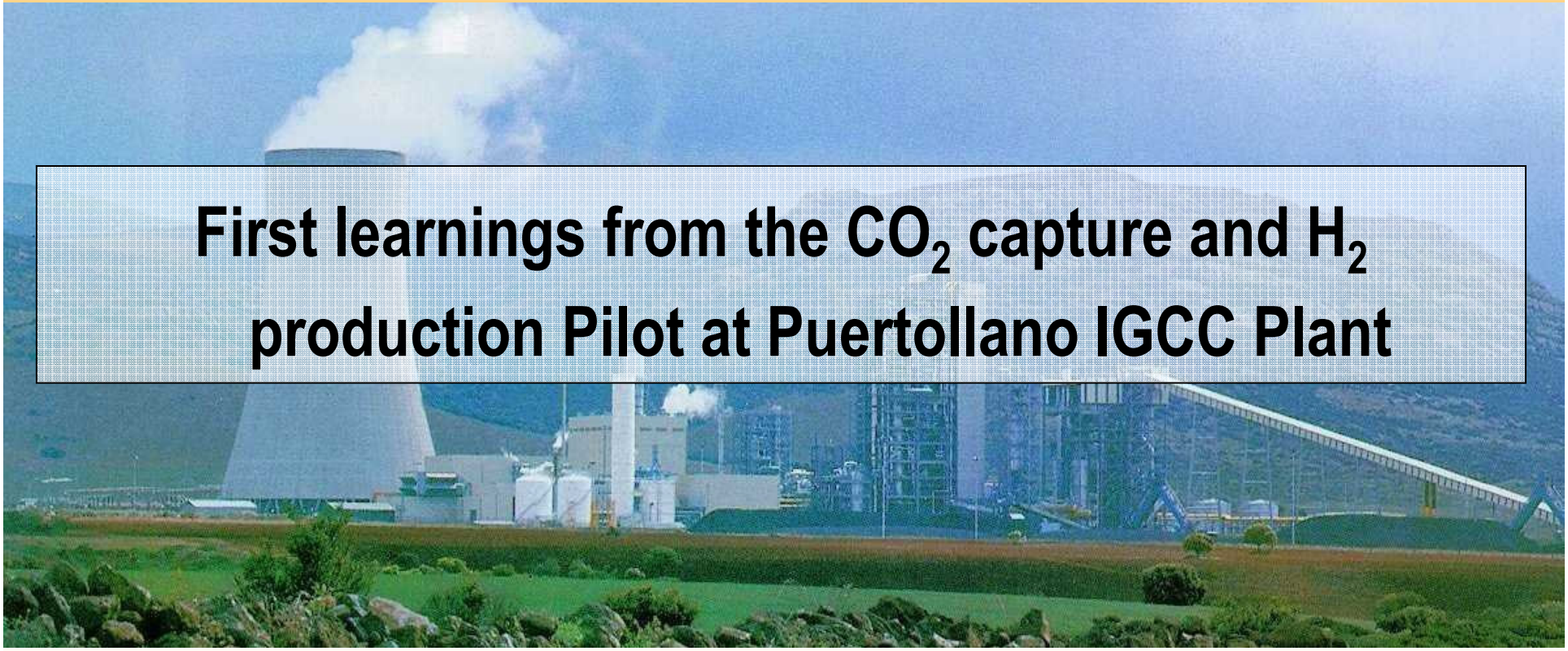
Fuel Cells & Hydrogen Joint Undertaking Stakeholders General Assembly
9-10 November 2010
Brussels



First learnings from the CO_2 capture and H_2 production Pilot at Puertollano IGCC Plant

Pedro Casero (pcasero@elcogas.es)

ELCOGAS S.A.

ELCOGAS

FIRST CO_2 CAPTURED IN THE PILOT PLANT OF ELCOGAS PUERTOLLANO IGCC POWER PLANT

September 14, 2010. Yesterday, between 8 and 10 pm, the first tonne of CO_2 was captured in the 14 MW pilot plant that ELCOGAS has built in its Integrated Gasification Combined Cycle (IGCC) power plant at Puertollano.

Now, an optimization of the processes begins to perform the required tests to get technical, and reliable, information about economics and efficiency of coproduction of Clean Hydrogen and Electricity with capture of CO_2.

The Pilot Plant has been built with the support of the Spanish Science and Innovation Ministry and the Regional Government of Castilla La Mancha, under the program of Singular and Strategic Projects into the project called "CO_2 technologies" that is being coordinated by Spanish Research Centre Ciemat.

Through its process of Integrated Gasification Combined Cycle, that uses a mixture of local fuels (Puertollano coal and refinery wastes, with demonstrated options of biomass), ELCOGAS has shown since 1998 an excellent environmental performance –with emissions very much lower than any other technology based on coal, coke, or biomass, and very close to or better than those from Natural Gas Combined Cycle– with an efficiency higher than the conventional thermal power plants.

With the commissioning of this 14 MW pilot plant for H_2 production and CO_2 capture –first industrial-scale pilot plant in service in Spain and first worldwide integrated into an IGCC plant dedicated to electricity production– ELCOGAS expresses once again its commitment to the environment and its contribution to climate change mitigation in the short-medium term with present and existing technologies.

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AHORA COMIENZA UN PROCESO DE OPTIMIZACIÓN DE SU FUNCIONAMIENTO

Elcogas logra capturar la primera tonelada de CO2 en su planta

Es la primera de escala industrial en España y la primera en el mundo en una central GICC que produce electricidad

Elcogas vivía en la tarde-noche del pasado lunes un momento histórico dentro de la central, y es que, entre las 20:00 y las 22:00 horas, se produjo la primera captura de una tonelada de CO2 en la planta piloto que Elcogas ha construido en su Central de Gasificación Integrada en Ciclo Combinado (GICC) de Puertollano. A partir de ahora comienza un proceso de optimización del funcionamiento. En su proceso, en el que utiliza una mezcla de combustibles autóctonos, Elcogas ha demostrado un comportamiento medioambiental excelente, con emisiones muy inferiores a las de cualquier otra tecnología que utilice carbón o coque.

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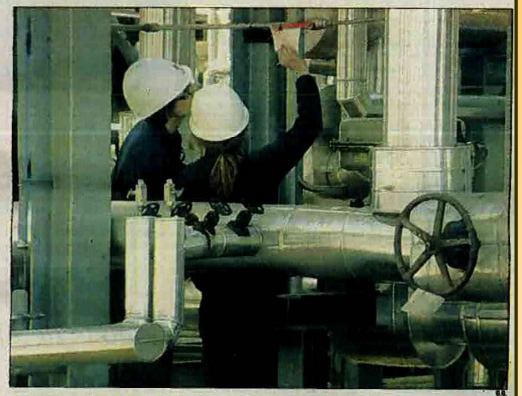


Es la primera planta a escala industrial que se pone en marcha en España

INDUSTRIA

Elcogas captura su primera tonelada de dióxido de carbono

LA TRIBUNA / PUERTOLLANO

Entre las 20 y las 22 horas del lunes se produjo la captura de la primera tonelada de dióxido de carbono (CO2) en la planta piloto que Elcogas ha construido en su central de gasificación integrada en ciclo combinado (GICC) de Puertollano. A partir de ahora comienza un proceso de optimización del funcionamiento, además de una etapa en la que se realizarán las pruebas requeridas para los estudios comprometidos con el Ministerio de Ciencia e Innovación.

A través de su proceso, en el que utiliza una mezcla de combustibles autóctonos, Elcogas ha demostrado desde sus inicios un comportamiento medioambiental excelente, con emisiones muy inferiores a las de cualquier otra tecnología que utilice carbón o coque, muy próximos, o mejores en algunos casos, que los de los ciclos combinados con gas natural, y con una eficiencia superior a las centrales térmicas convencionales.

Con la puesta en marcha de esta planta piloto de captura de CO2 de 14 Megawatios -primera de escala industrial que se pone en servicio en España y primera a nivel mundial integrada en una central GICC dedicada a la producción de electricidad-, Elcogas pone de manifiesto, una vez más, su compromiso medioambiental y su aportación a la mitigación del cambio climático en el corto y medio plazo.

Cabe recordar que la planta finalizó su puesta en marcha la pasada semana, y que se espera que antes de finales de año pueda arrojar los primeros resultados sobre este proceso, realizado por primera vez a escala industrial.

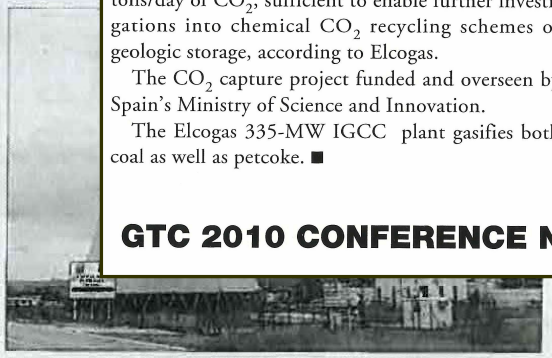


Imagen de archivo de la planta de GICC de Elcogas en Puertollano. / P. G. M.

Elcogas Launches CO_2 Capture at IGCC Plant

Spain-funded project will eventually capture 100 tons/day of CO_2.

By Jack Peckham, Executive Editor, *Gasification News*

Spain's Elcogas integrated gasification combined-cycle (IGCC) power plant has officially started capturing carbon dioxide (CO_2) at an adjacent 14 megaWatt (MW) pilot plant.

According to a September 14 press release from the company, the new CO_2 capture scheme will undergo further optimization tests.

The pilot plant eventually will capture 100 tons/day of CO_2, sufficient to enable further investigations into chemical CO_2 recycling schemes or geologic storage, according to Elcogas.

The CO_2 capture project funded and overseen by Spain's Ministry of Science and Innovation.

The Elcogas 335-MW IGCC plant gasifies both coal as well as petcoke. ■

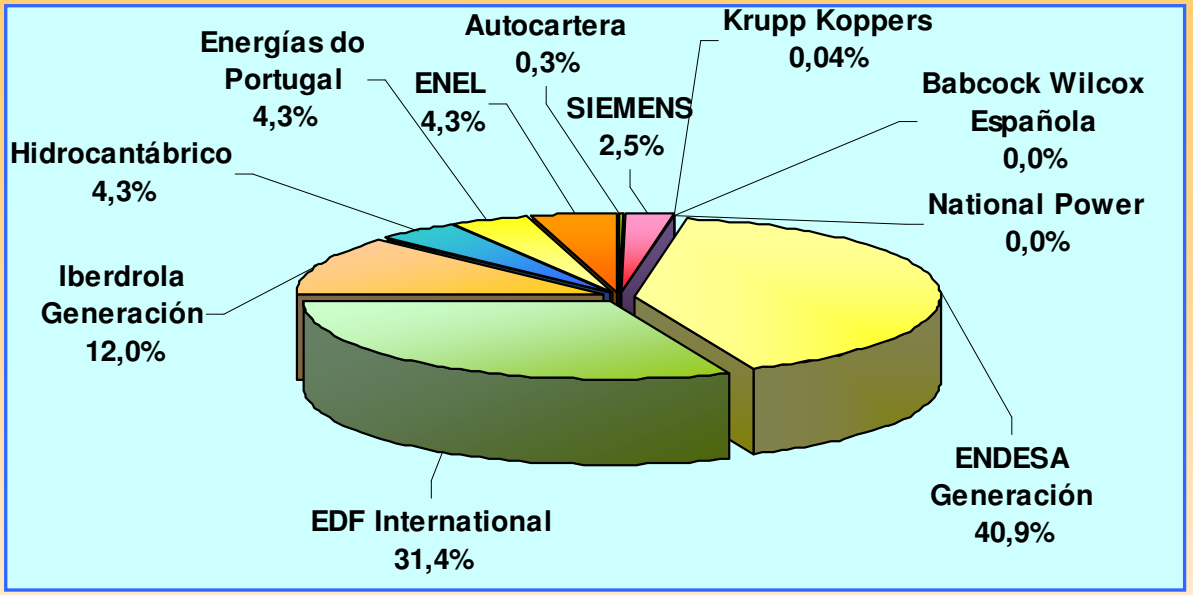
GTC 2010 CONFERENCE NE

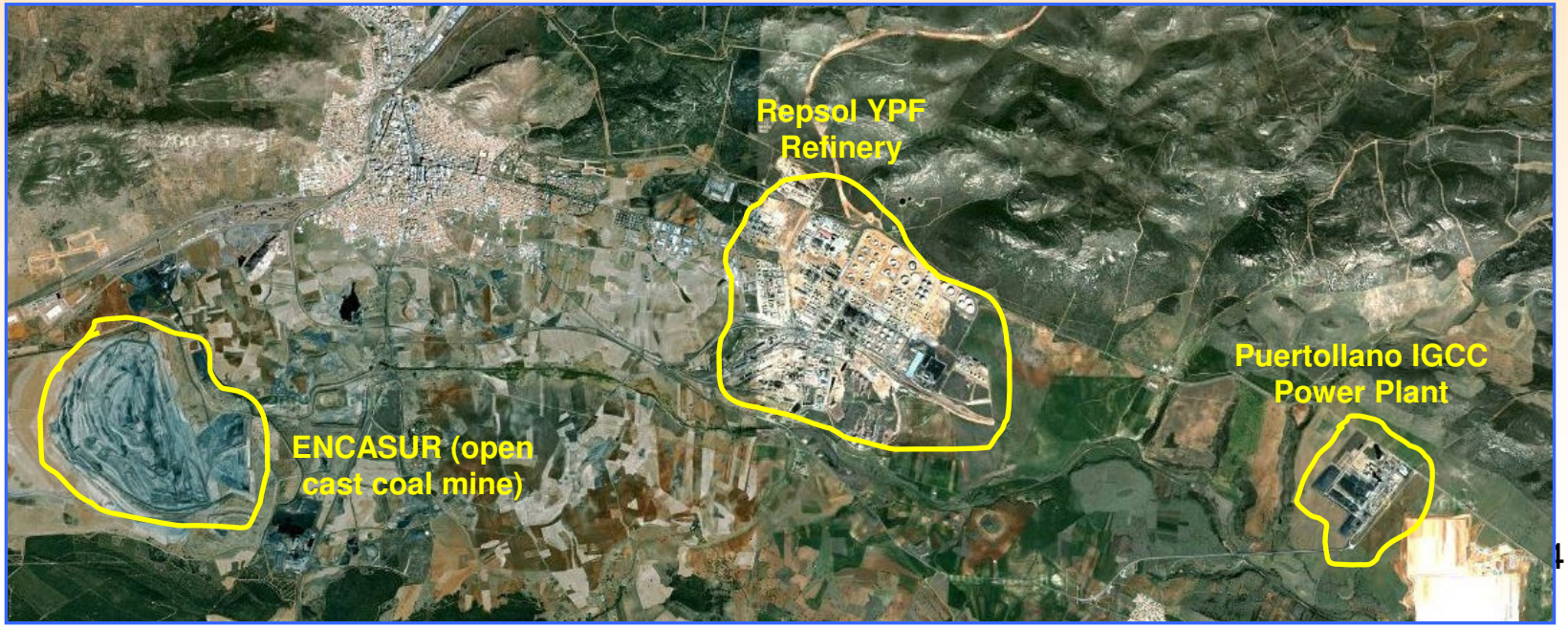
Outline

1) Elcogas
2) R&D Investment Plan
3) Carbon Capture and H2 production Pilot
4) First results and short-term schedule

ELCOGAS, S.A.

European company established in April 1992 to undertake the planning, construction, management and operation of a 335 MW_{ISO} IGCC plant located in Puertollano (Spain)





Puertollano IGCC Power Plant. Operational Data

Fuel mode	Fuel	Consumo (GJ_{PCS})	Production (GWh)	Heat rate (GJ_{HHV}/GWh)	Fuel cost (€/GJ_{HHV})	Partial cost (€/MWh)	Total cost (€/MWh)
GT	Natural gas	82.483	4,49	18.383	7,86	144,49	**144,49**
NGCC	**Natural gas**	**106.871**	**10,46**	**10.220**	**7,86**	**80,33**	**80,33**
NGCC + ASU	Natural gas	2.001.422	178,73	11.198	7,86	88,02	**88,02**
NGCC+ASU+ Gasifier (by flare)	Natural gas	473.830	45,14	10.498	7,86	82,51	**95,97**
	Coal	95.899		2.125	3,20	6,80	
	Petcoke	246.180		5.454	1,22	6,66	
IGCC	**NG auxiliar consumption**	**235.818**	**1.302,19**	**181**	**7,86**	**1,42**	**18,74**
	Coal	**3.560.131**		**2.734**	**3,20**	**8,74**	
	Petcoke	**9.138.518**		**7.018**	**1,22**	**8,57**	

Note: Real net costs for year 2009

Average price of electricity in Spain in 2009: 40 €/MWh

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Elcogas R&D Investment Plan

Since 2007 ELCOGAS has defined a R&D Investment Plan to develop IGCC technology in order to decrease the environmental impact of power production as main target

ELCOGAS presents a yearly results report of that R&D Plan to Spanish government for evaluation

MAIN LINES OF R&D PLAN ARE:

- ***CO_2*** **EMISSION REDUCTION IN UTILIZATION OF FOSSIL FUELS**
- ***H_2*** **PRODUCTION BY GASIFICATION OF FOSSIL FUELS**
- ***DIVERSIFICATION*** **OF RAW FUELS AND PRODUCTS**
- **OTHER *ENVIRONMENTAL* IMPROVEMENTS**
- ***IGCC PROCESSES OPTIMIZATION***
- ***DISSEMINATION*** **OF RESULTS**

National Research Project. Singular & Strategic Projects

TARGETS

To demonstrate the **feasibility of capture of CO_2 and production of H_2** in an IGCC that uses solid fossil fuels and wastes as main feedstock.

To obtain **economic data** enough to **scale** it to the full Puertollano IGCC capacity in synthetic gas production.

PARTICIPANTS & BUDGET

ELCOGAS – UCLM – Ciemat – INCAR CSIC

COORDINATED

Project of pilot plant in existing IGCC of Puertollano is part of a Spanish national initiative, ***"Advanced technologies of CO_2 conversion, capture and storage"*** and it is coordinated with other related projects:

Project # 2 is to explore CO_2 capture with oxyfuel technology in a 20-30 MW pilot plant. To be built in El Bierzo, NW of Spain. CIUDEN

Project # 3 is to study and regulate geological storage in Spain. IGME

Project #4 is to study public awareness of CCS technologies. CIEMAT

Outline

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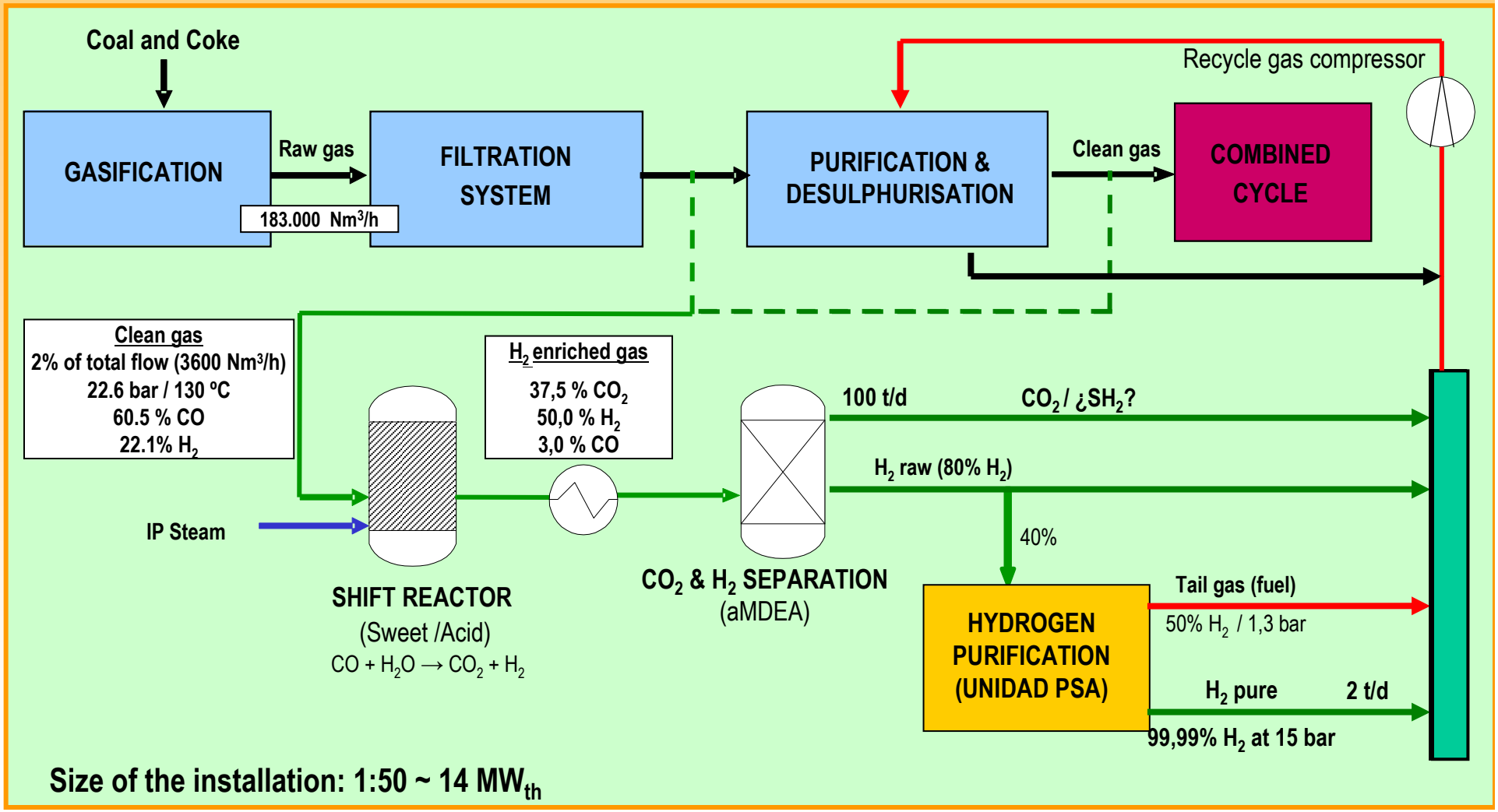
Carbon Capture & H_2 Production Pilot. Facts

Company	ELCOGAS, S.A (Spanish Utility)
Location	Puertollano (Spain). Integrated in Puertollano IGCC Plant
Feed gas	Coal gas at 20-24 bar
Size	14 MWt (2% of total coal gas produced in IGCC Plant)
Technology	Pre-combustion Carbon Capture (90%). No Storage foreseen
Budget	Construction & Commissioning ~ 13 M€
Frame	National Research Project, granted by *Spanish Science and Innovation Ministry* and *Regional Government (JCCM)*
Start date	2005
End date	Commisioning accomplished in October 2010.

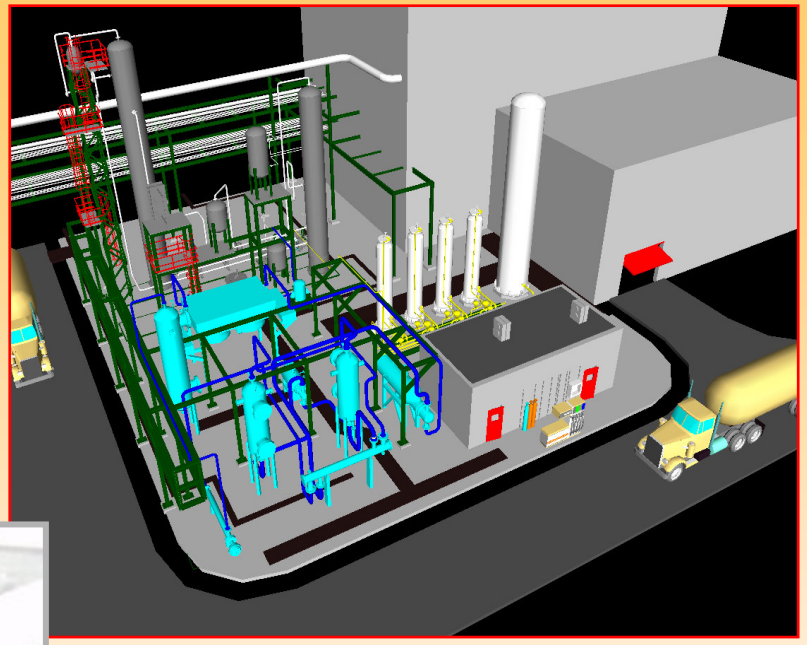
GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN
Junta de Comunidades de Castilla-La Mancha

Carbon Capture & H_2 Production Pilot. Block Diagram



Size of the installation: 1:50 ~ 14 MW_{th}

Carbon Capture & H_2 Production Pilot. Construction



3D artistical view

December 2008

Carbon Capture & H_2 Production Pilot. Construction

May 2009

Carbon Capture & H_2 Production Pilot. Construction

September 2009

Carbon Capture & H_2 Production Pilot. Construction

October 2009

Carbon Capture & H_2 Production Pilot. Construction

January 2010

Carbon Capture & H_2 Production Pilot. Construction

August 2010

Carbon Capture & H_2 Production Pilot. Status

1st tonne of CO2 captured: 13th September 2010

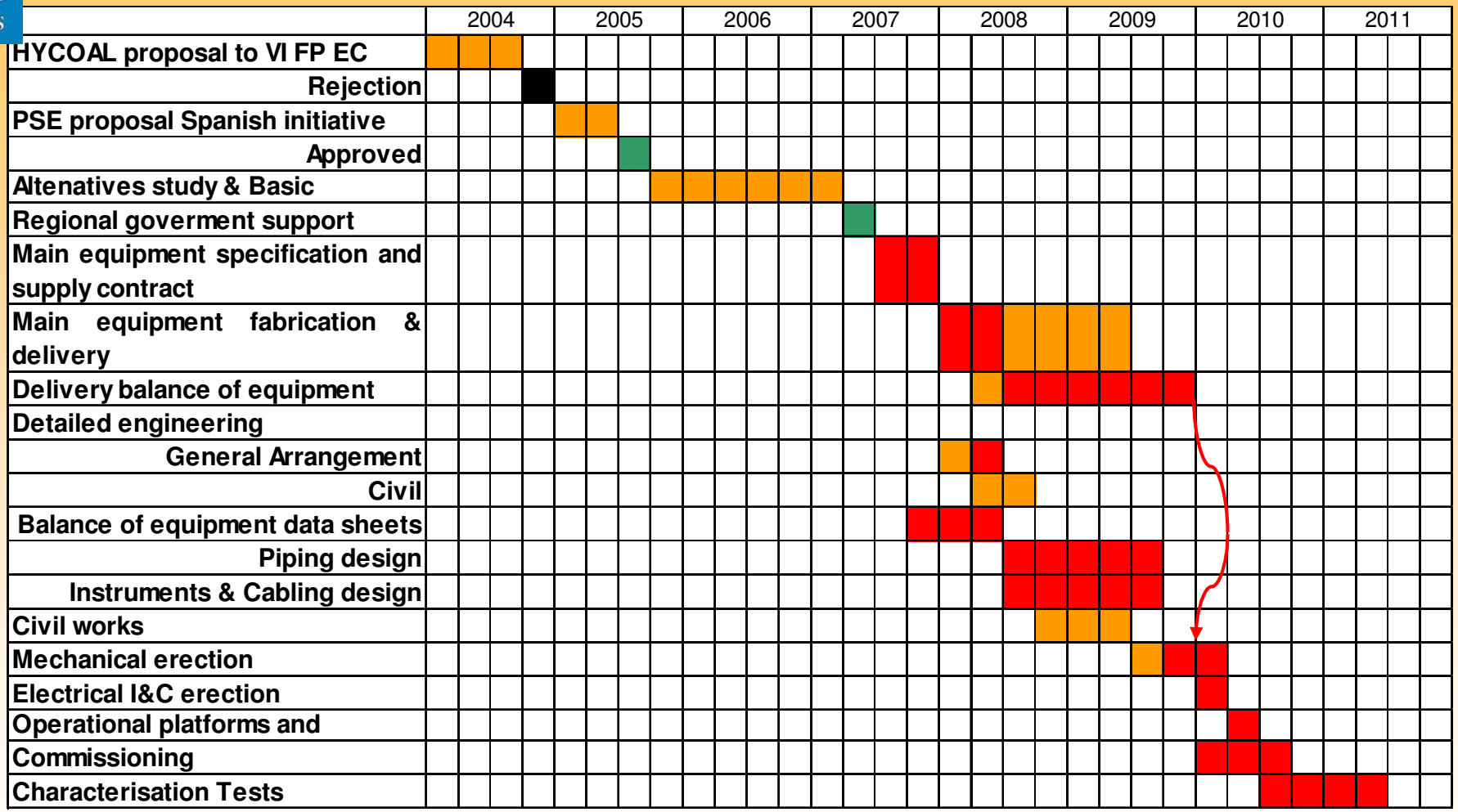
End commissioning: October 2010

End of scheduled tests (under PSE): June 2011

KEY CONTRACTORS

Engineering	**Empresarios Agrupados**
CO_2 Unit	**Linde-Caloric**
PSA Unit	**Linde**
Civil work	**Local company (Construcciones Ocaña-Cañas)**
Control	**Zeus Control**
Reactors	**Tecnical**
Heat exchangers	**Tecnical and Boreal-Vila**
Catalysts	**Johnson Matthey**
Piping and fitting	**Local suppliers (Sidsa and Cuñado)**
Control valves	**SAMSON**
Safety and relief valves	**Tyco Valves and Controls**
Manual valves	**Local supplier (SAIDI)**
Electrical components	**GE Power**
On-line analysis system	**ABB Process Automation Division**

Carbon Capture & H_2 Production Pilot. Timeline



1. **Finance**
2. **Delivery time:** Main equipment between 12 and 14 months
3. **Detailed engineering**: Conditioned by suppliers
4. **Construction:** Working permits with plant in operation
5. **Commissioning:** Low availability of experimented personnel

Carbon Capture & H_2 Production Pilot. Operational Team

The team in charge of the operation of the Pilot was composed during commissioning by 3 Chemical Engineers contracted by UCLM (regional university) within the scope of the national research project. The 2nd of November 6 more Engineers joined them.

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Carbon Capture & H_2 Production Pilot. Preliminary result

Expected vs obtained compositions of main streams

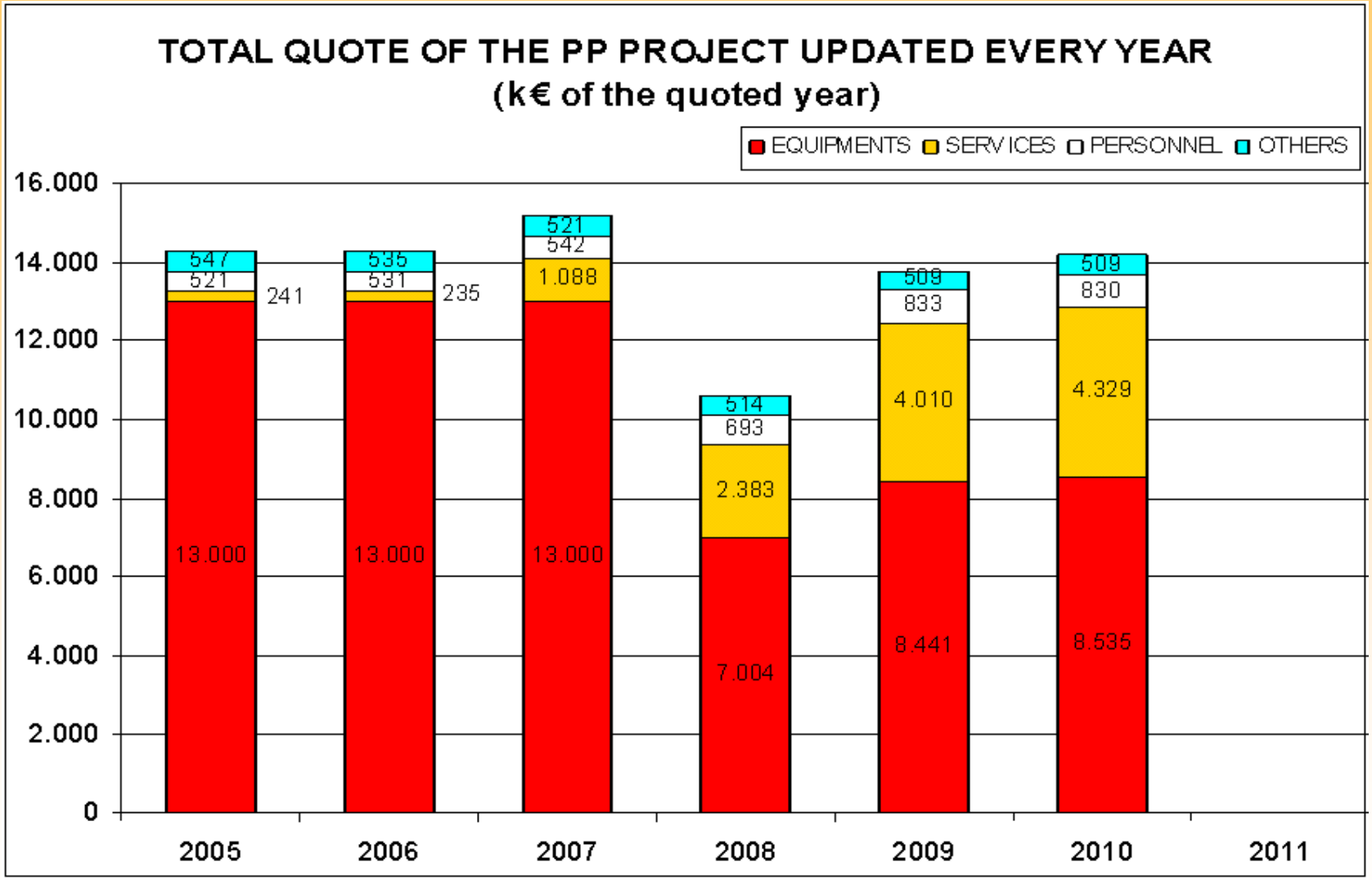
	Shifted gas		CO_2		H_2 rich gas		Pure H_2	
Compound	Expected	Lab analysis	Expected	Lab analysis	Expected	Lab analysis	Expected	Lab analysis
H_2	50.05	51.88	0.19	0.36 - 1.31	79.75	82.3 - 82.6	99.99	99.969 - 99.992
CO	2.92	1.85	0	0.053 - 0.07	4.65	2.86 - 3.78	4 ppm	
CO_2	37.56	37.36	99.78	98.2 - 99.5	0.5	0.02 - 0.82	1 ppm	
N_2	8.76	8.30	0.01	0.09 - 0.28	13.97	12.2 - 13.6	15 ppm	4 - 17 ppm
Ar	0.71	0.60	0.02	0.05 - 0.09	1.13	0.89 - 0.97	80 ppm	3 - 14 ppm

i) All compositions are in % vol (dry basis)
ii) Analysis taken during 19th and 22nd October, and realized by Elcogas Lab.

Carbon Capture & H_2 Production Pilot. Tests

- Comparison of **sweet & sour catalysts**: sweet tests up to Feb 2011, sour tests up to June 2011
- Optimization of **steam/gas** ratio at shifting unit
- Optimization of **energy balance**
- **Real costs** of CO_2 capture and H_2 production

Carbon Capture & H_2 Production Pilot. Costs



Services costs have increased up to 50% of equipment

Pilot Plant beyond PSE project

Pilot plant *for CO_2 capture and production of H_2 and electricity with IGCC technology*

Other activities: To be done **after PSE** as R&D platform:

- Water shift reaction **catalyst** optimization. Tests of different catalyst
- **New processes** to separate CO_2-H_2
- CO_2 different **treatment** processes
- Improvement of **integration** efficiency between CO_2 separation processes and IGCC plant

ELCOGAS offers both the Puertollano IGCC and the Pilot Plant for CO_2 capture and H_2 production as technical platforms to develop of process, equipments, components, or even pre-engineering of new plants with CCS and Zero emissions

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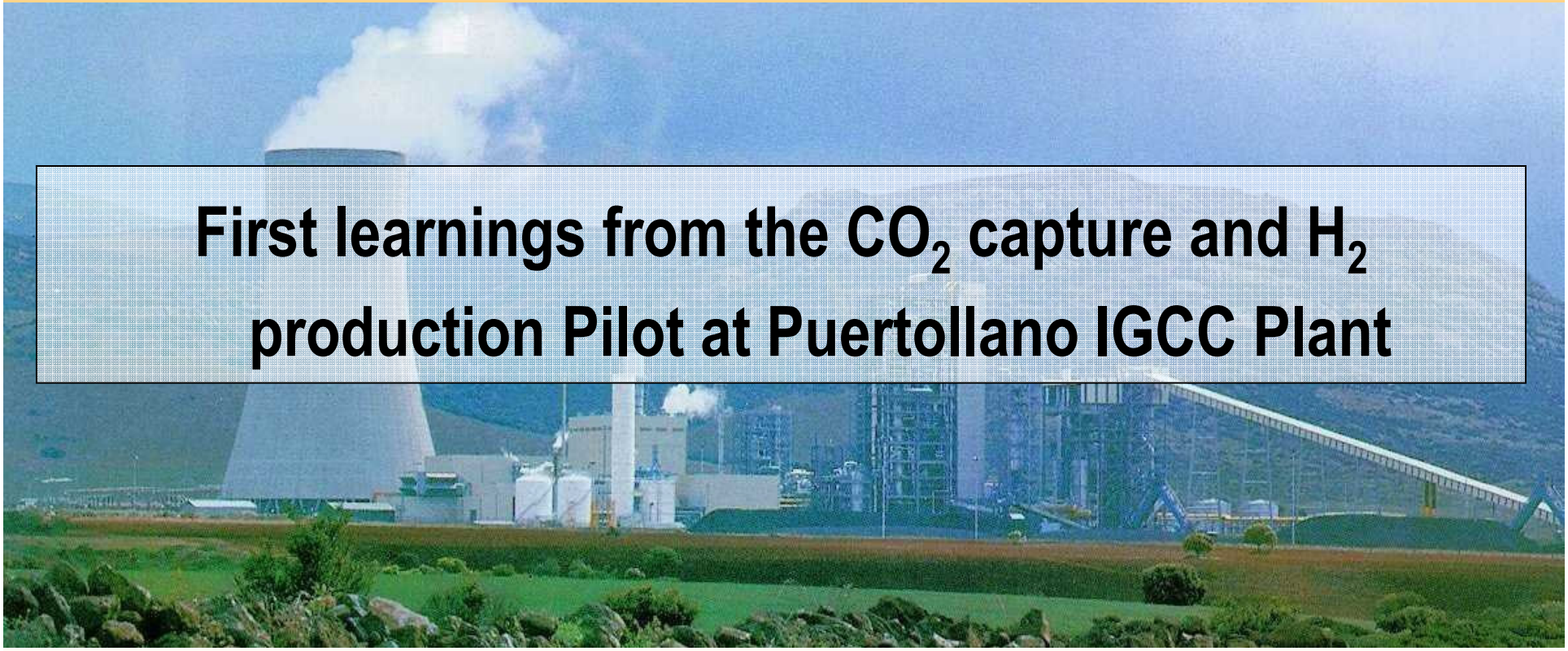

First learnings from the CO_2 capture and H_2 production Pilot at Puertollano IGCC Plant

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