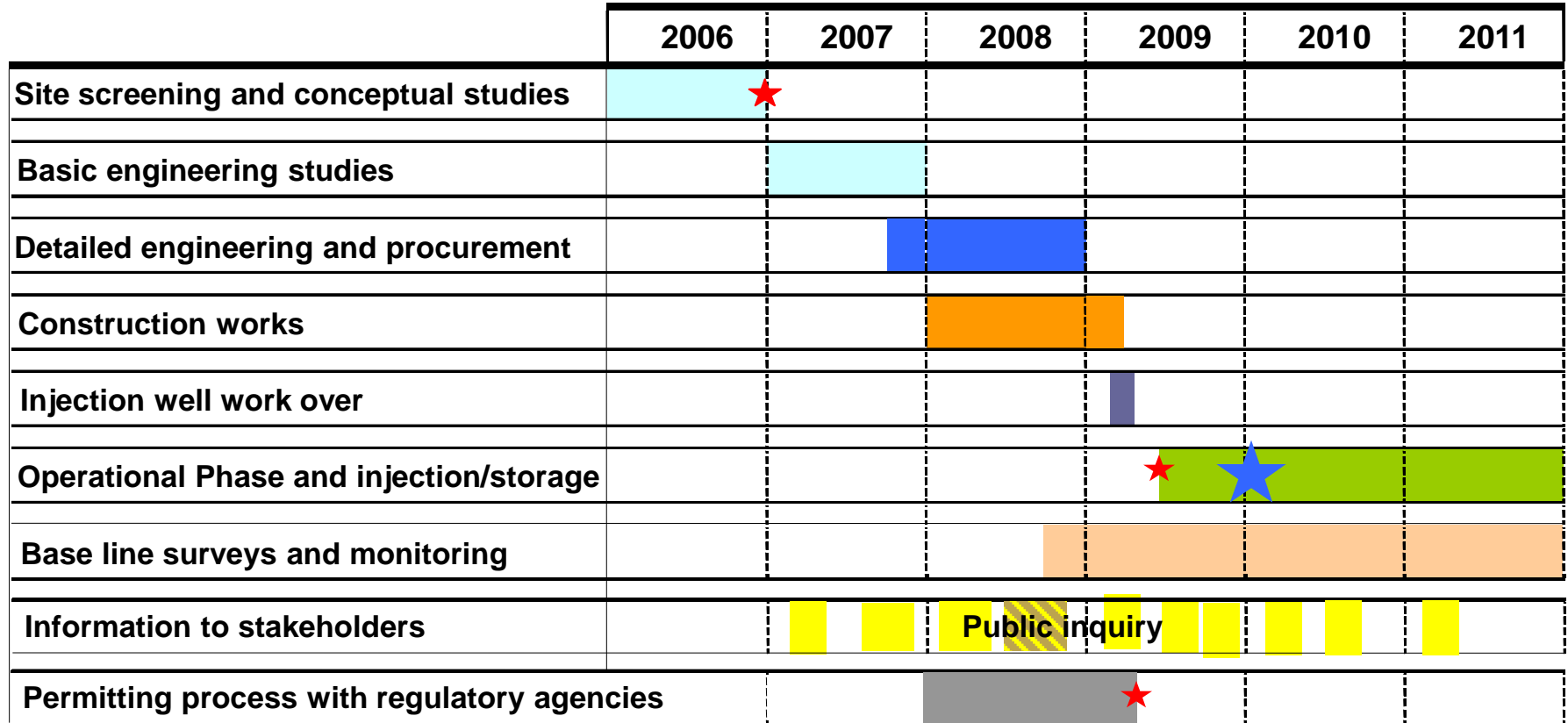


An integrated carbon capture, transportation and geological storage in a depleted gas field project



Industrial scale:
30MW_{th} oxycombustion
60'000 t/year CO₂
Integrated within existing facilities

Project schedule milestones

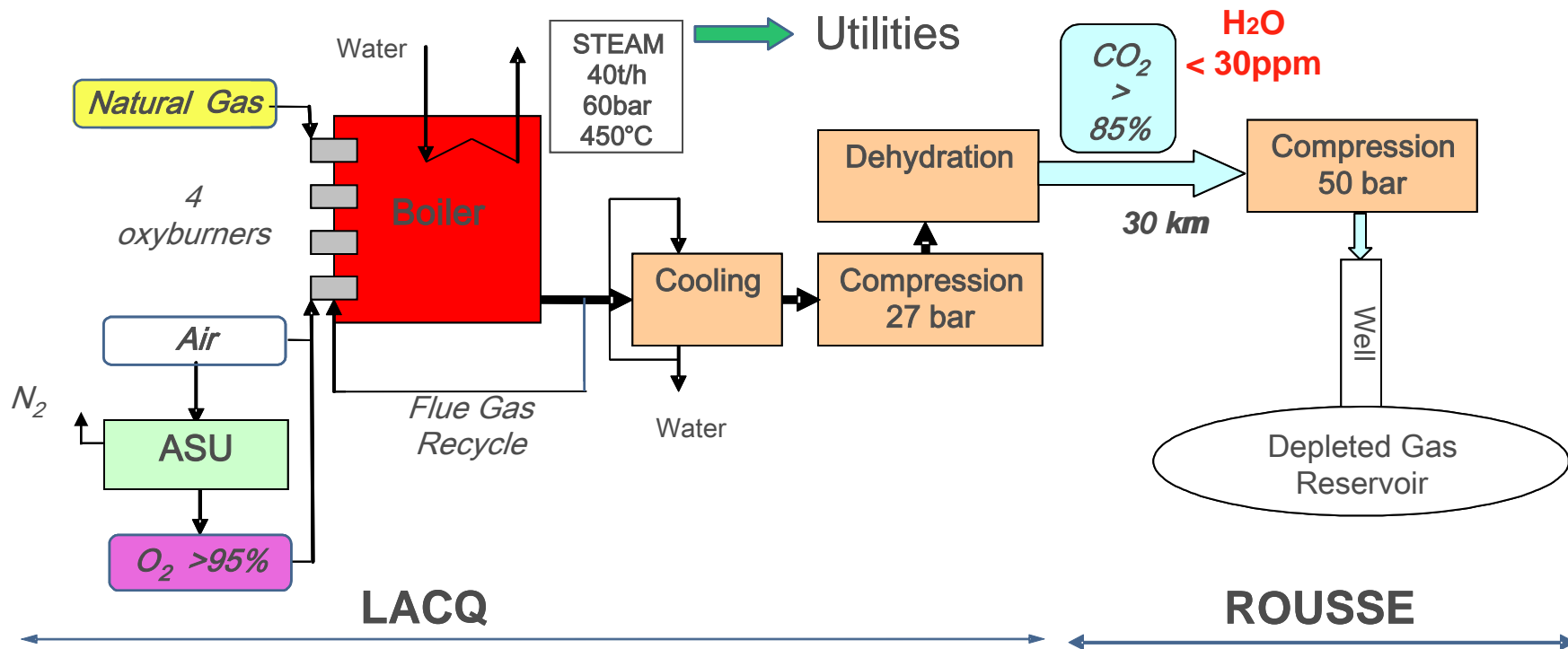


Start up of operational phase : July 3rd, 2009

Official integrated project inauguration on Jan. 11th, 2010



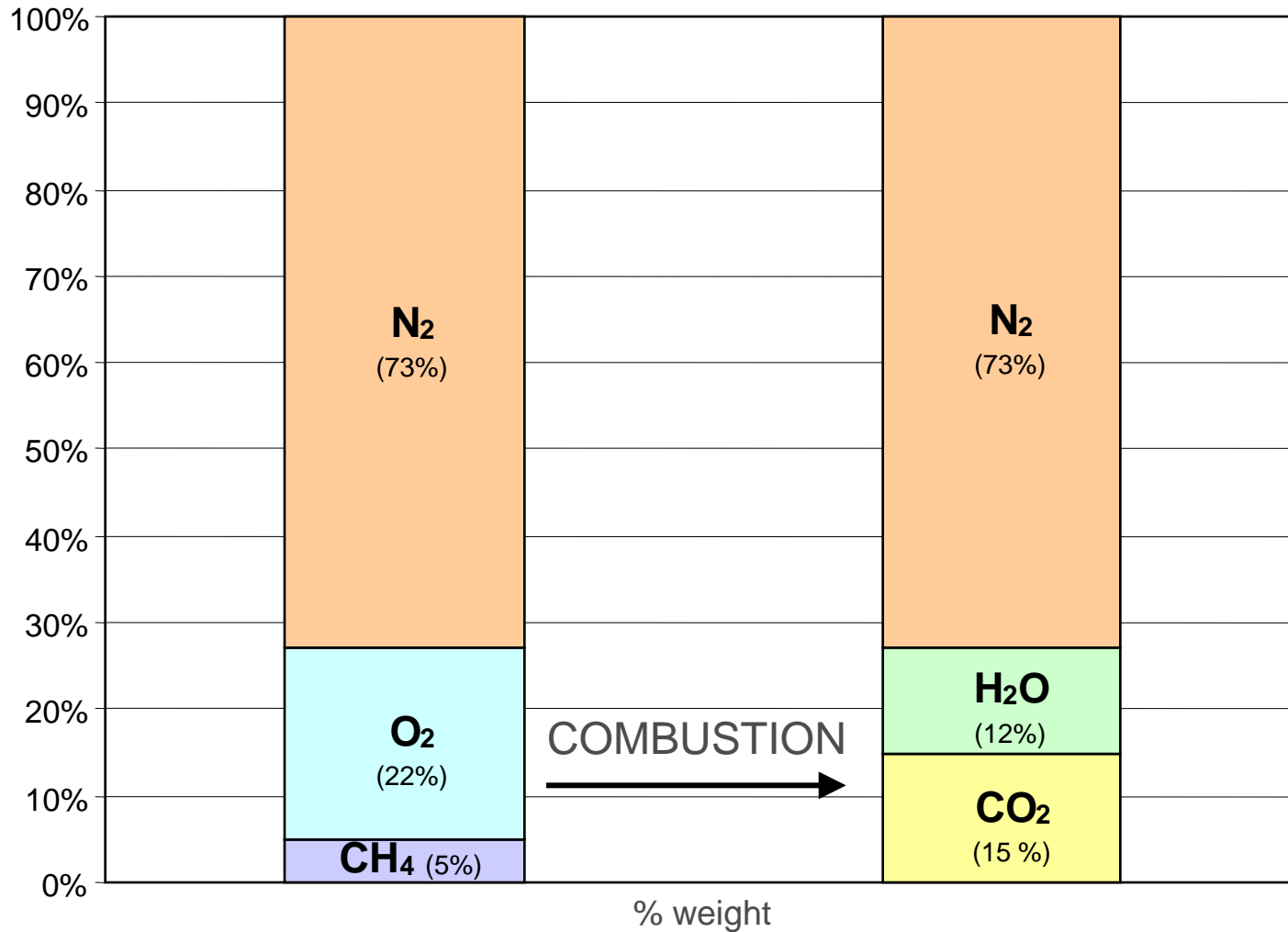
Oxycombustion as part of a CCS integrated pilot



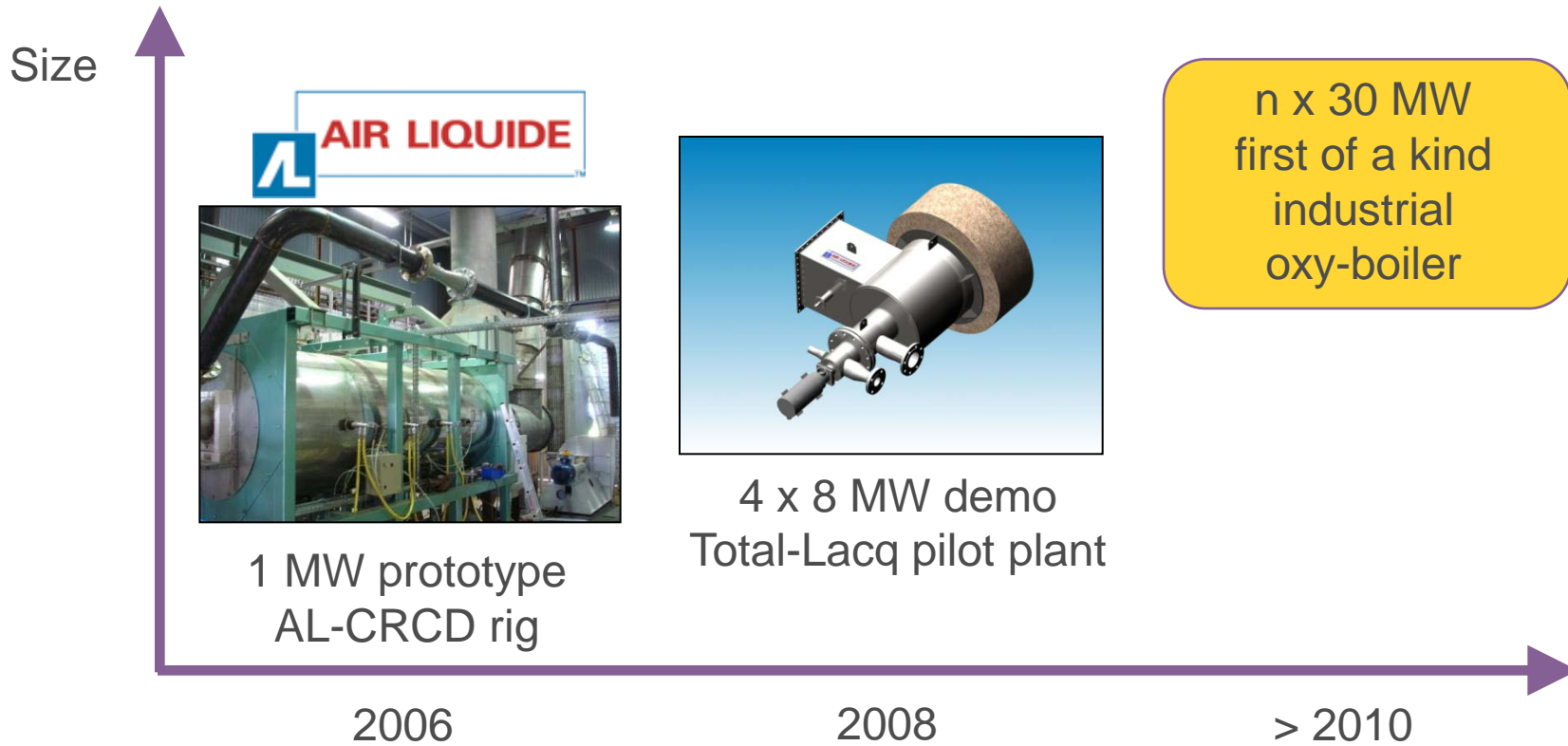
- Industrial scale 30MWth oxycombustion unit with gas
- Revamping of a conventional boiler
- CO₂ transport and injection for 2 years
- 120 kt CO₂ storage in a depleted reservoir
- First CO₂ injection for storage in France
- Public acceptance with consultation and dialogue
- Upscaling of oxyboilers for high steam/power generation

Principle of oxycombustion

AIR COMBUSTION



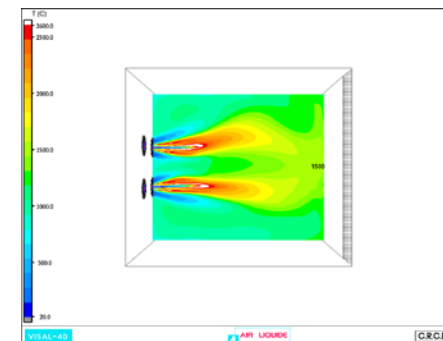
Oxyburner and oxyboiler upscaling program set up



► Upscaling know-how

► CFD modeling using proprietary code

- Specific to oxycombustion
- Calibrated with real oxycombustion data



1 MWth Oxycombustion test rig



Objectives:

- Expand scientific knowledge on oxy-flames.
- Contribute to industrial oxyburner design
- Test Lacq 1MW prototype burner

Versatile and functional test rig

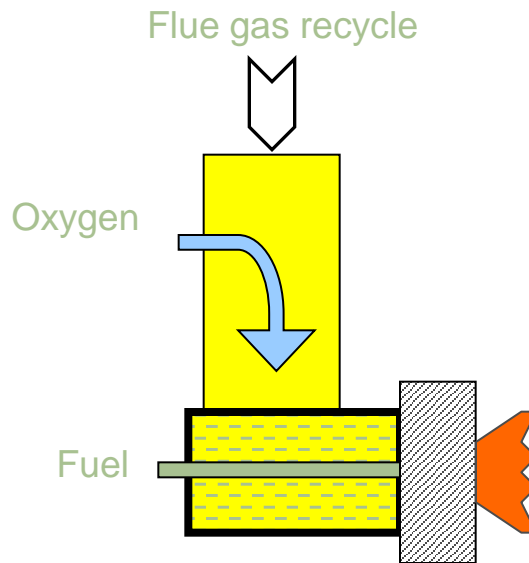
- Variable FGR rate and temperature
- Liquid / gas fuel feed capability
- Cold wall configuration
- Combustion monitoring



Air Liquide Oxy-burner Principle

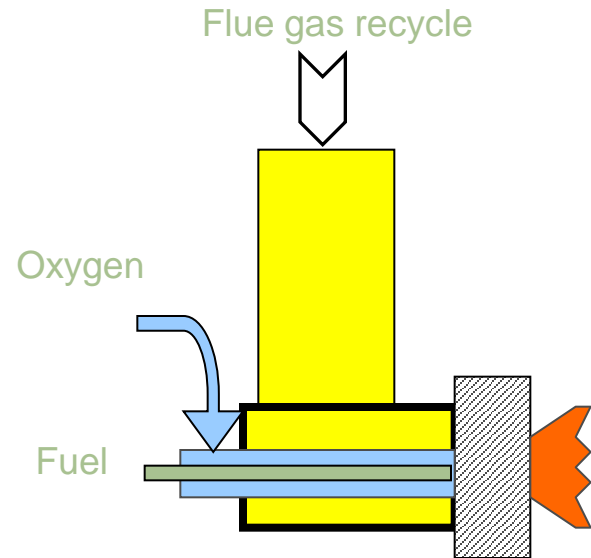
No external oxygen mixing:

- ▶ Intrinsic oxygen flames advantages: flame stability, turndown ratio, uneasy fuels.
- ▶ Improved operating safety: dedicated pure oxygen circuit all along distribution system.
- ▶ Additional flexibility to adjust FGR rate.



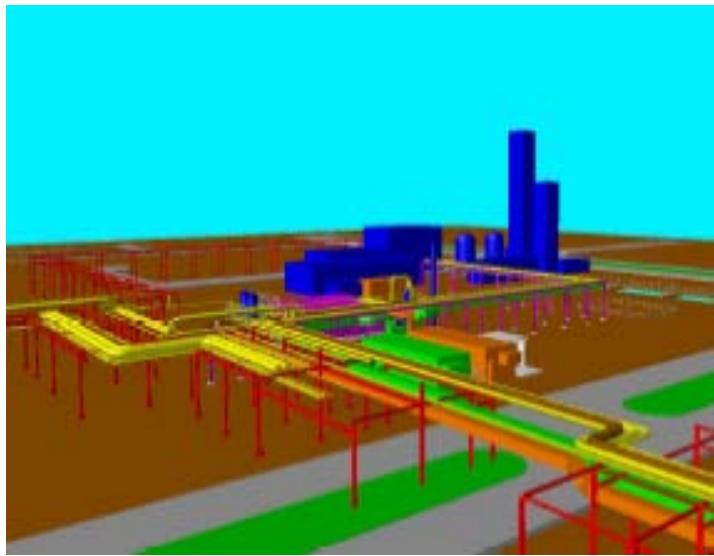
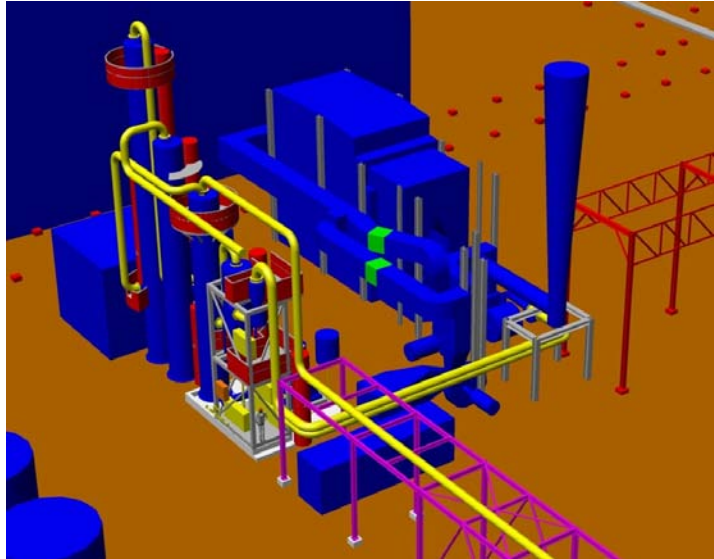
Synthetic air approach

Lacq CCS project - NA

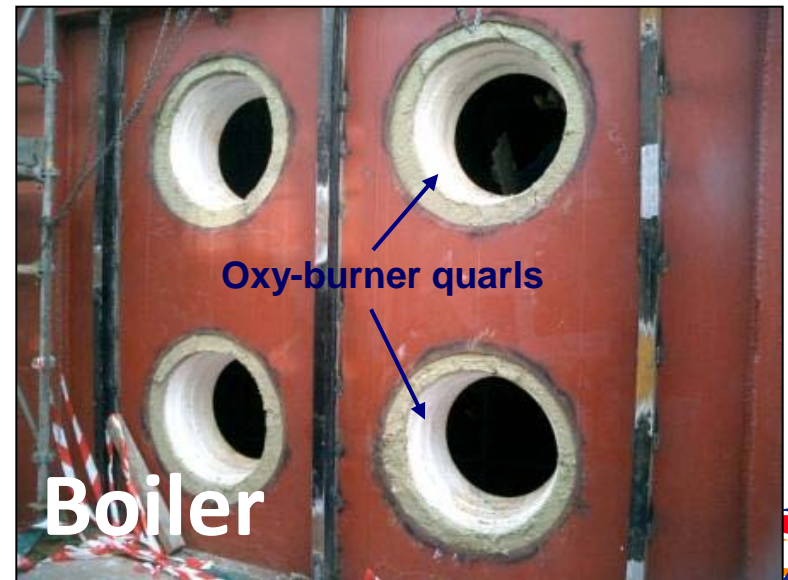
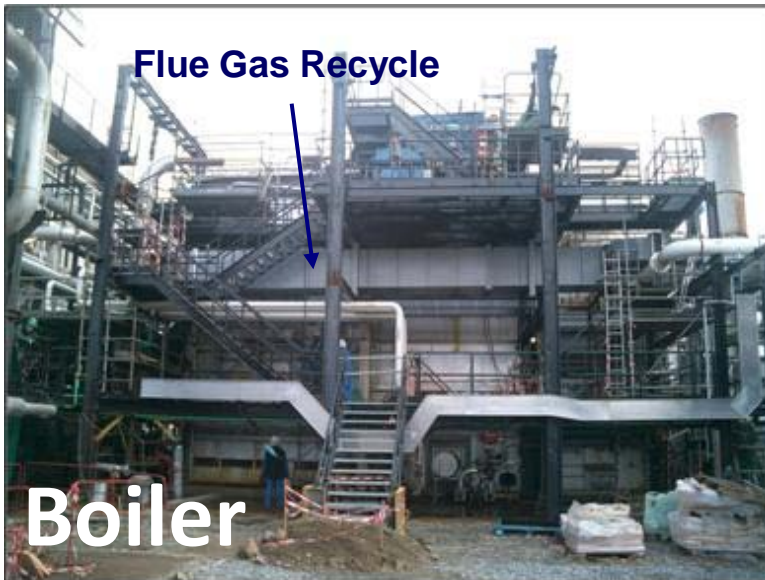


Air Liquide oxy-burner

Capture facilities within Lacq existing utilities plant



Construction Phase at Lacq



Air Separation unit by cryogenic distillation

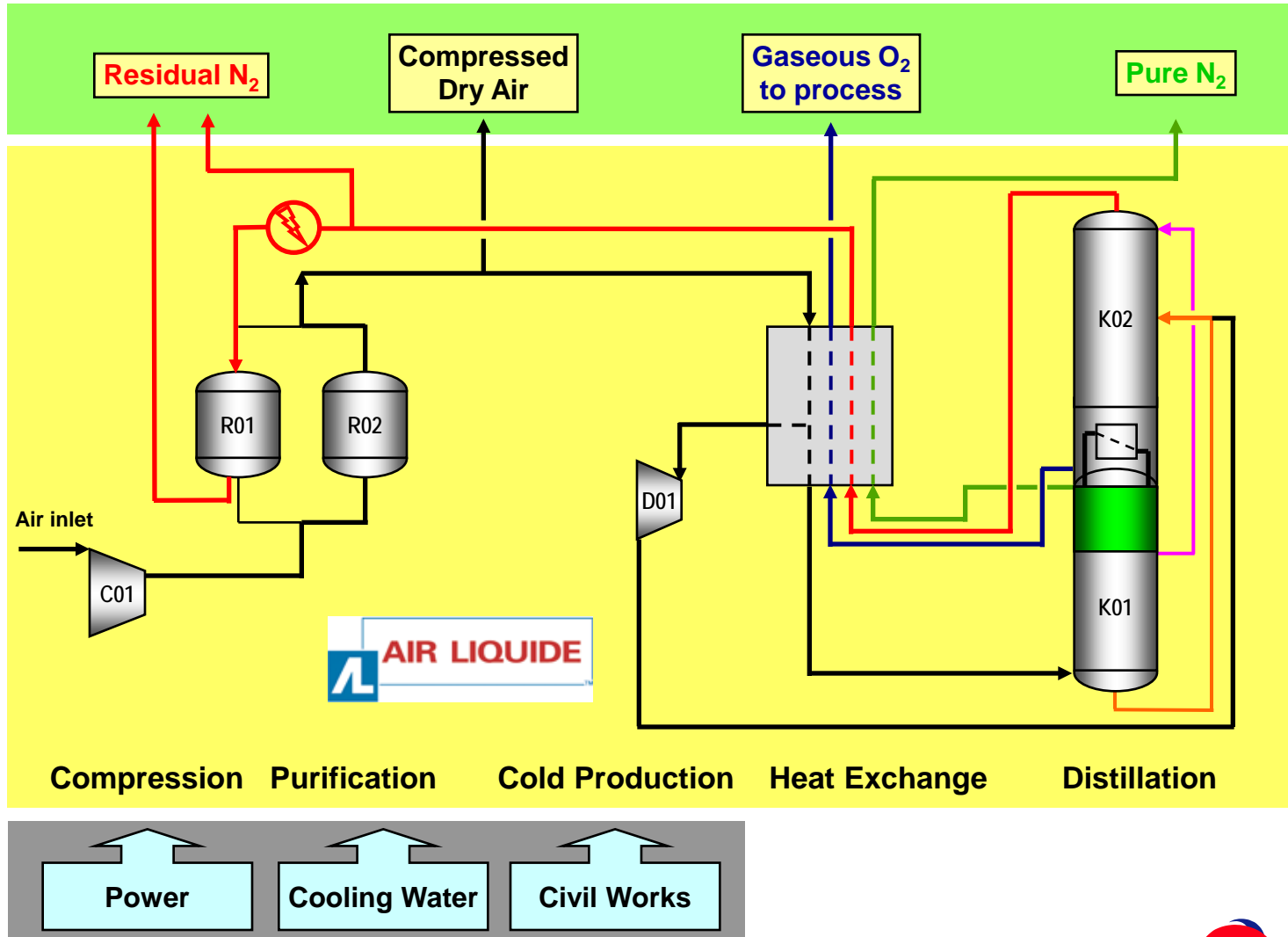


Lacq CCS project - NA

- ▶ 240 t/day of oxygen
- ▶ 95% to 99,5% oxygen purity
- ▶ Nitrogen for CO₂ dehydration
molecular sieves regeneration

Air Separation Unit for Lacq pilot

- ▶ Standard ASU packaged plant
- ▶ 240 tpd O₂
- ▶ LP: 1,8 bar abs
- ▶ Variable purity (95-99,5% O₂)
- ▶ No oxygen storage



Industrial steam boiler in oxycombustion mode



Oxyburner implementation into Lacq CH2 boiler

- ▶ **Retrofitting of an air-fired boiler**
 - Oil & Gas boiler configuration
 - Fixed geometry:
 - four horizontal burners
 - Chamber: L 5 m; W 4,5m; H 6-7m
- ▶ **Careful sealing at every interface to minimize air in-leakage**
- ▶ **Fluid distribution control and measurement**
- ▶ **Operating mode**
- ▶ **Safe operation Safety analysis**
- ▶ **Tests and measurement plans**



Openings for the four existing air-fired natural gas burners

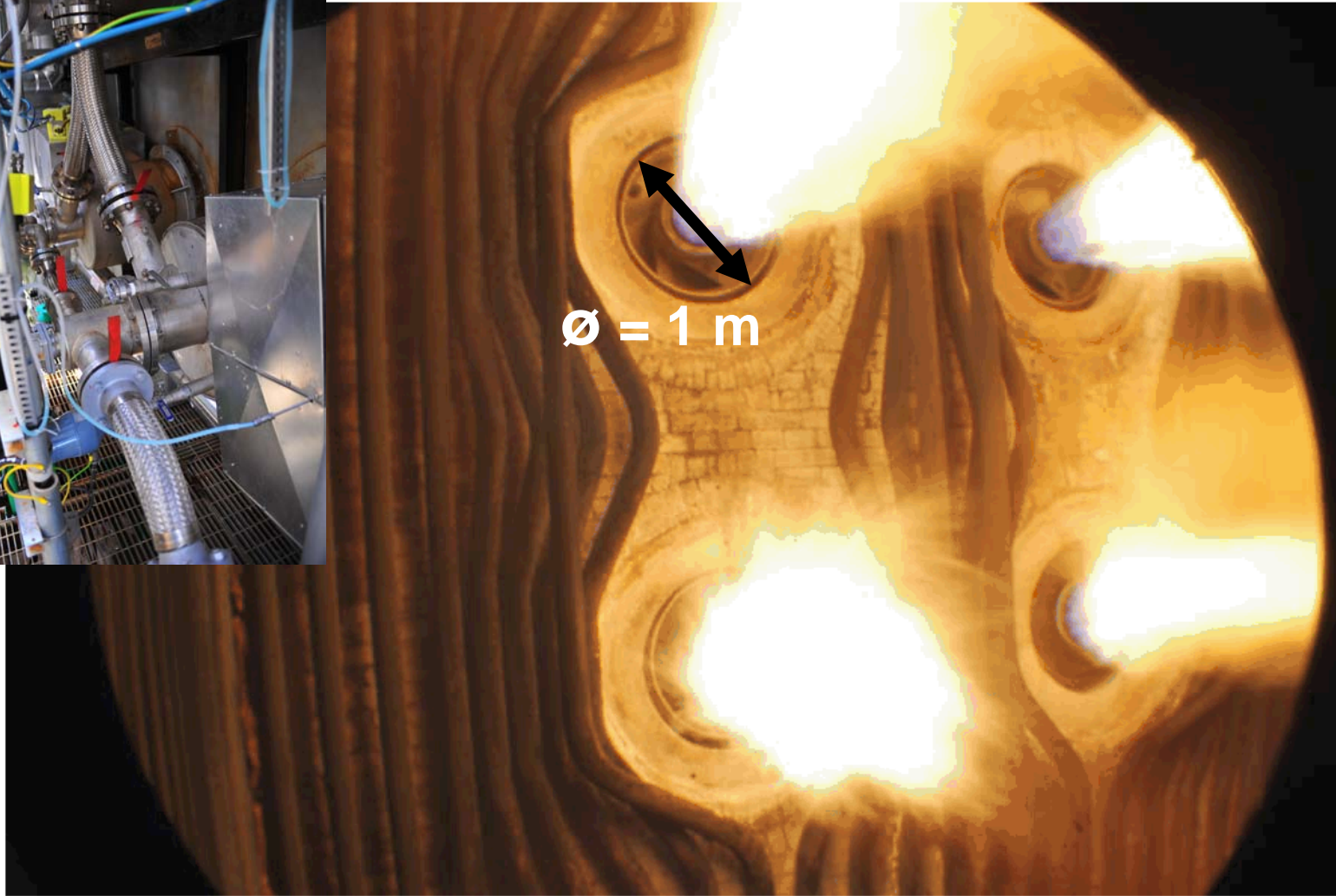


Existing measurement port

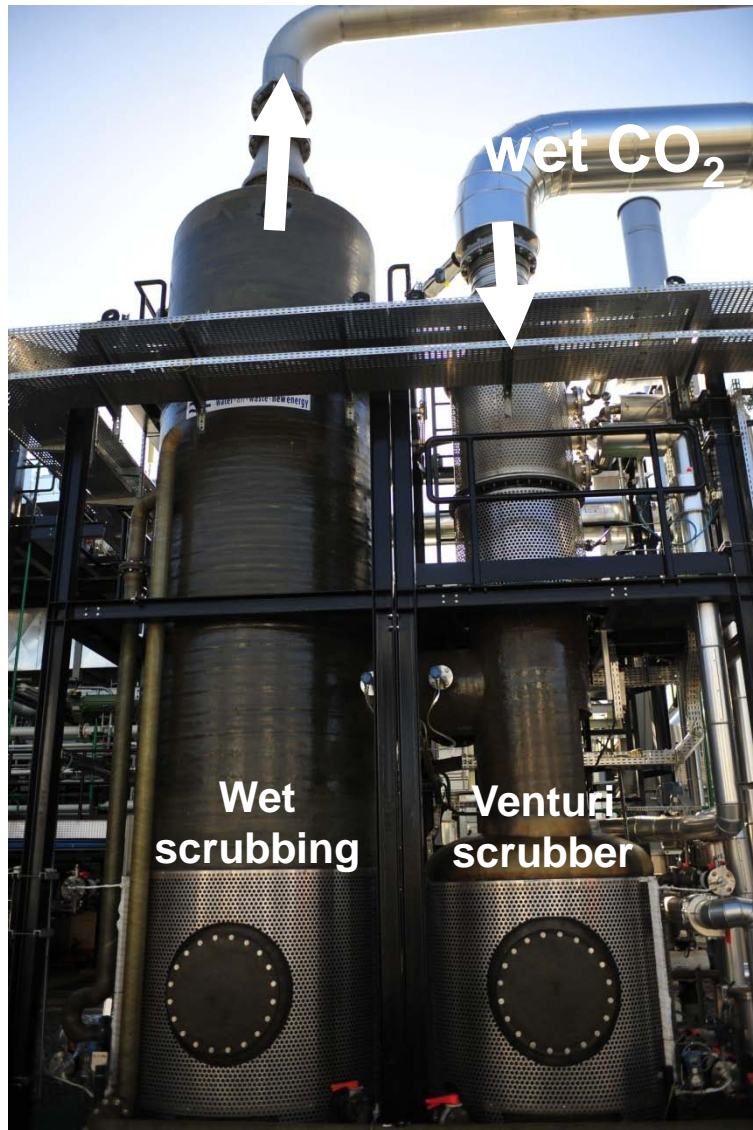
Oxyburner implementation into Lacq CH2 boiler



"Oxyfiring" started on July 3rd, 2009



Wet scrubbing of high CO₂ content flue gas

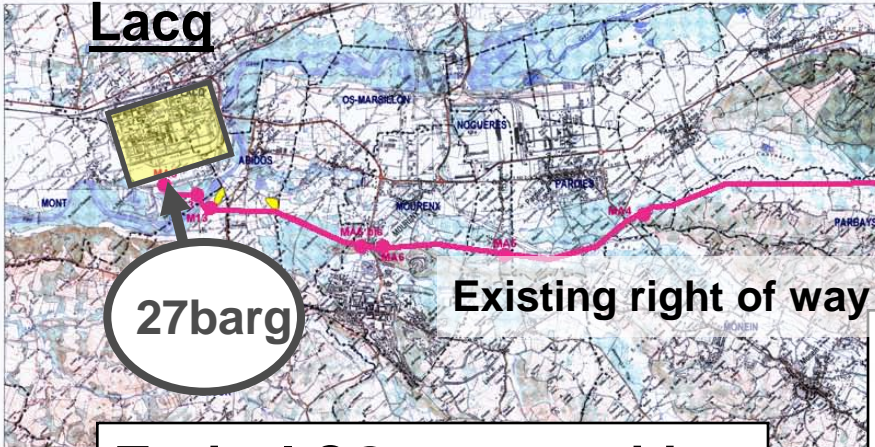
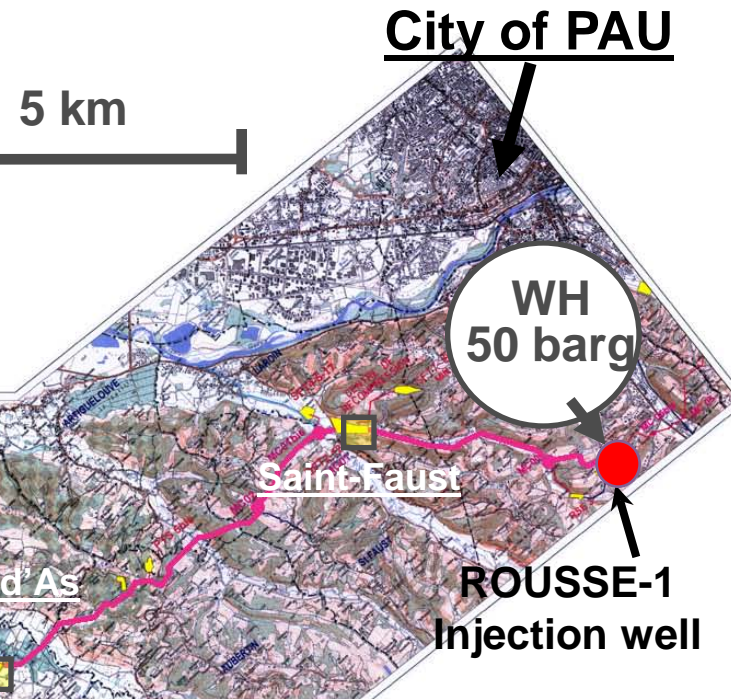
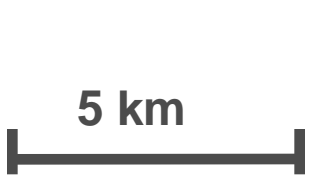


- Flue gas (~ 48% H₂O, 48% CO₂) @ 200°C and atm pressure
- Venturi scrubbing
- Wet scrubbing
 - Water condensed
 - flue gas outlet @ 50°C

CO2 compression, dehydration and export



Transportation and injection into a gas depleted reservoir

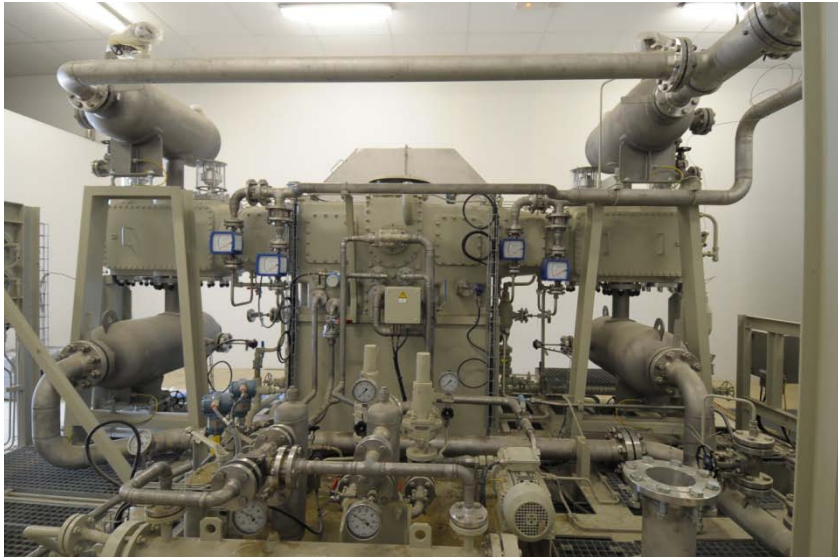


Typical CO₂ composition

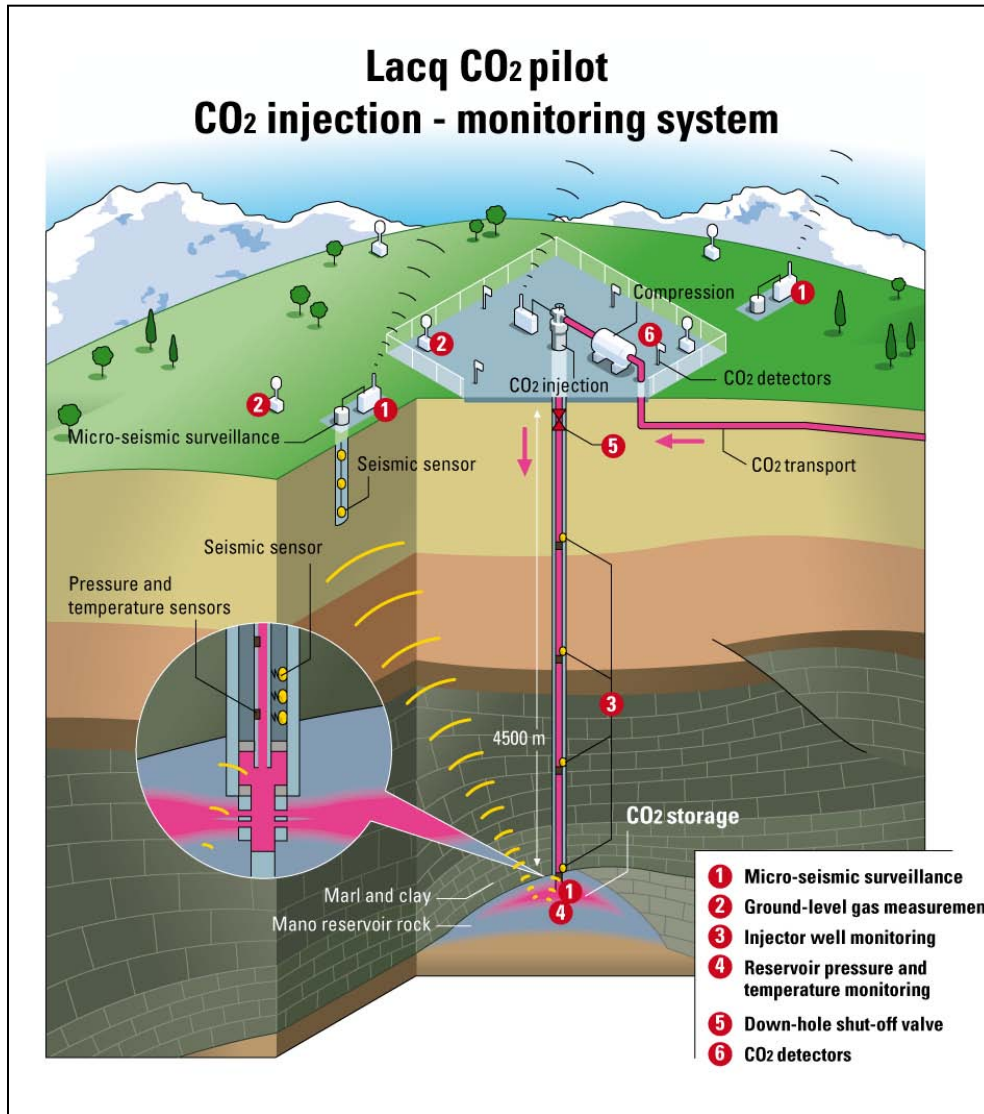
CO ₂ :	92.0 %
O ₂ :	4.0%
Ar:	3.7%
N ₂ :	0.3%
water content # 30ppm	



Facilities at Rousse well pad



CO₂ Monitoring plan



Injection phase

- Flowrate & composition of injected gas
- P and T borehole and reservoir pressure (optical fibre)
- Microseismic monitoring of reservoir and caprock
 - baseline before injection
- Gas migration at the surface :
 - soil gas survey (baseline before injection)
 - surface detectors on well pad
- Environmental monitoring
 - Underground aquifers and surface water
 - Fauna and flora

Post injection phase

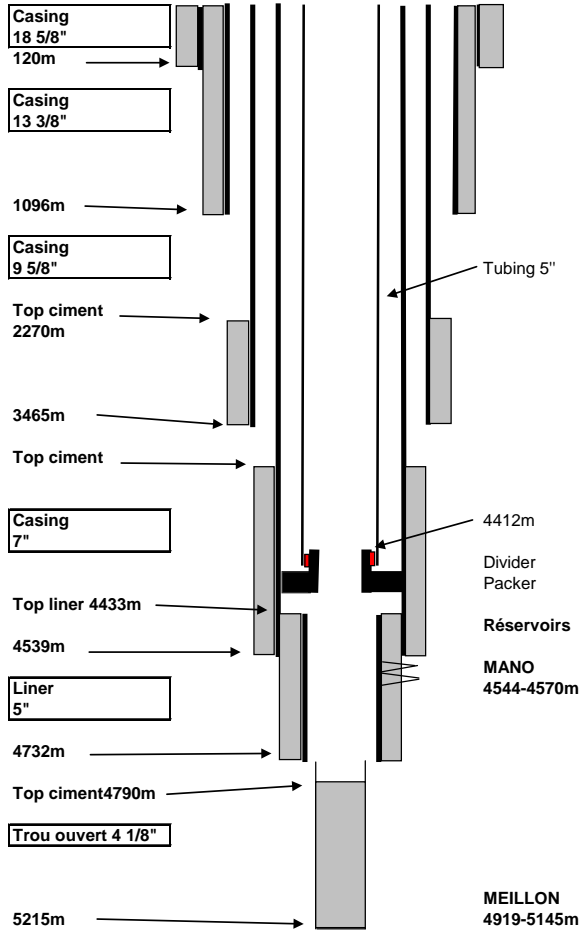
- P and T bottom hole and reservoir pressure
- Microseismic monitoring of reservoir and caprock
- Gas migration at the surface
- Environmental monitoring

Monitoring system installation during work over

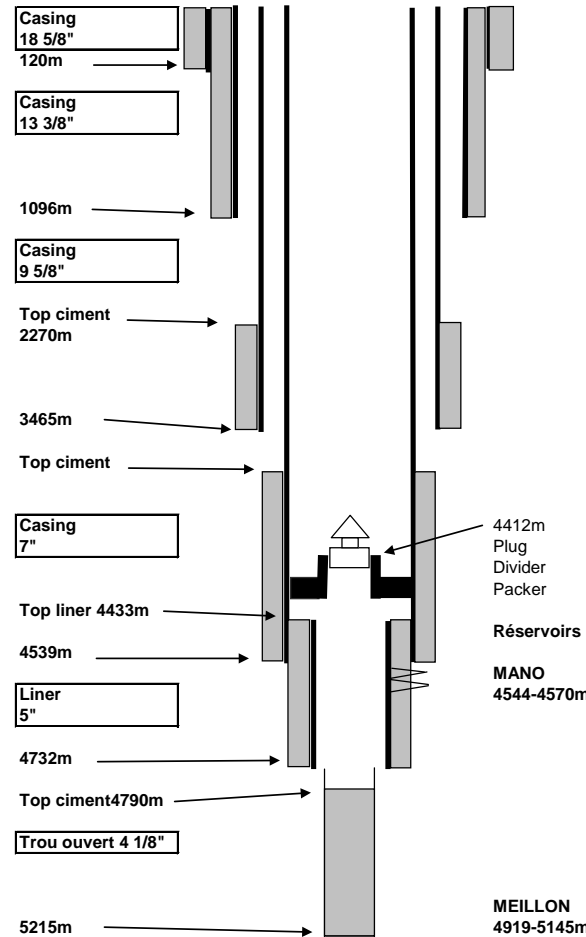


OPERATIONAL SEQUENCE

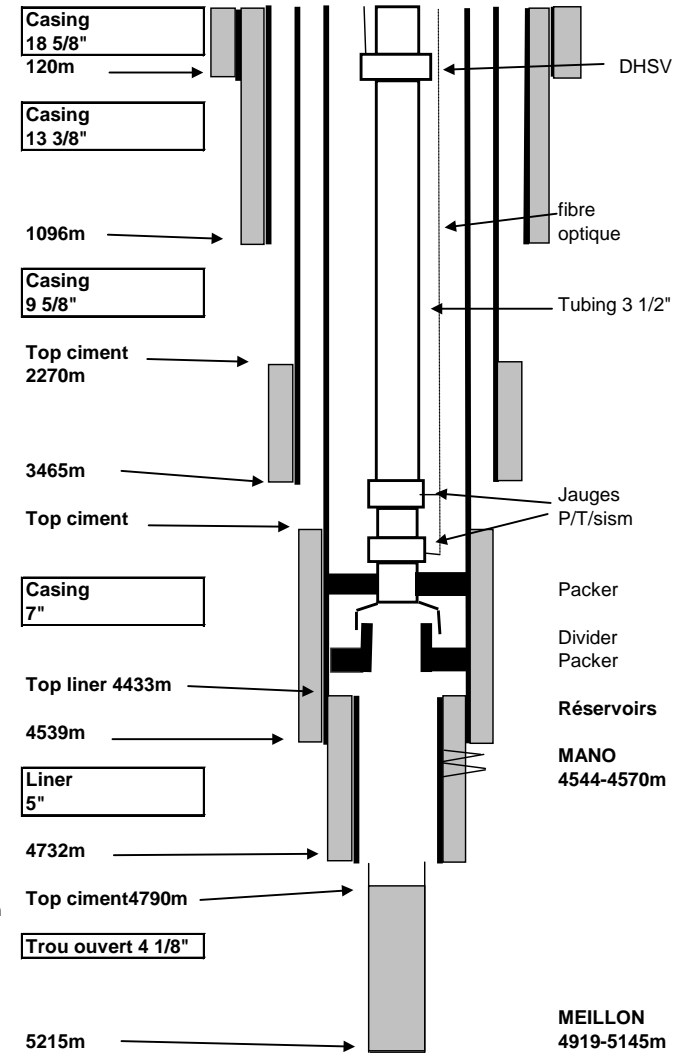
RSE 1 Avant le work-over



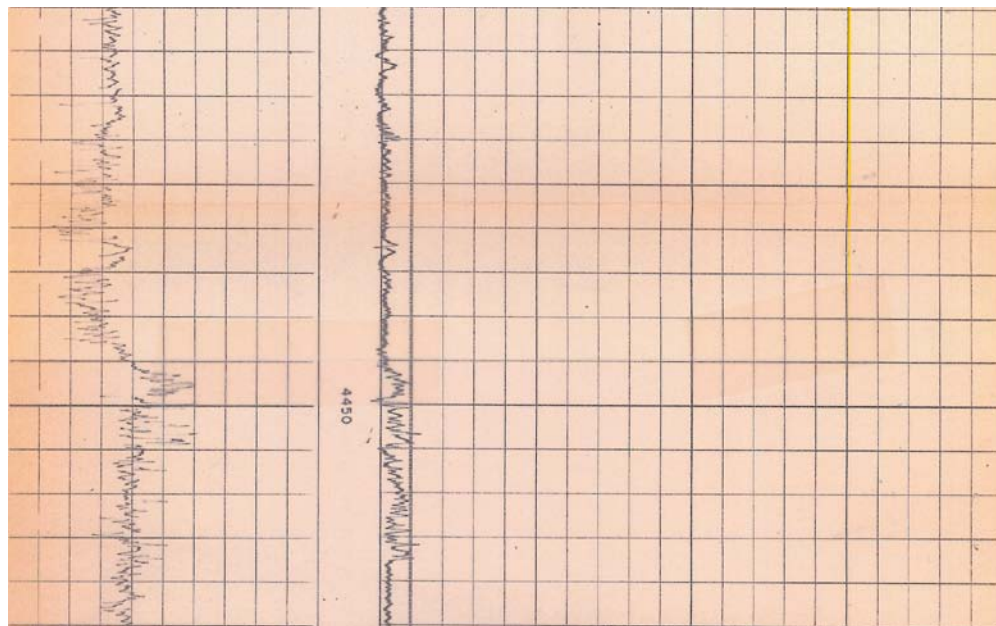
RSE 1 Pendant le work-over



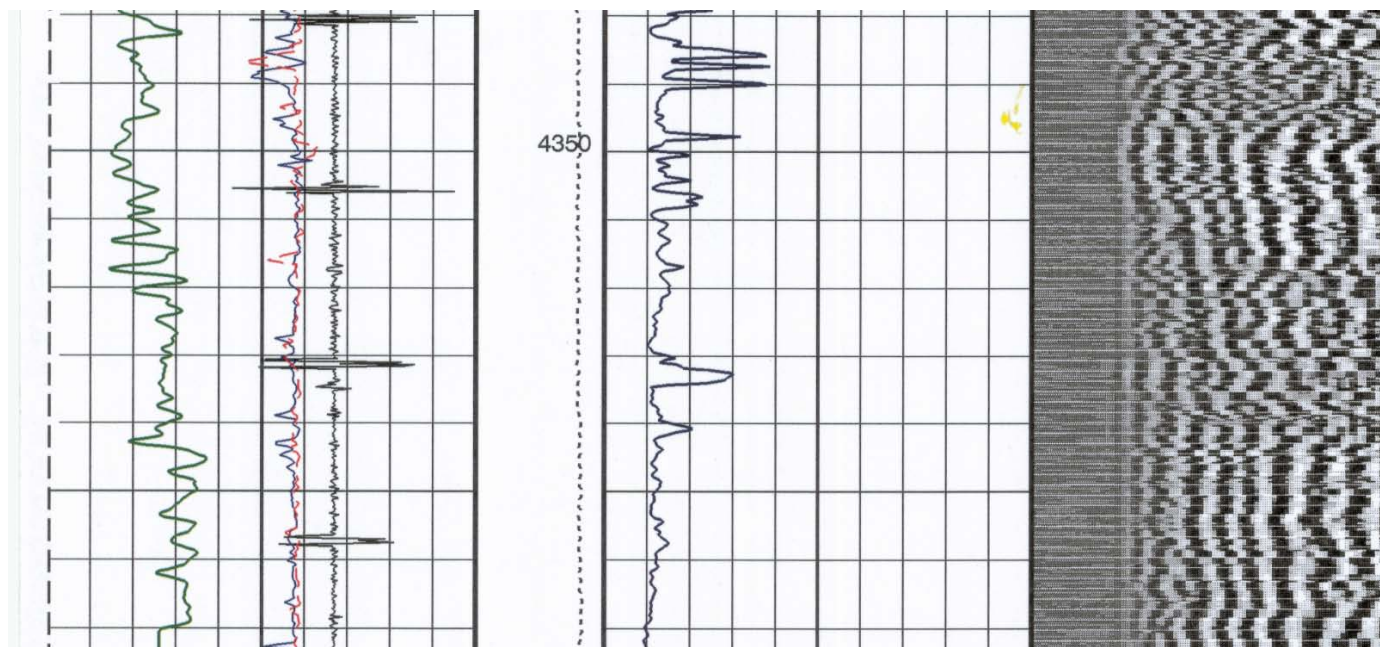
RSE 1 Complétion installée

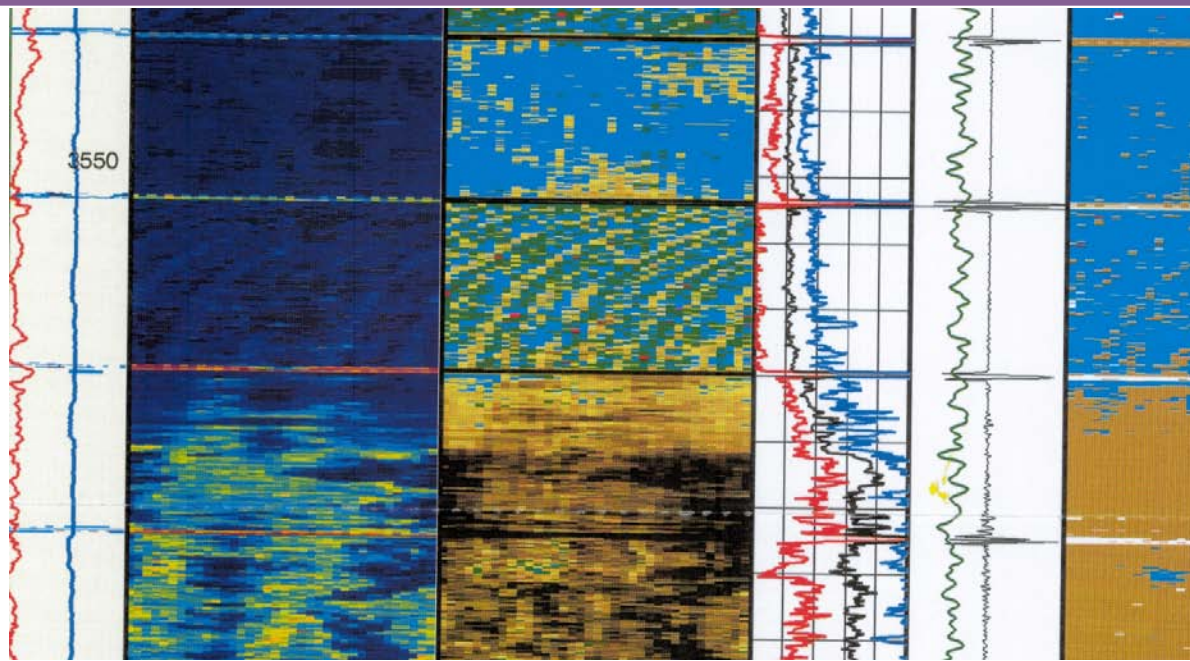


CBL 7" 1967 Bottom cement log

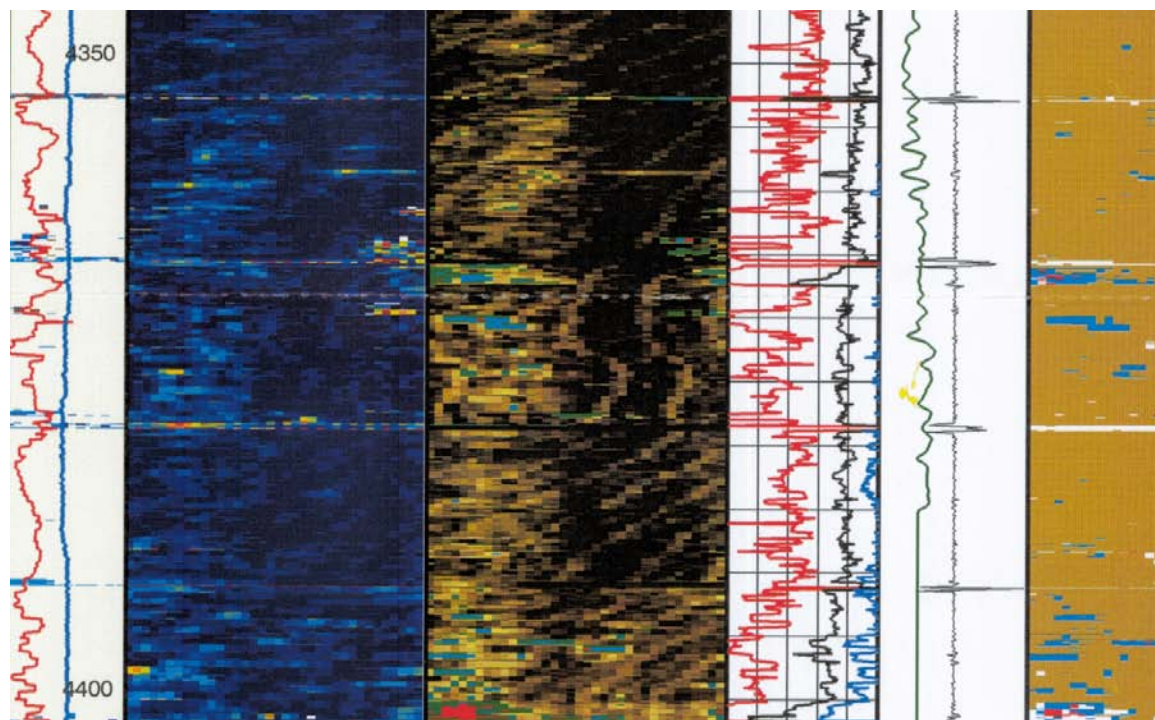


2009

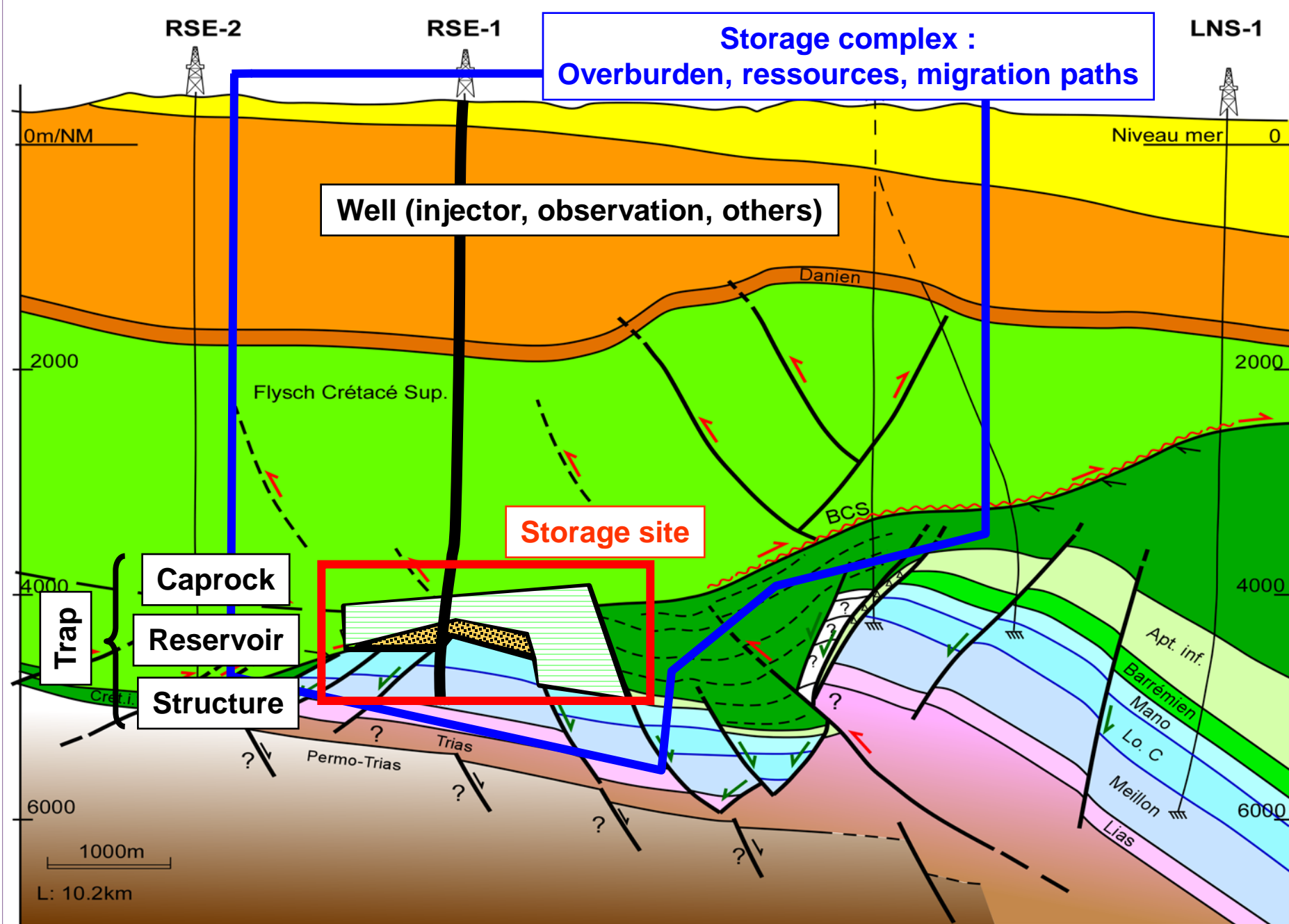




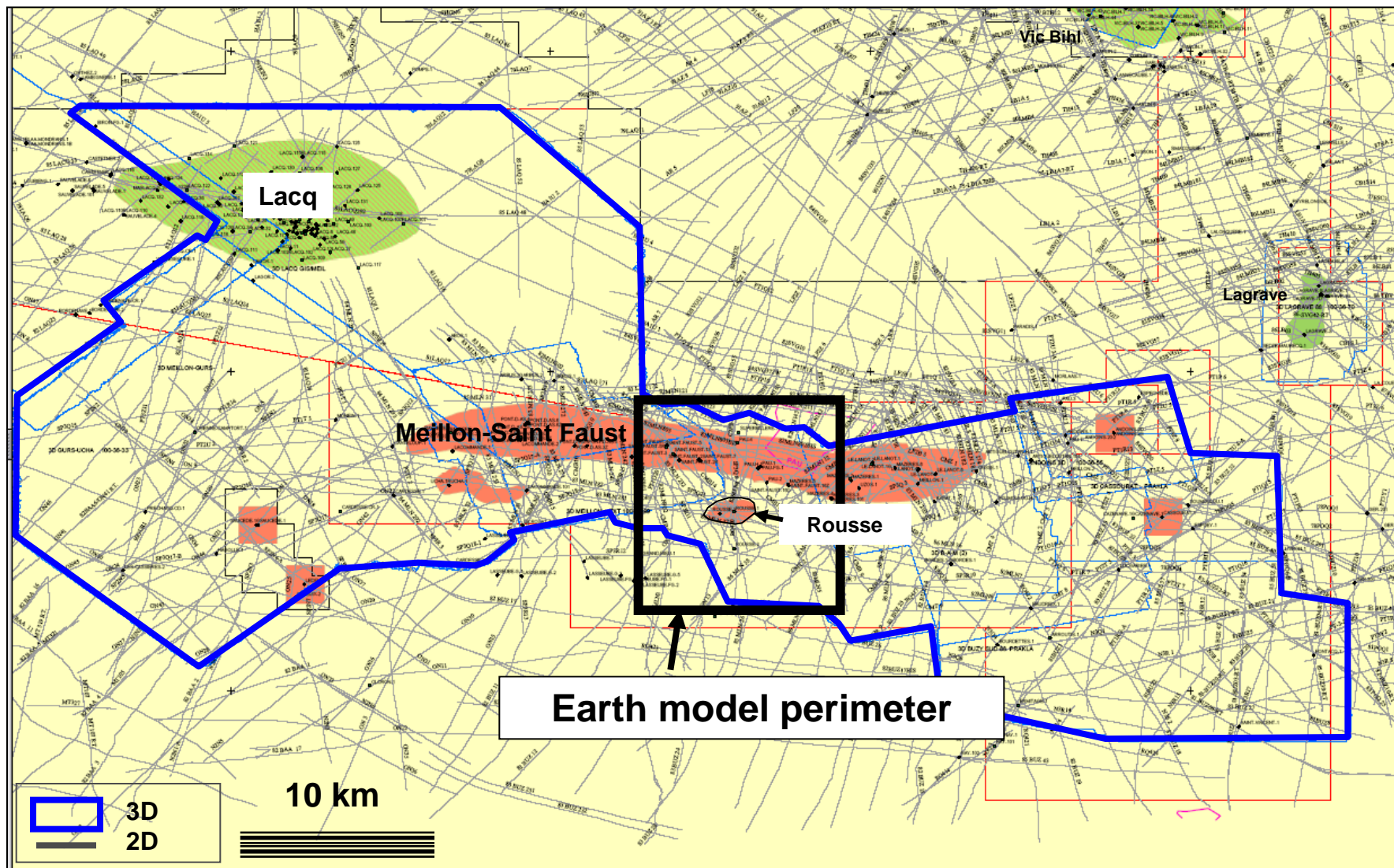
USIT 2009
top cement



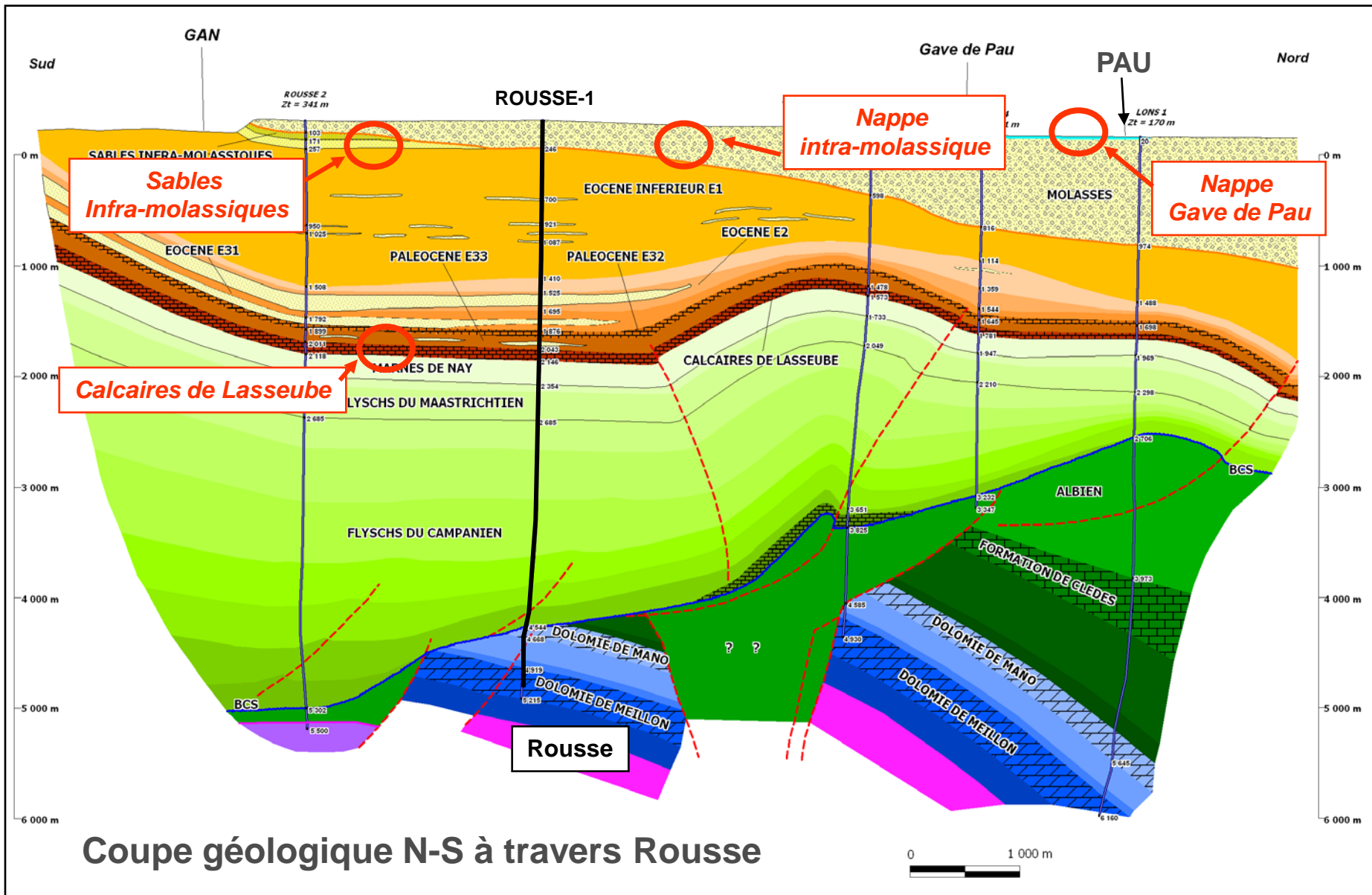
Bottom cement



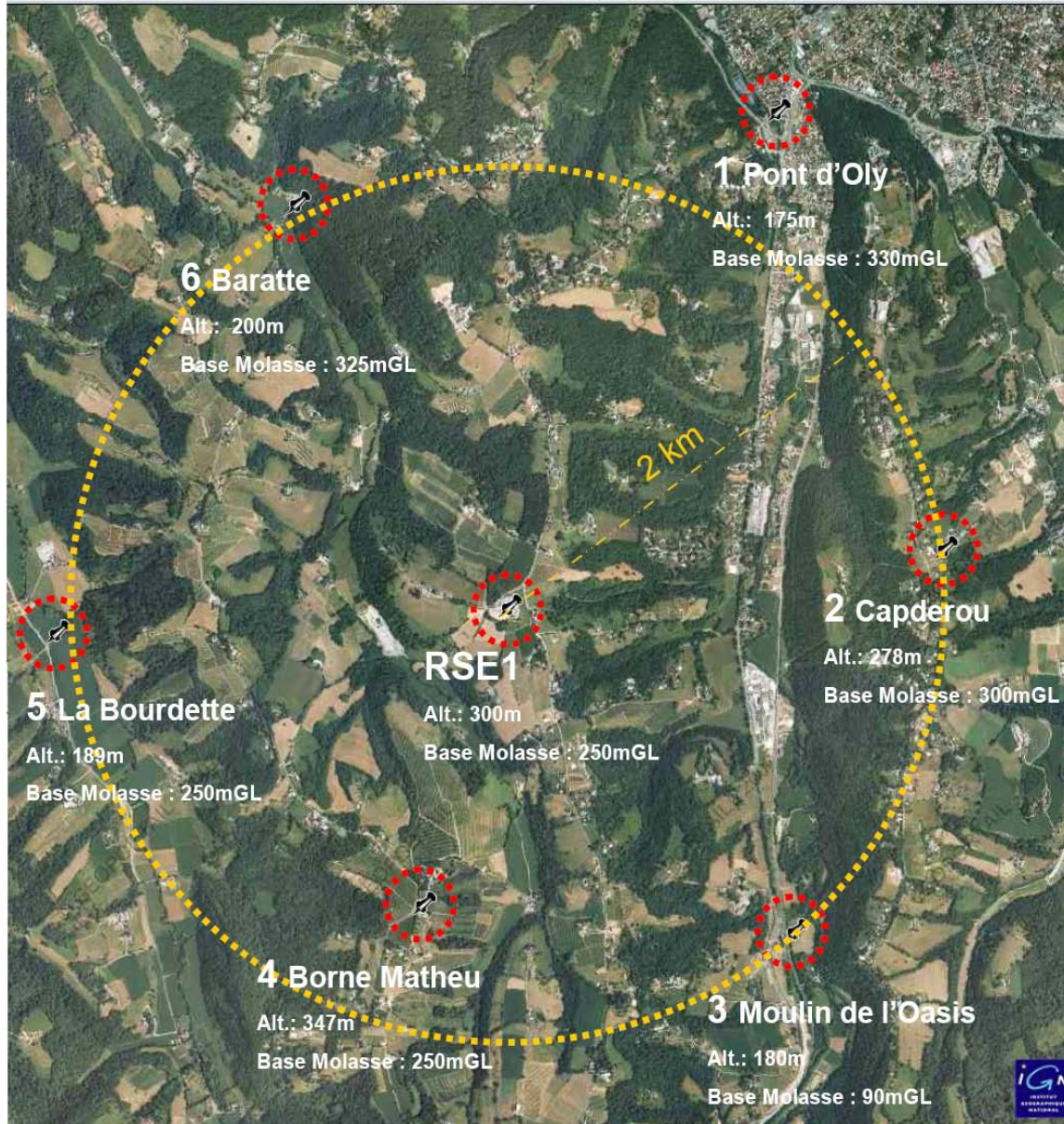
Seismic data and wells available



Aquifers within the storage complex



Microseismic monitoring and RSE1 well work over



500 m

A long process for a well known depleted gas field

2006 : Early presentations of the concept

Jan – Oct 2007 : Formal information to the french administration, mayors

March 2007: Public meeting Rouse

Nov 2007 : press conference and launch of the dialogue phase

Nov – dec 2007: **3 public meetings (Jurançon, Pau, Mourenx)**

Apr – June 2008 : several meetings with small groups

May 2008 : meeting with all mayors from Lacq to Rouse

June – July 2008 : CLIS n°1 et 2

July 2008 : working meetings with Jurançon

July – Sept 2008 : **official public hearings**

Sept 2008 : CLIS n°3

Dec 2008 : well pad open to the public – information letter to project neighbours

Feb – March 2009: CLIS n°4, CLIS n°5

May 2009 : **Official permit to capture, transport, inject and store 120'000 t of CO2**

June 2009 : CLIS n°6

July 2009 : **CO2 capture start up - first oxycombustion test**

July 2009 : One local NGO taking administrative actions against official permit

Sept. – Oct. 2009 : pre-injection baseline data and detailed monitoring procedures set up

Jan. 8th 2010 : **Fully operationnal CCS project**



Project information also available on
www.total.com/corporate-social-responsibility

LACQ CO₂ CAPTURE AND
GEOLOGICAL STORAGE PILOT PROJECT

TOTAL'S COMMITMENT TO STAKEHOLDER CONSULTATION

In order to ensure that the consultation process initiated by Total is useful to all concerned, and to guarantee a meaningful dialogue with all stakeholders, the Group undertakes to:

- Provide full, honest and clearly expressed information about the project (characteristics, impact, surveillance and monitoring system, etc.) so as to facilitate the sharing of knowledge and to foster open discussion with all stakeholders.
- Execute and report on the project with advice from a number of independent scientific and technical experts.
- Provide answers to all questions asked by stakeholders or members of the public.
- Publish minutes of all public discussion meetings as well as a summary of the consultation process, and take these into account in deciding final project details.
- Provide stakeholders and general public with regular updates of project progress and timetable.

SUMMARY

PROJECT INFORMATION DOSSIER

Lacq Basin CO₂ Capture and Geological Storage Pilot Project

The reason for the Lacq Basin pilot project

There is no longer any doubt that the Earth's climate is changing, and in the opinion of the international scientific community this climate change is very probably due to human activities generating large amounts of greenhouse gases (GHG), especially carbon dioxide (CO₂). There are a number of ways we could curb global warming: consume less energy, improve energy efficiency and use more non-fossil fuels. At the same time, technology for the capture and geological storage of CO₂ (CCS) now looks like a promising transition solution. This technology would allow us to diminish concentrated sources of CO₂ emissions generated by the combustion of fossil fuels. But before such technology can be implemented on an industrial scale, data must be obtained from pilot schemes such as the project at Lacq.

PREFET DES
PYRENEES-ATLANTIQUES

Actualités

- Flash info
- Communiqués de presse
- L'Etat recrute

Vos démarches

- Particuliers
- Professionnels
- Associations

Publications

- Actes administratifs
- Textes officiels
- Rapports d'activités des Services de l'Etat
- Enquêtes Publiques
- Appels d'offres
- Règlement Sanitaire

Liens

- Sites nationaux
- Sites locaux



CO2 à Lacq

Sommaire

- **Projet de captage CO2 de Total**
- Projet Total_091110_CLIS
- Projet Total_090622_CLIS
- Arrêté préfectoral du 13 mai 2009 autorisant le pilote de stockage CO2
- Projet Total_090330_CLIS
- Projet Total_090209_CLIS
- Projet Total_081127_CLIS
- Projet Total_081031_Commission d'enquete
- Projet Total_080929_CLIS
- Projet Total_080718_CLIS
- Projet Total_080603_CLIS

Projet de captage CO2 de Total

Le groupement intergouvernemental d'experts sur l'évolution du climat (GIEC) travaille sur des solutions de **réduction des émissions de CO2 dans l'atmosphère**, et notamment au **captage et au stockage géologique du CO2**.

Total travail au développement de cette technique pour réduire ses émissions industrielles. Le **projet dans le bassin de Lacq** s'inscrit dans cette perspective.

Calendrier :

- 11 janvier 2010 : Inauguration des installations de



Actions de l'Etat

- Grippe A/H1N1
- Les risques et vous
- Votre sécurité
- Economie et Aménagement du territoire
- Elections
- Cohésion sociale
- Santé et Protection des populations
- Agriculture et Pêche
- Environnement et Développement durable
 - Actualité
 - **CO2 à Lacq**
 - Profil environnemental
 - Protection des sites et des espèces
 - Protection de l'eau
 - Prévention des nuisances et des risques
 - Eco-responsabilité
 - Déchets
 - Avis Autorité environnementale
 - Associations agréées de protection de



Project public information

<http://www.pyrenees-atlantiques.pref.gouv.fr/>

Lessons learned from early operations

► Oxycombustion

- No major issue from revamping (but initial boiler status assesment critical)
- Several weeks of control system tuning
 - Presure control in the boiler
 - Flame stability
 - Change of load
 - Automatic switch from air to oxy
- Air and oxygen firing compatibility is essential
- After adjustments, very smooth operation for plant operators

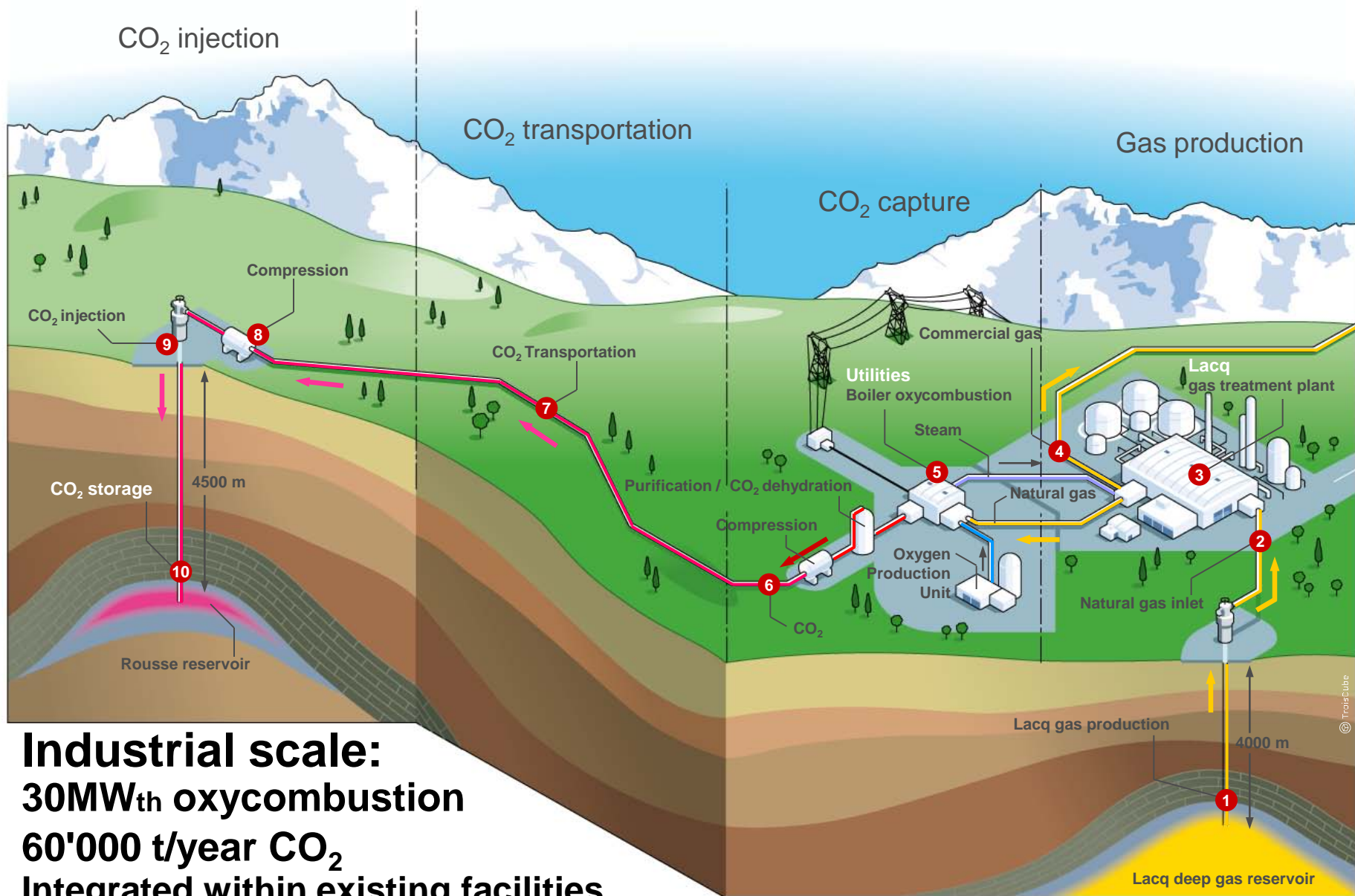
► Compression and drying

- NO_x content in condensed water differs from design
- Liquid carry over in compression is more critical than classical gas compression

► Transportation and injection

- No problem of pipeline start up
- No problem of injectivity
- Microseismic system downhole sensors sensitive to temperature
- Microseismic passive monitoring is a promising technique

An integrated carbon capture, transportation and geological storage in a depleted gas field project



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