

# Hontomín project presentation

Ramon Carbonell





CIUDEN: Spanish government foundation to promote, among other things, Carbon Capture and Storage



Hontomin is the Tech Demonstration Plant of the Compostilla OXYCFB300 EEPR project, run by ENDESA, in collaboration with CIUDEN and FOSTER-WHEELER



EEPR “European Energy Programme for Recovery” facilitates investments on infrastructure and technology projects in the energy sector; helps improve the security of supply of the Member States and, promotes implementation of the 20/20/20 objectives for 2020.



CSIC is the “Spanish Agency for Scientific Research”, a network of research institutes.

# The Players

**The Responsible Team:** M. Montoto<sup>1</sup>, J. Carrera<sup>1,2</sup>, A. Pérez-Estaún<sup>1,3</sup>, J.L. Fuentes-Quintanilla<sup>4</sup>, F. Recreo<sup>1,5</sup>, J. Bruno<sup>1,6</sup>

**The Journalist:** R. Carbonell<sup>1,3</sup>.



1. Subprogram of CO2 Storage, Energy City Foundation



2. Institute of Environmental Assessment and Water Research, CSIC



3. Institute for Earth Sciences Jaume Amera, Spanish Agency for Scientific Research, CSIC



4. Association for Research and Industrial, Development of Natural Resources



5. Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas



6. Amphos 21, Consulting, Barcelona

# EU strategy against CO2 emissions

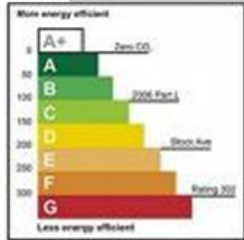
Energy efficiency

+

Renewable energies

+

Carbon Capture and Storage  
CCS



CCS could deliver 19% of global emissions reductions by 2050 (IEA)



# In December 2009, the European Commission granted financial assistance to 6 CCS demonstration projects



European  
Energy Programme  
for Recovery



## ***Hatfield, United Kingdom***

The aim of this project is to demonstrate the innovative integrated gasification combined cycle (IGCC) technology on a new 900MW power plant at a 91% CO<sub>2</sub> emission capture rate.

## ***Rotterdam, The Netherlands***

This project aims to demonstrate the full chain of CCS on a 250MW coal-fired power plant using post-combustion technology. The captured CO<sub>2</sub> will be stored in, an offshore depleted gas field.

## ***Compostilla, Spain***

This project will demonstrate the full CCS chain using oxyfuel technology firstly at a pilot scale on a 30MW coal-fired plant that will be scaled to a demonstration plant of 323MW. Captured CO<sub>2</sub> will be stored in a saline aquifer.



## ***Belchatów, Poland***

The aim is to demonstrate the full CCS chain on a new 250 MW unit that is part of an existing power plant. The capture technology is post-combustion. The captured CO<sub>2</sub> will be transported and stored in a saline aquifer.

## ***Jänschwalde, Germany***

This project aims to demonstrate both oxyfuel and post-combustion capture technologies. The storage will be carried out either in a depleted gas field or in a deep saline aquifer.

## ***Porto Tolle, Italy***

The objective of this project is to install CCS technology in a new 660MW coal power plant using post-combustion. The CO<sub>2</sub> will be stored in an offshore saline aquifer.



# CCS concept



**Compression**



**Transport**



**Injection-geological storage**

## **CIUDEN overall objective**

**To create a world-wide reference centre for CCS technology development by means of research facilities for CO<sub>2</sub> Capture, Transport and Storage.**

# CIUDEN

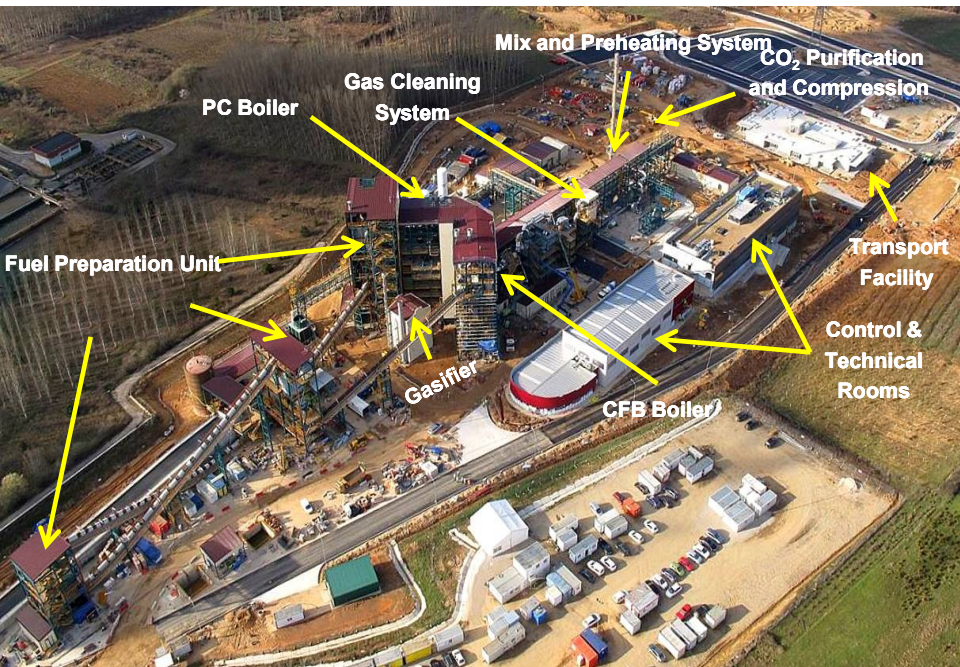


An initiative of the Spanish Administration

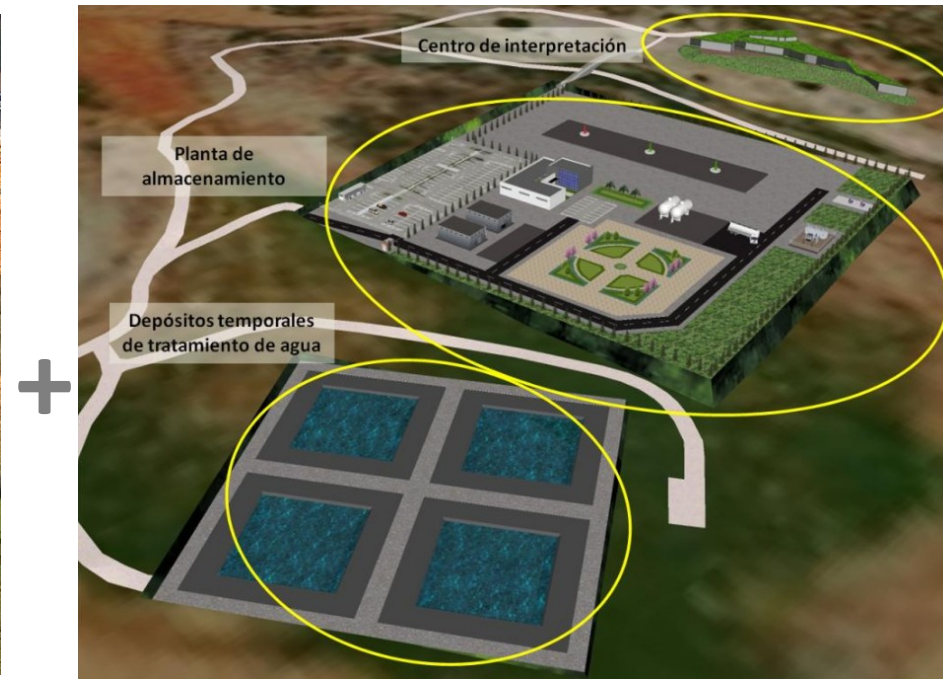
Compostilla OXYCFB300 project



**Facilities goal:** development of advanced "clean" combustion coal and evaluate environmental and economic feasibility for geological storage.



CO<sub>2</sub> Capture Technological Development Plant  
El Bierzo, Cubillos del Sil



CO<sub>2</sub> Storage Technological Development Plant  
Hontomín, Burgos



# Our three-pronged strategy

## Capture

- To validate close-to-market and emerging technologies for application at commercial scale

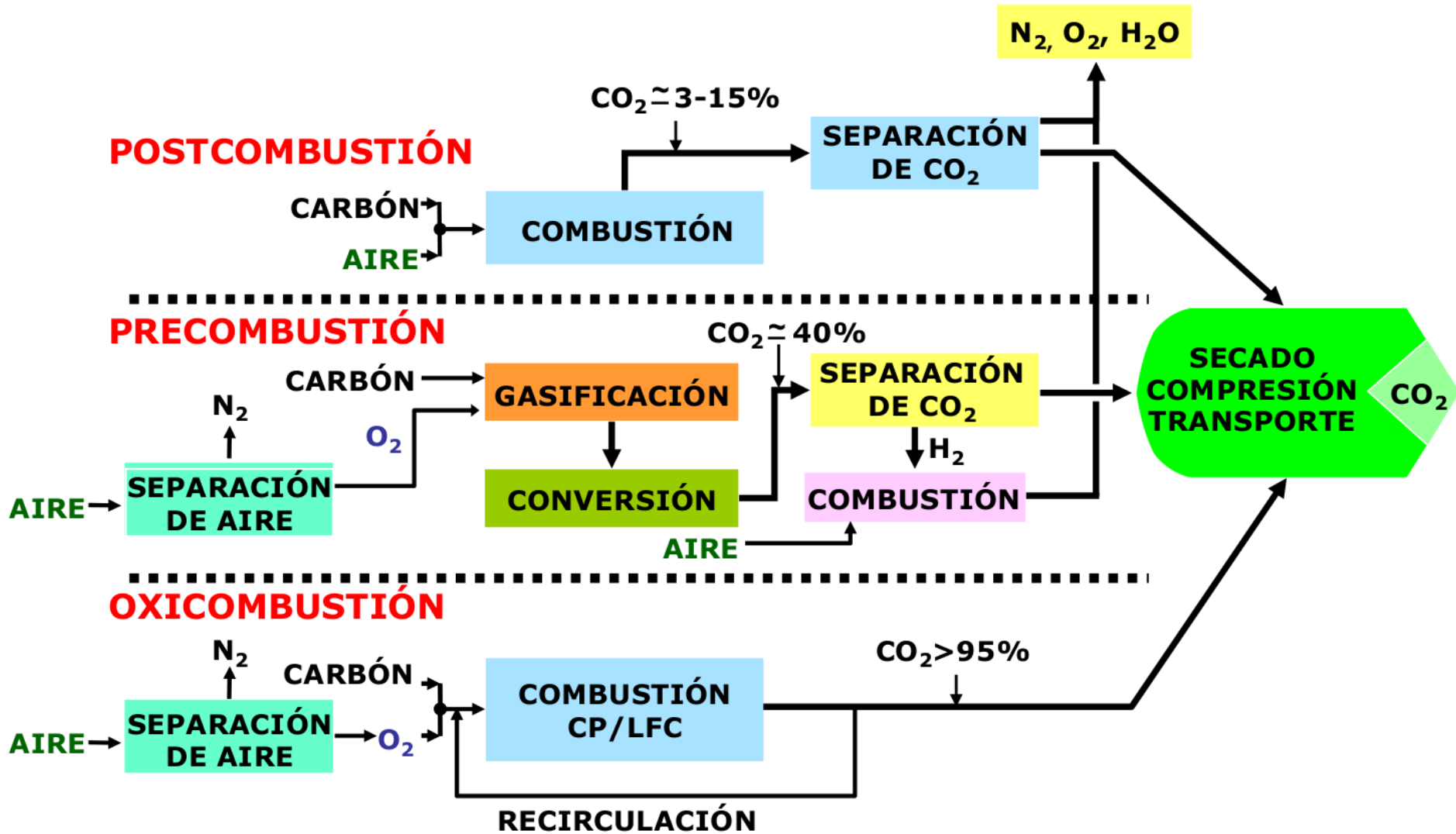
## Transport

- To obtain technical criteria for design, management and safe operation of CO<sub>2</sub> pipelines through long-term runs

## Storage

- To develop technologies and processes for injection and monitoring in saline aquifers to support industrial-scale activities

# CO<sub>2</sub> Capture



# CIUDEN capture

Oxycombustion

CFB  
Circulating  
Fluidized Bed  
30 MWth

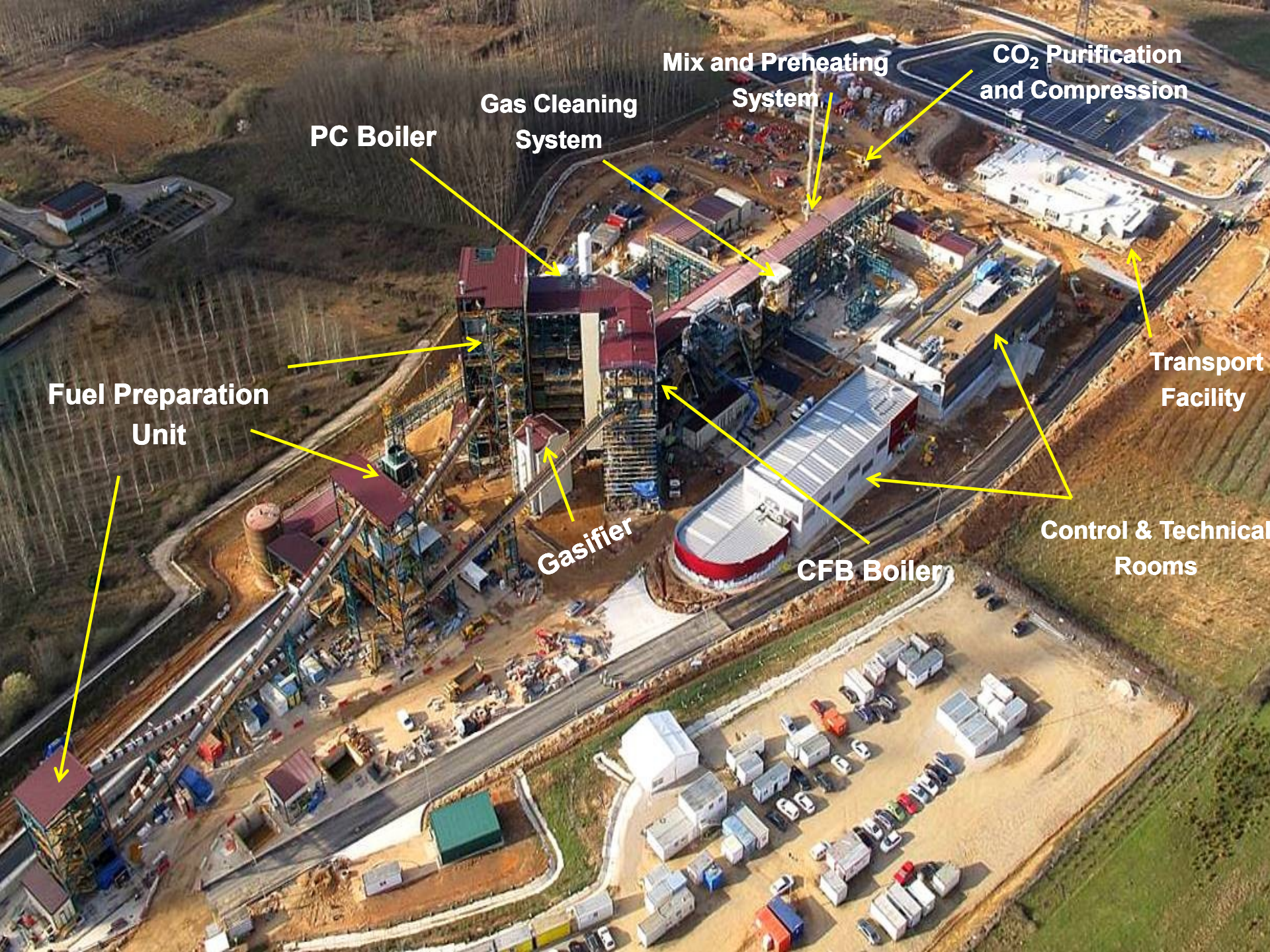
PC  
Pulverized Coal  
20 MWth

Biomass  
Gasifier  
3 MWth

CO<sub>2</sub> purification and compression

Fuels: anthracites, bit & subbit coals, pet coke, sustainable biomass





**CO<sub>2</sub> Purification and Compression**

**Mix and Preheating System**

**Gas Cleaning System**

**PC Boiler**

**Transport Facility**

**Fuel Preparation Unit**

**Control & Technical Rooms**

**Gasifier**

**CFB Boiler**

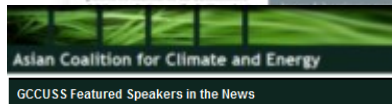


# es.CO<sub>2</sub> - The first fire

## CIUDEN LIGHTS THE FIRST FIRE IN THE CO<sub>2</sub> CAPTURE CENTRE

2011-04-20 12:31:59

Ponferrada. "Saturday 16 April, at 7:30 pm, a stable and simultaneous ignition of the four burners on the pulverised coal (PC) boiler was carried out, thus reaching this important milestone in the commissioning of the Technology Development Centre for CO<sub>2</sub> Capture,



### CIUDEN lights first fire in the CO<sub>2</sub> Capture Centre

- CIUDEN has completed a milestone at its CO<sub>2</sub> Capture Centre near León, Spain. "Saturday 16 April, at 7:30 pm, a stable and simultaneous ignition of the four burners on the pulverised coal (PC) boiler was carried out, thus reaching this important milestone in the commissioning of the Technology Development Centre for CO<sub>2</sub> Capture, performed by the Fundación Ciudad de la Energía" confirmed José Ángel Azuara



# es.CO<sub>2</sub> CFB boiler. The first fire

## CIUDEN LIGHTS THE FIRST COAL FIRE

2011-09-02

Diario de León.es El Bierzo

Noticias Provincia Deportes Multimedia Más actualidad Servicio Canales Participo

A fondo León El Bierzo Castilla y León Opinión Cultura Economía España Internacional Titulares Última Hora

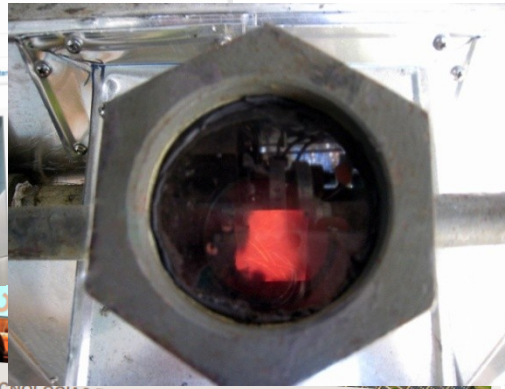
### Ciuden inicia la próxima semana nuevas pruebas de combustión en Cubillos

Estos ensayos permiten cumplir el compromiso adquirido con la Unión Europea

LYDIA ALONSO | POFERRADA  
21/08/2011

El Centro de Desarrollo de Tecnologías de Captura de CO<sub>2</sub>, que la Fundación Ciudad de la Energía (Ciuden) ha puesto en marcha en Cubillos del Sil, iniciará a finales de agosto el encendido con carbón en modo de combustión convencional con aire en la caldera de Lecho Fluido Circulante (LFC).

Este es el primer paso que «permitirá abordar de forma inmediata los ensayos»



FUNDACIÓN  
TECNOLOGÍAS DE USO LIMPIO DEL CARBÓN  
Almacenamiento Geológico de CO<sub>2</sub>  
Captura de CO<sub>2</sub>  
DESARROLLO TERRITORIAL  
MUSEO

**QUE HACEMOS** : TECNOLOGÍAS DE USO LIMPIO DEL CARBÓN: Captura de CO<sub>2</sub> :  
Comienza la puesta en marcha de la caldera de Lecho Fluido Circulante en el Centro de Captura de CO<sub>2</sub>

### Comienza la puesta en marcha de la caldera de Lecho Fluido Circulante en el Centro de Captura de CO<sub>2</sub>

El proceso de puesta en marcha de la caldera de Lecho Fluido Circulante (LFC), que comenzó a finales del mes de julio, sigue su curso según lo planificado. Recientemente ha completado el "primer fuego" con gas, para lo que ha sido necesario superar varios hitos relevantes e imprescindibles, como la prueba de señales del sistema de control y de los sistemas auxiliares de preparación de combustibles y de la propia caldera. Después de todos estos ensayos, se ha comprobado que la caldera opera adecuadamente y se mantiene en funcionamiento estable.

A finales del mes de agosto está previsto que se produzca el encendido con carbón en modo combustión convencional con aire, lo que constituye uno de los hitos más importantes y relevantes de todo el proceso de puesta en marcha. Ello va a permitir abordar de forma inmediata los ensayos comprometidos con la Unión Europea para validar la tecnología de captura de CO<sub>2</sub> por oxicomustión en lecho fluido circulante de



# Oxy-Fuel Combustion

## Large Scale Pilot and Demo Projects

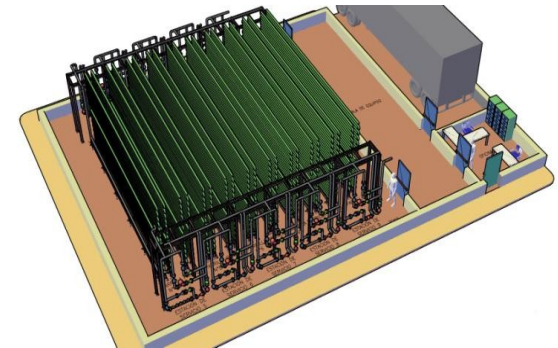
| PROJECT                         | Location  | MW <sub>th</sub> | Start up | Boiler Type     | Main Fuel         | CO2 Train       |
|---------------------------------|-----------|------------------|----------|-----------------|-------------------|-----------------|
| B & W                           | USA       | 30               | 2007     | Pilot PC        | Bit, Sub B., Lig. |                 |
| Jupiter                         | USA       | 20               | 2007     | Industr. No FGR | NG, Coal          |                 |
| Oxy-coal UK                     | UK        | 40               | 2008     | Pilot PC        |                   |                 |
| Vattenfall                      | Germany   | 30               | 2008     | Pilot PC        | Lignite (Bit.)    | <b>With CCS</b> |
| Total, Lacq                     | France    | 30               | 2009     | Industrial      | Nat gas           | <b>With CCS</b> |
| Pearl Plant                     | USA       | 66               | 2009     | 22 MWe PC       | Bit               | Side stream     |
| Callide                         | Australia | 90               | 2010     | 30 MWe PC       | Bit.              | <b>With CCS</b> |
| Ciuden - PC                     | Spain     | 20               | 2010     | Pilot PC        | Anthra.(Pet ck)   | <b>With CCS</b> |
| Ciuden - CFB                    | Spain     | 30               | 2010     | Pilot CFB       | Anthra.(Pet ck)   | <b>With CCS</b> |
| Jamestown                       | USA       | 150              | 2013     | 50 MWe CFB      | Bit.              | <b>With CCS</b> |
| <u>Endessa</u>                  | Spain     | ~ 1500           | 2015     | ???             | ???               | <b>With CCS</b> |
| <u>Vattenfall (Janschwalde)</u> | Germany   | ~1000            | 2015     | ~250 MWe PC     | Lignite (Bit.)    | <b>With CCS</b> |
| Youngdong                       | Korea     | ~400             | 2016?    | ~100 MWe PC?    | ?                 | ?               |

After IEAGHG



# CIUDEN Capture objectives

- Validation and scaling-up of oxyPC, oxyCFB, FGD and CPU
- Integration and optimization of the full process to produce CO<sub>2</sub> ready for transport and storage
- Evaluate combustion from several types of coal (anthracite among them, first in the world) and biomass

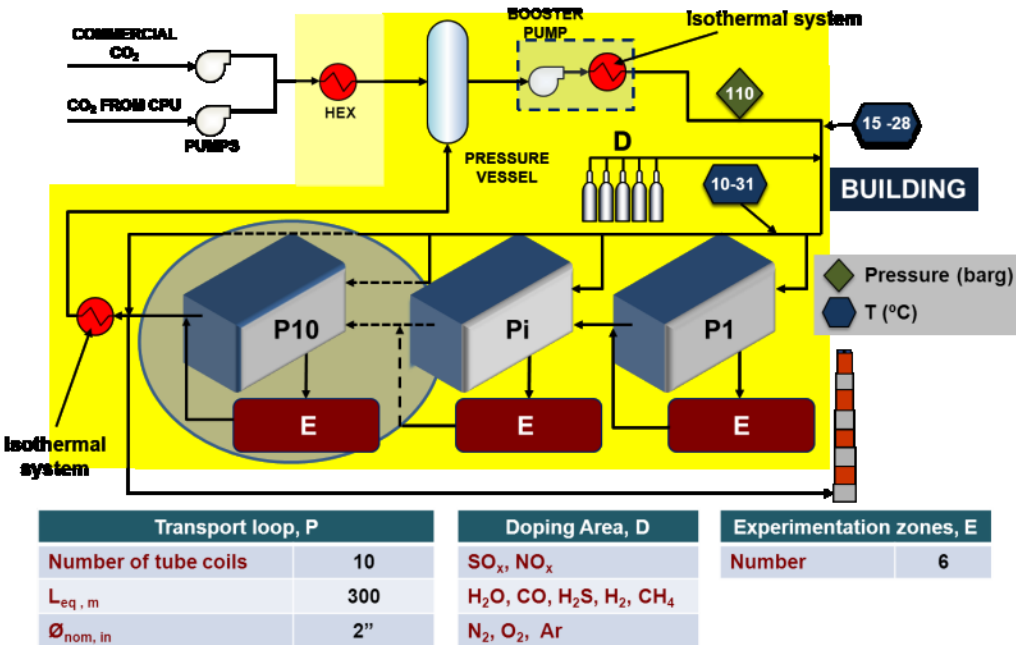




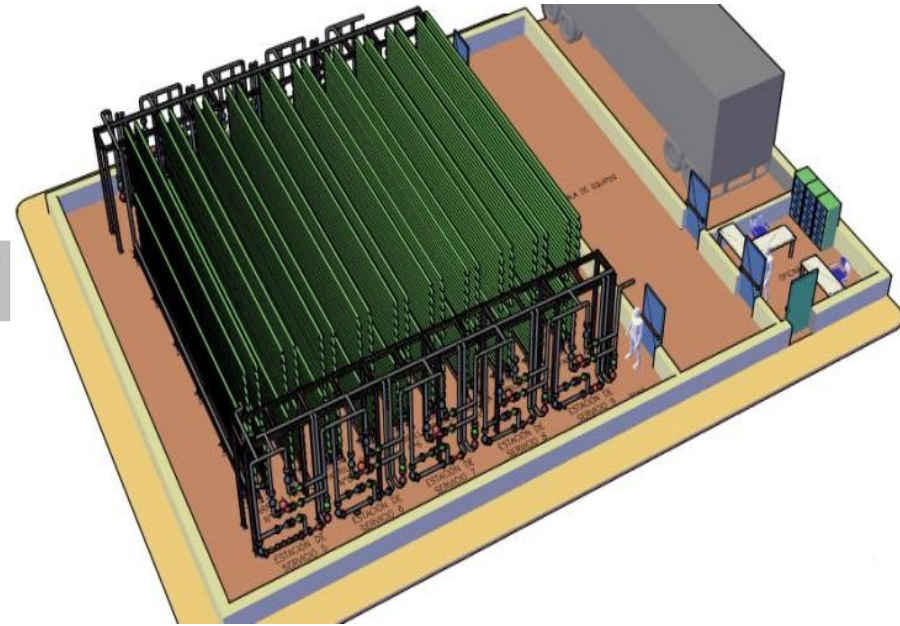


<http://www.nicholas.duke.edu/thegreengrok/co2pipeline>

# CO<sub>2</sub> Transport Experimental Facility CIUDEN

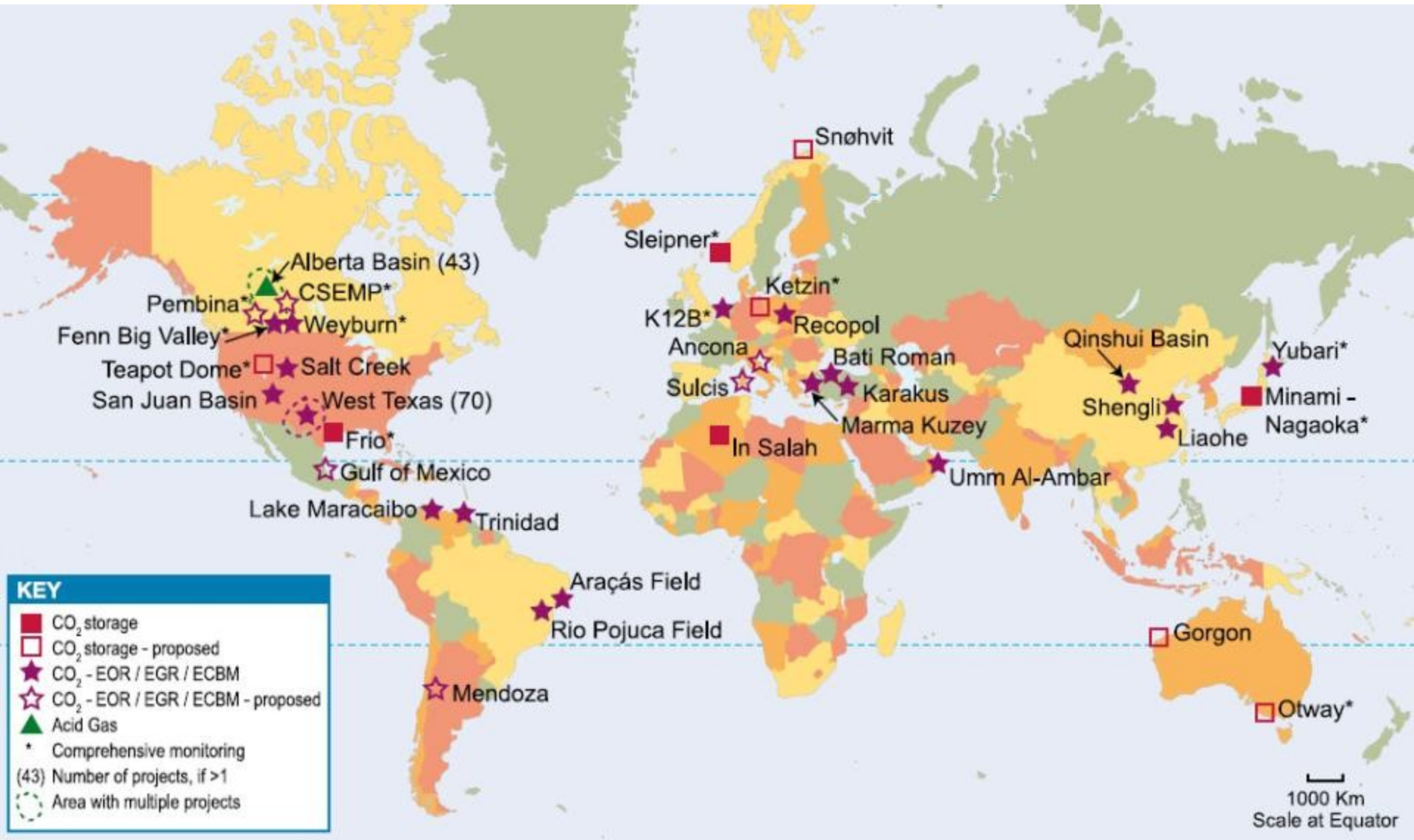


Block diagram of the CO<sub>2</sub> Transport Experimental Facility



simulation of CIUDEN's transport facility

# CO2 Storage experiences



| Type   | Project         | Leader        | Location    | CO2 Source                         | Size                 | CO2 Sink         | Start |
|--|-----------------|---------------|-------------|------------------------------------|----------------------|------------------|-------|
| <b>Deep saline aquifers</b> , porous contain very saline fossil water  | Sleipner        | StatoilHydro  | Norway      | Gas Processing                     | 1 Mt/Yr              | Saline           | 1996  |
|  | Entrada         | SWP           | CO/WY USA   | Gas Processing                     | 1.1 Mt/Yr            | Saline           | 2008  |
|  | AEP Mountaineer | AEP           | WV, USA     | Powe Plant, Coal (Post-Combustion) | 30 MW                | Saline           | 2009  |
|  | Entrada         | SWP           | CO/WY USA   | Gas Processing                     | 1.1 Mt/Yr            | Saline           | 2008  |
| <b>Depleted oil and gas reservoirs</b> , porous reservoir containing a combination of water and hydrocarbons   | K12-B           | Gaz de France | Netherlands | Gas Processing                     | 0.2 Mt/Yr            | Depleted Gas Res | 2004  |
|  | Snohvit         | StatoilHydro  | Norway      | LNGProcessing                      | 0.7 Mt/Yr            | Depleted Gas Res | 2008  |
|  | In Salah        | BP            | Algeria     | Gas Processing                     | 1.2 Mt/Yr            | Depleted Gas Res | 2004  |
|  | Otway           | CO2CRC        | Australia   | Natural Deposit                    | 0.1 Mt/Yr            | Depleted Gas Res | 2008  |
|  | Lacq            | Total         | France      | Powe Plant, Oil Oxy                | 35 MW                | Depleted Gas     | 2010  |
|  | Schwarze Pumpe  | Vattenfall    | Germany     | Powe Plant, Coal Oxy               | 30 MW                | Depleted Gas     | 2008  |
| <b>Enhanced oil recovery</b> involves injecting CO2 into geological formations to achieve greater oil recovery.  | SACROC          |               | USA         |                                    | ~ 90 Mt              | EOR              | 1972  |
|  | La Barge        | ExxonMobil    | WY, USA     | Gas Processing                     | 6 Mt/Yr              | EOR              | 2008  |
|  | Weyburn         | Pan Canadian  | Canada      | Coal Gasification                  | 1 Mt/Yr              | EOR              | 2000  |
|  | Brindisi        | Enel &Eni     | Italy       | Powe Plant, Coal (Post-Combustion) | 48 MW                | EOR              | 2010  |
| <b>Deep coal seams</b> are coal deposits that cannot be mined due to technological or economic constraints. CO2 is stored in these sites via a gas adsorption mechanism that leads to the release of methane, which can be used. | Burke County    | DOE           | USA         |                                    | 90 t (pilot project) |                  | 2009  |



# CIUDEN Storage project

## Objectives

- **Characterisation** of a potential reservoir for the long-term storage of CO<sub>2</sub> in a saline carbonated aquifer.
- Test & development techniques for **monitoring** the injection of CO<sub>2</sub> and for its subsequent medium-term behaviour.
- **Modelling** the long-term behaviour of CO<sub>2</sub> in the reservoir, including the integrity, sealing and security of the storage
- **Optimize** characterization, monitoring and modelling techniques for **up scaling** and transfer to commercial storage.

# CIUDEN Storage project

## Research lines

- Operate a research CO<sub>2</sub> geological storage facility in a carbonated saline aquifer
- Improve knowledge of underground CO<sub>2</sub> behavior, natural analogs
- Develop injection techniques for improving CO<sub>2</sub> storage
- Develop low-cost techniques for CO<sub>2</sub> monitoring
- Develop techniques for risk analysis and leakage early detection
- Public perception and acceptance

# CO<sub>2</sub> Storage cronogram

2007      2008      2009      2010      2011      2012      2013      2014      2015

Pilot Plant - Site selection

Selected geological structure -  
Characterization

Research on Behaviour & Evolution  
CO<sub>2</sub> injected

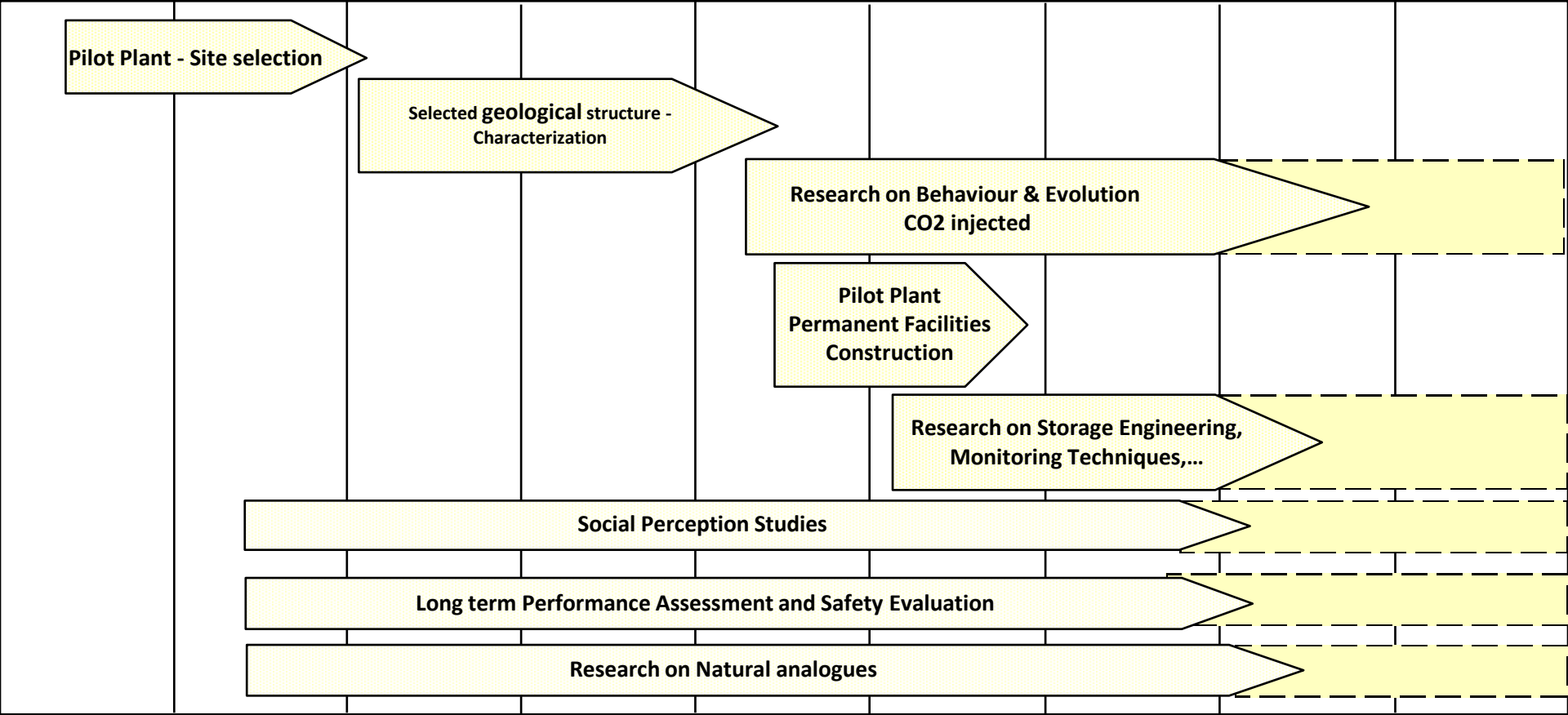
Pilot Plant  
Permanent Facilities  
Construction

Research on Storage Engineering,  
Monitoring Techniques,...

Social Perception Studies

Long term Performance Assessment and Safety Evaluation

Research on Natural analogues





## CO<sub>2</sub> Storages TDP sequence

1. Selection
2. Characterisation
3. Conception
- 4. Construction**
5. Injection
6. Closure
7. Responsibility transfert

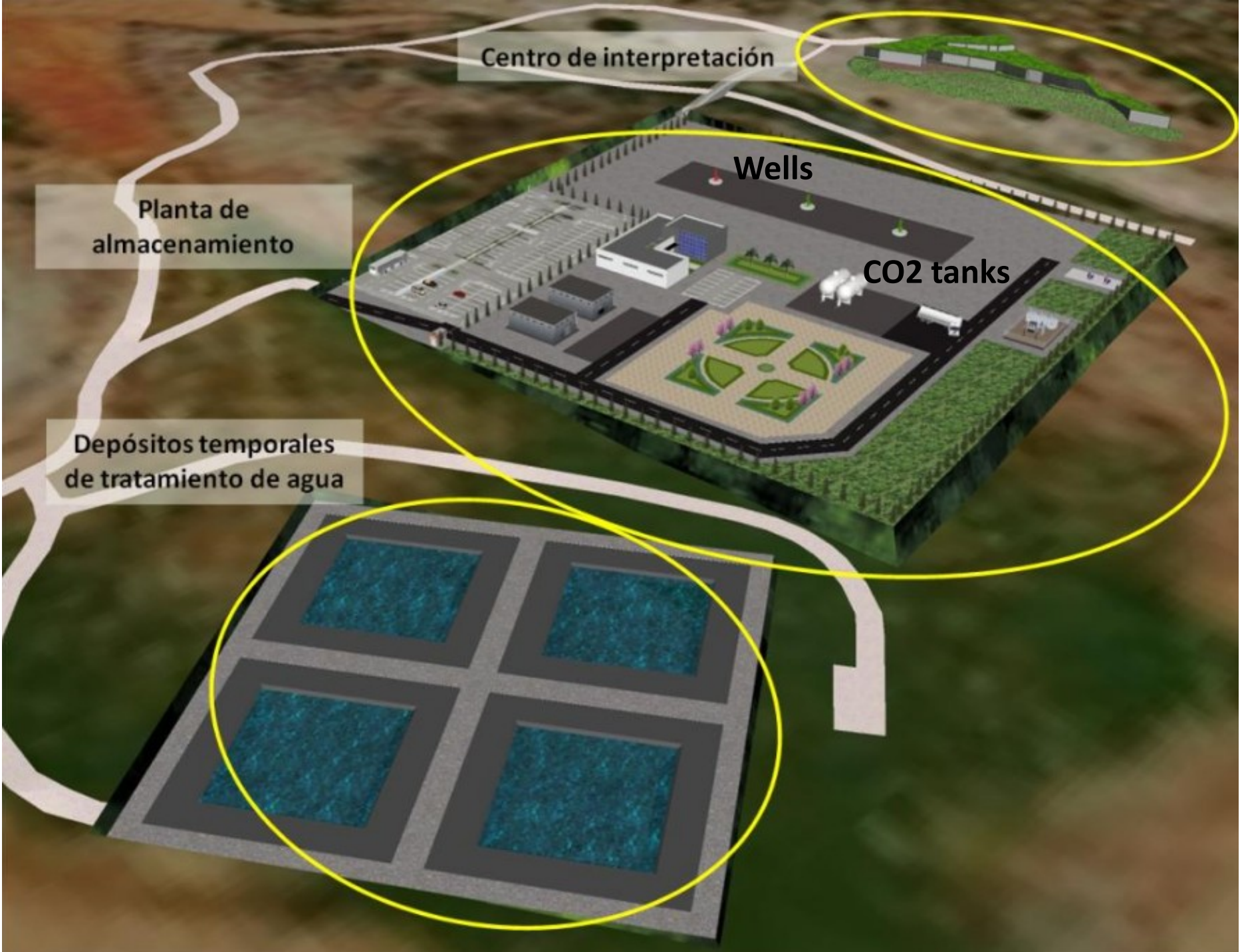
Centro de interpretación

Planta de almacenamiento

Depósitos temporales de tratamiento de agua

Wells

CO2 tanks

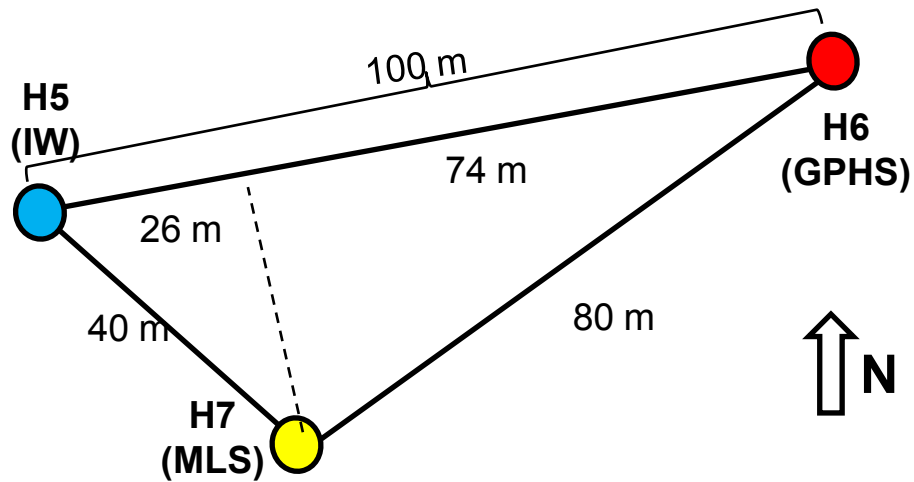






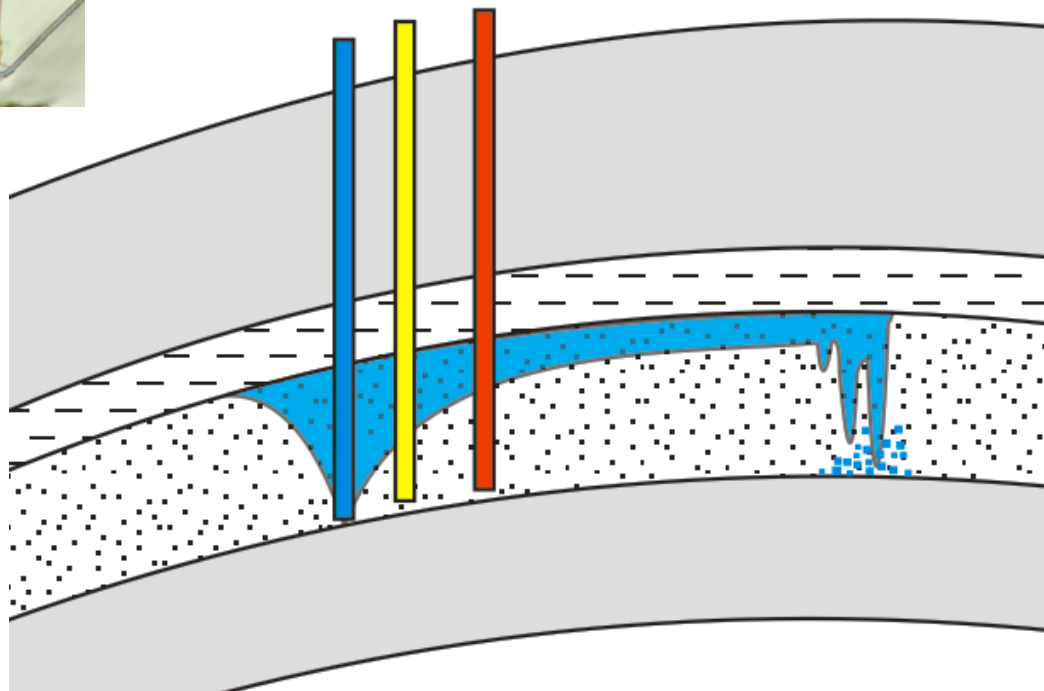


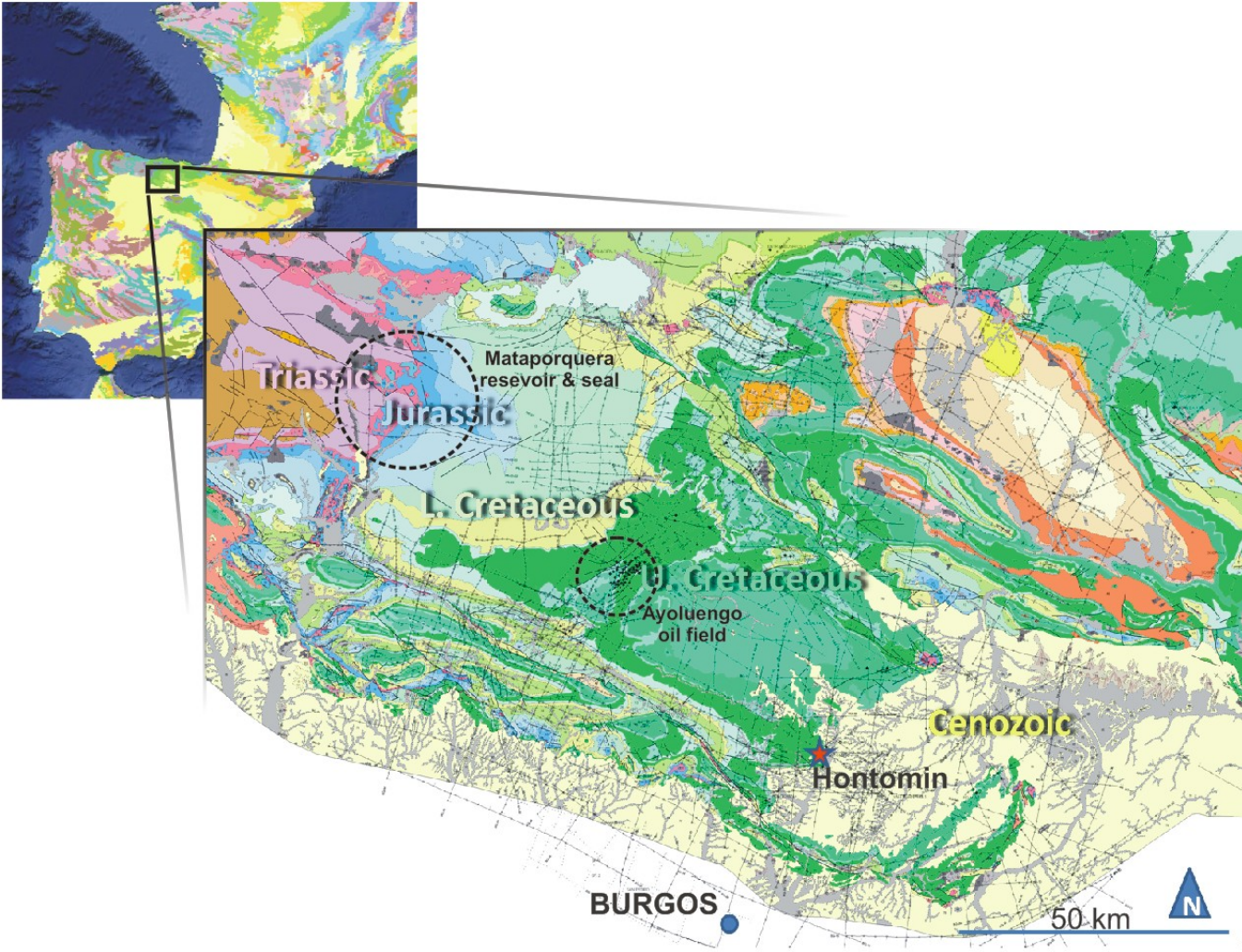
## Planned wells



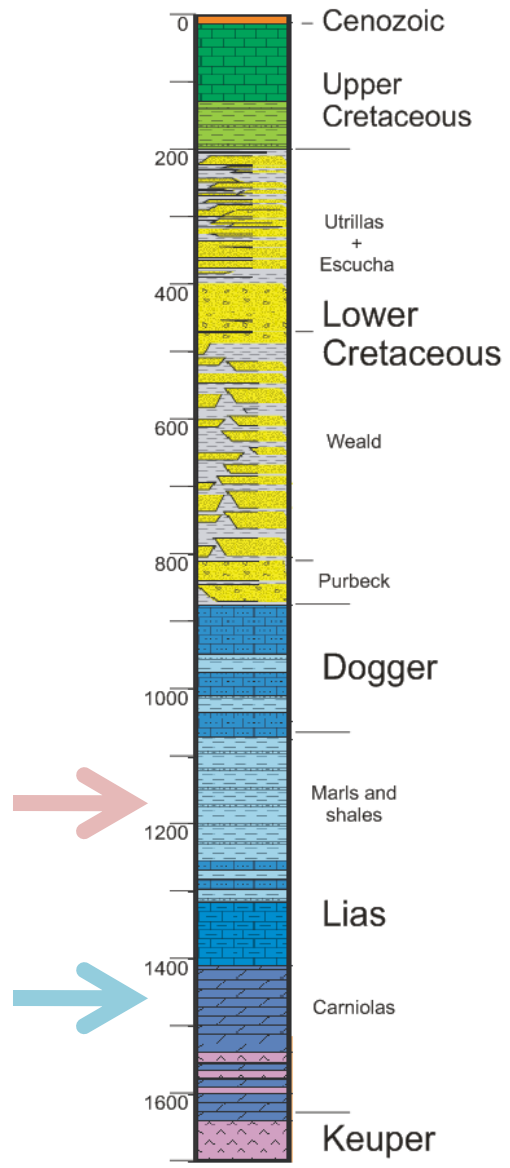
### 3 wells ~1500m

- **H5:** Injection (IW)
- **H6:** Monitoring (GPHS, GeoPHysical System)
- **H7:** Monitoring (Multi Level System)





### Hontomín stratigraphy



The target **reservoir** is a saline aquifer set in Early Jurassic (Lias) carbonates, around 150 m thick and 1500m deep.

The main **seal** is formed by more than 200 m of interlayered Early to Middle Jurassic marlstones and marly limestones.

# Characterization tests to identify HMTC parameters

During first 2013 semester

- Single interval tests
  - Pulse injection tests
  - Gas pressure threshold test
- Water pumping-injection (“quita y pon”) tests
  - Coupled to tracer tests at injection well
- Tracer tests
- High pressure injection test: big push (“apretón”)
- CO<sub>2</sub> Push-pull (“mete-saca”) tests

# CO<sub>2</sub> injection tests

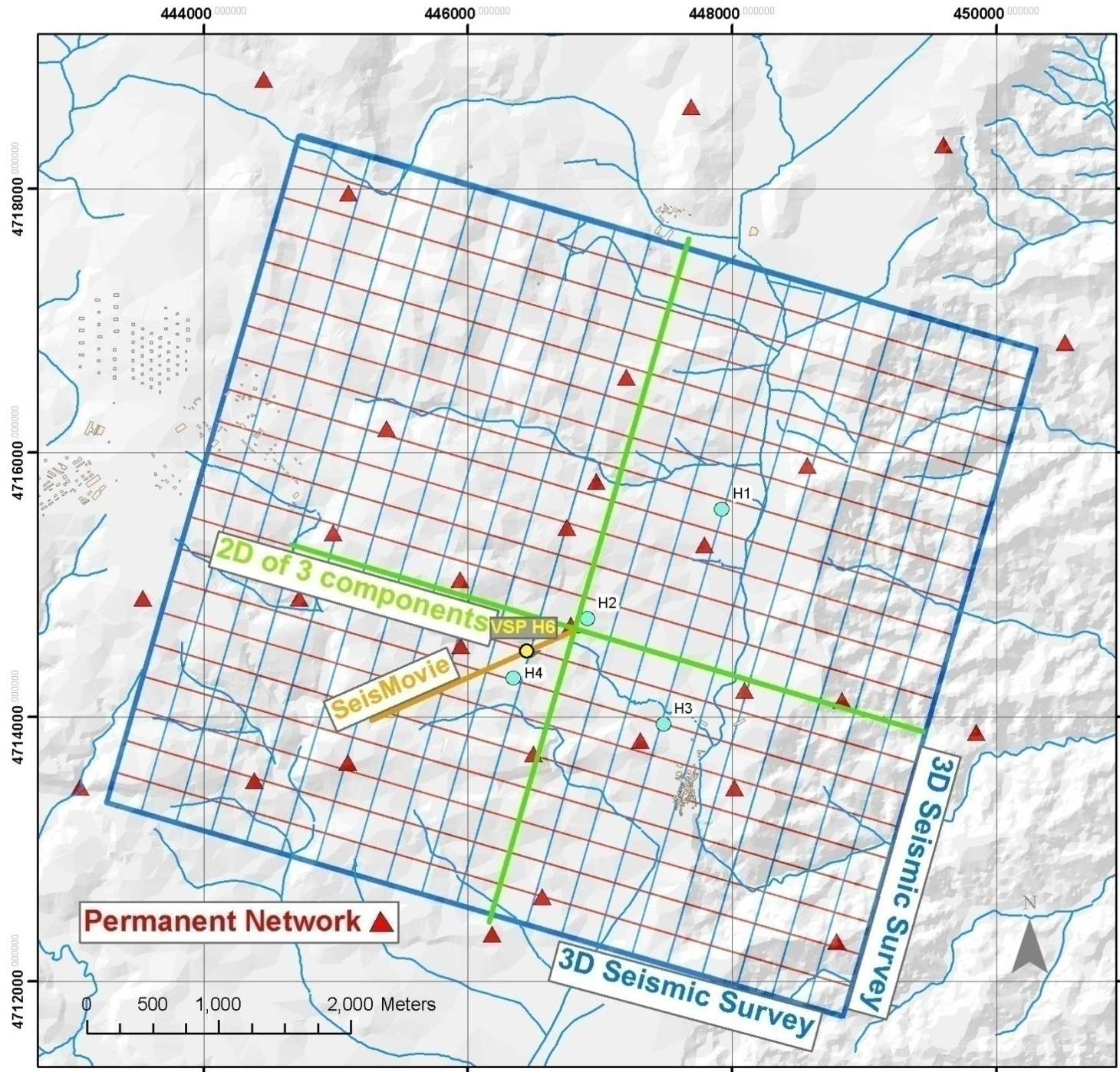
During 2013-2016

- Conventional ScCO<sub>2</sub>
- Fluctuating flow rate
- Liquid CO<sub>2</sub> injection
- Fluctuating with impurities
- Dissolved

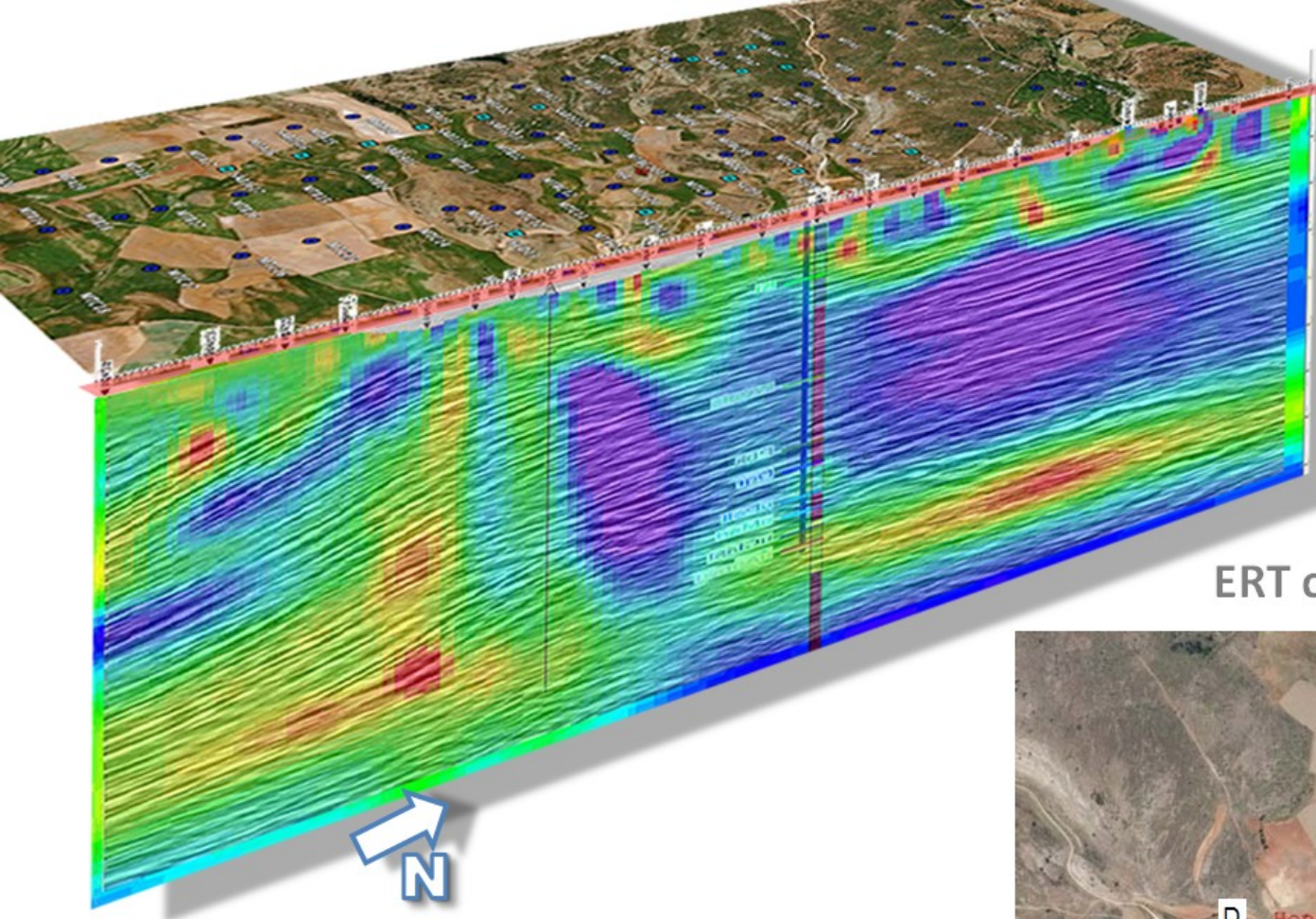
Extensive modelling for

- 1) Test design
- 2) Interpretation
- 3) Long term prediction





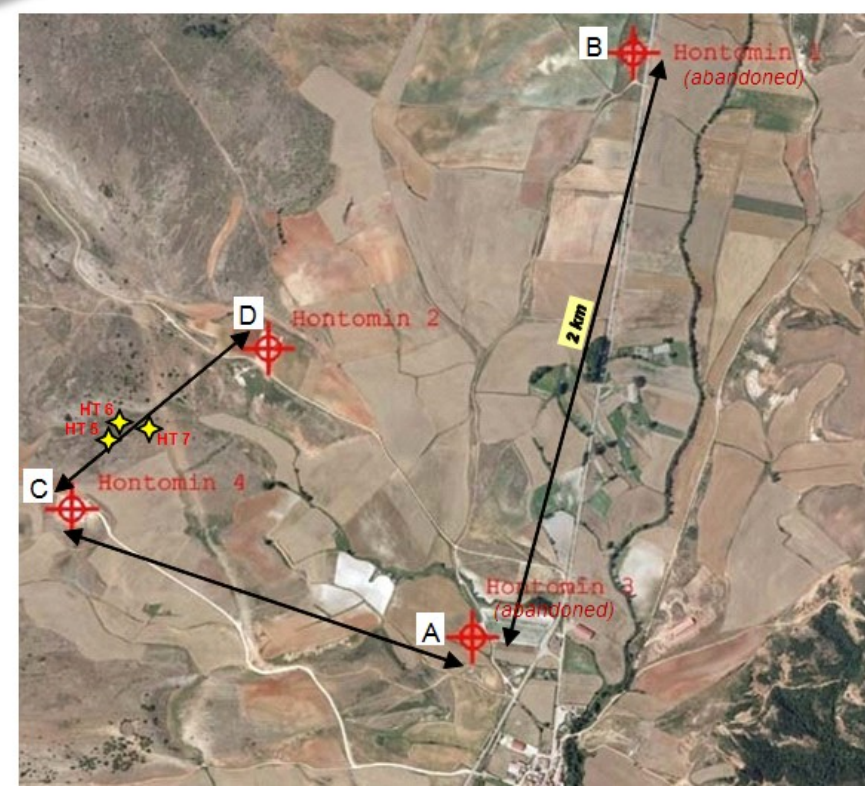




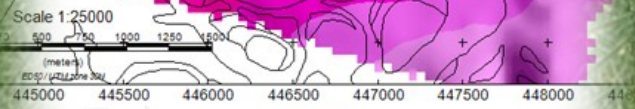
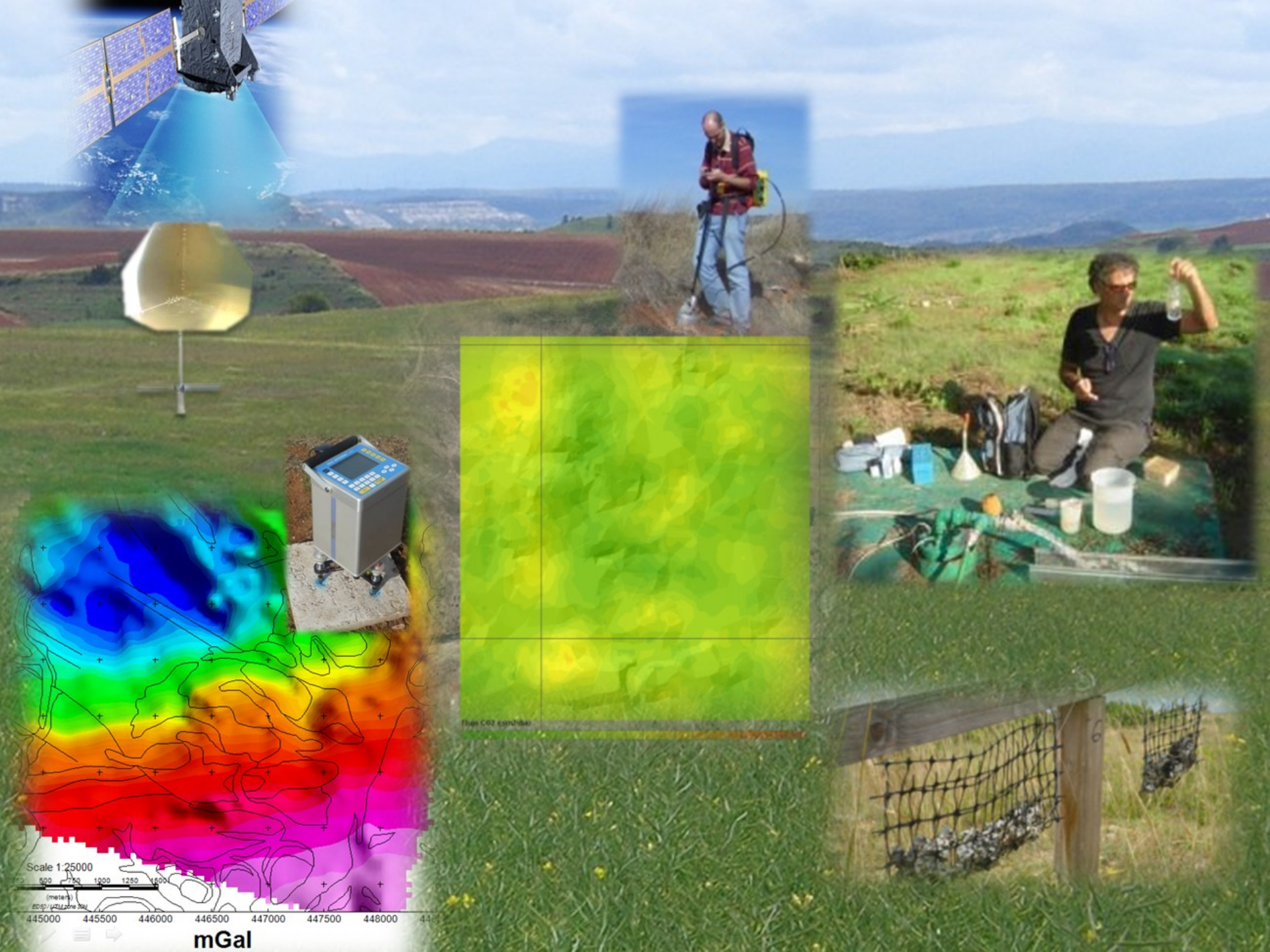
ERT crosshole & LEMAM

### 3D Magnetotellurics

139 sites de MT  
(4x3km<sup>2</sup>)







mGal

Thin CO2 sensor

# Geological Storage of CO<sub>2</sub>

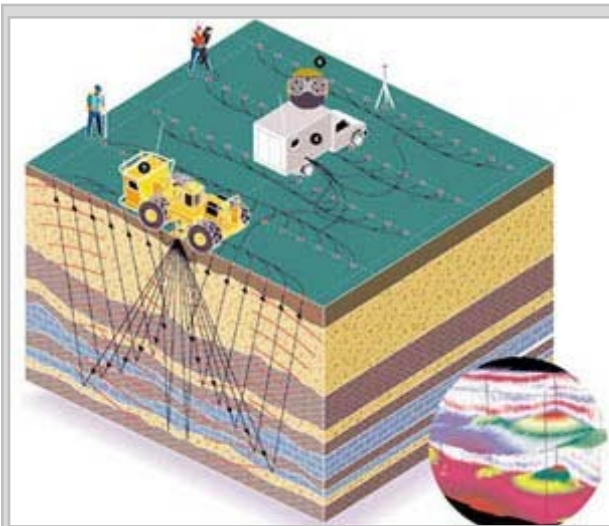
## “Life-cycle”

Pre-operational

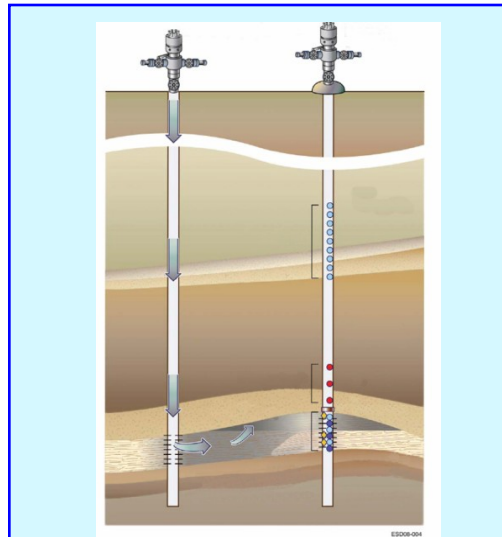
Operational

Post-operational

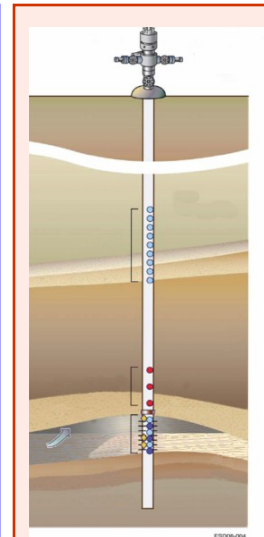
Transfer to state



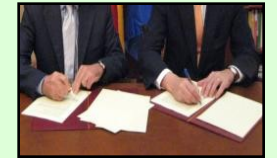
Site selection and characterisation



Injection and monitoring wells



Monitoring CO<sub>2</sub>



Transfer of responsibility to the State

Identification



Storing



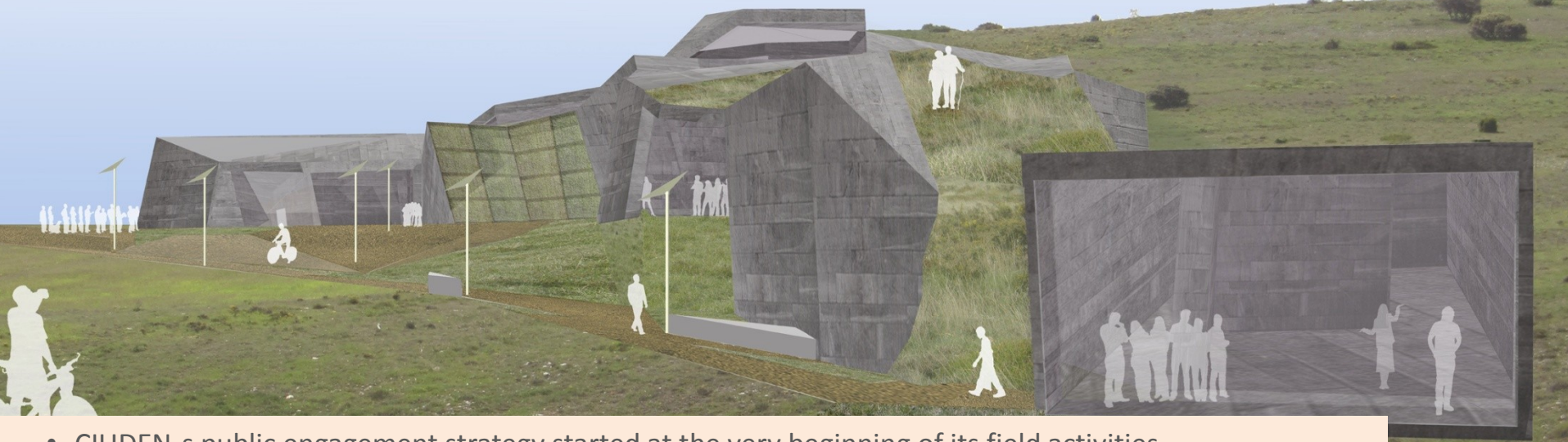
Closing



Transfer

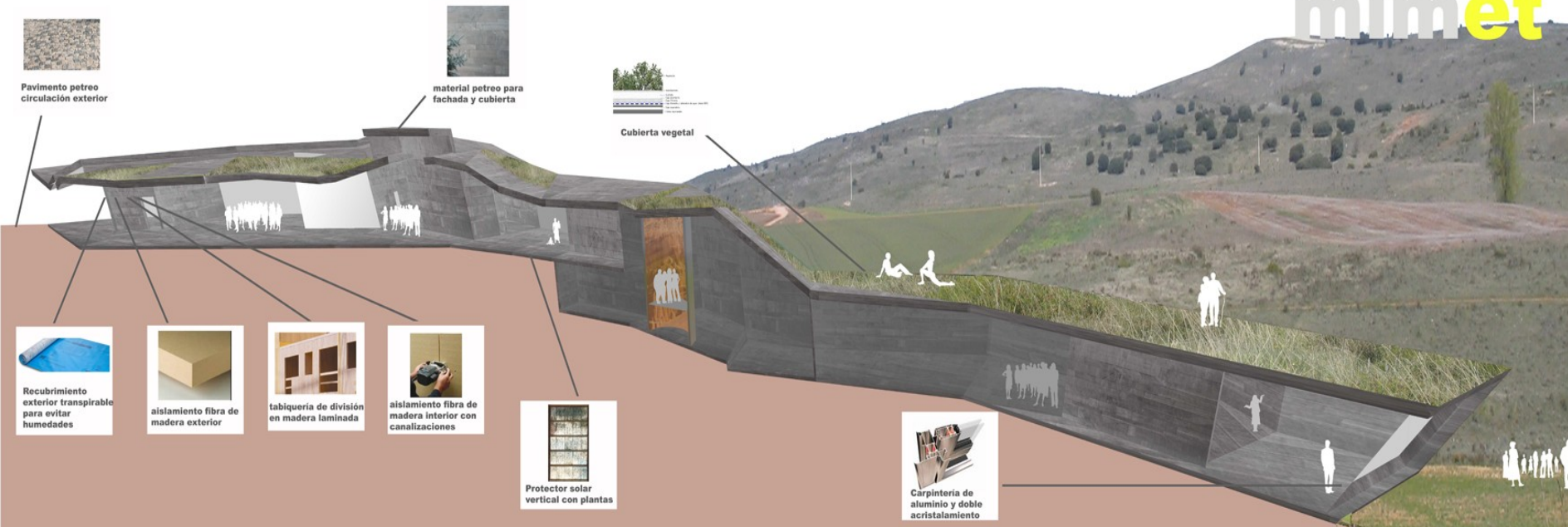


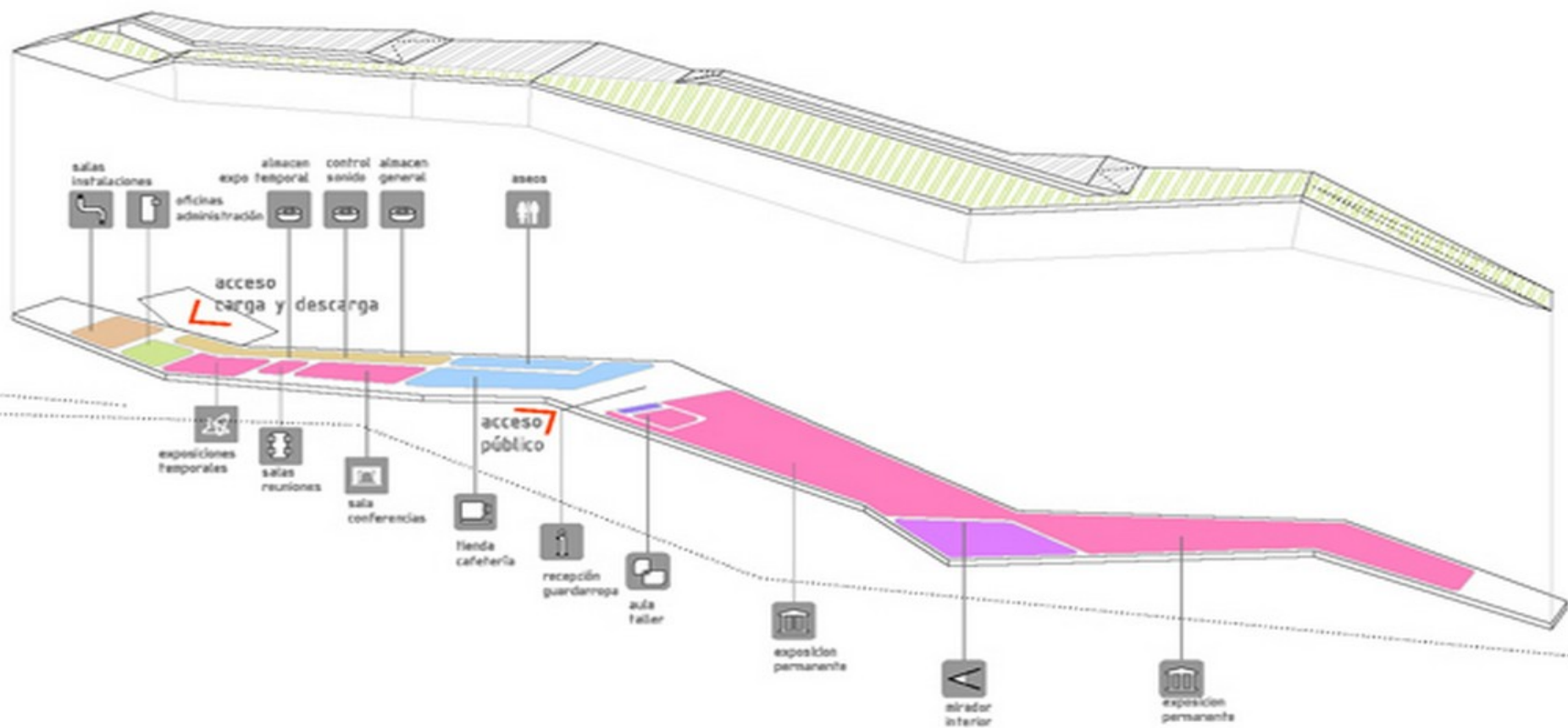
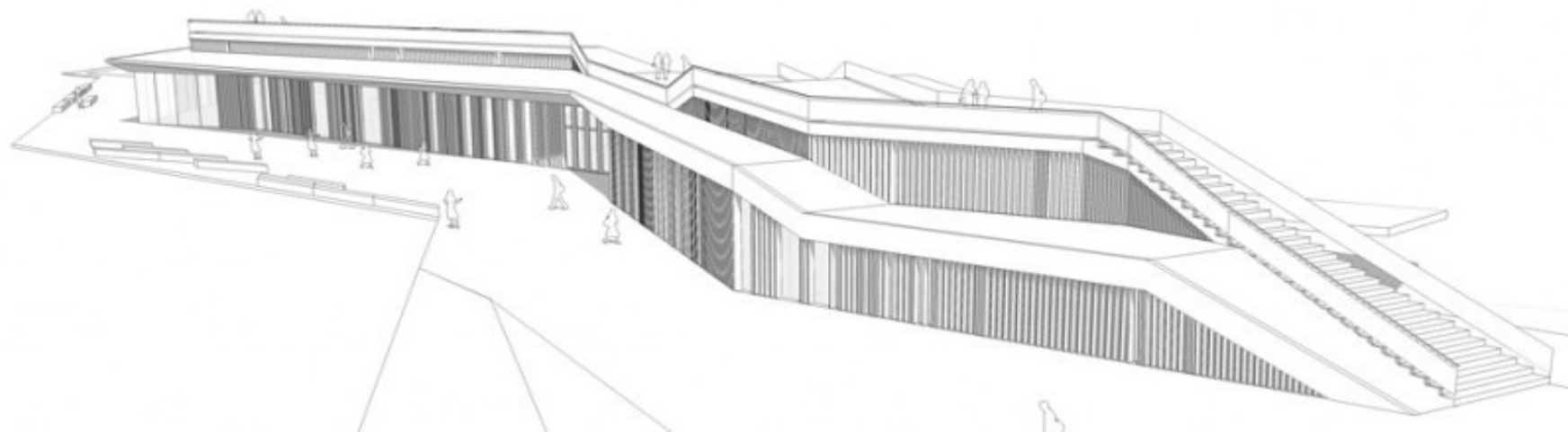
# Communication and Public Acceptance



- CIUDEN s public engagement strategy started at the very beginning of its field activities.
- CIUDEN maintains a permanent communication and engagement with the stakeholders.
- These activities will be reinforced with the Visitor s Centre that will be located next to the TDP.

mimet





**Thanks for your attention**