Tecnologías CCUS en el proceso de descarbonización de la economía

20/05/2021

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Naturgy

Introducción

Plataforma Tecnológica Española del CO_2

https://www.pteco2.es

https://youtu.be/rCiqWkG_wnM

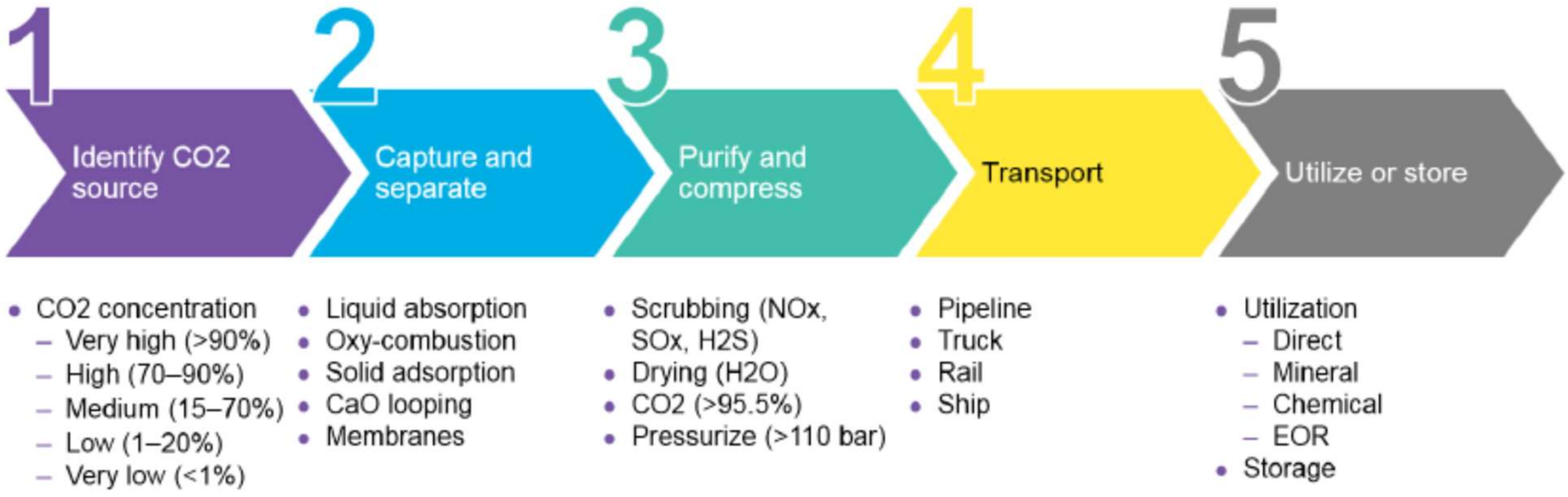
La Misión de la Plataforma es fomentar el desarrollo e implantación de las tecnologías de CAUC y los usos del CO_2 con el propósito de que España cumpla sus compromisos de reducción de emisiones y logre un sector del CO_2 económico y competitivo.

Referente en España en el seguimiento y promoción de las tecnologías CAUC.

Naturgy participa de forma activa.

Tecnologias CAUC - CCUS

- Captura, transporte, almacenamiento y usos del CO_2.
- Carbon capture, use and storage.



Fuente: BNEF. Feb 2020

¿Qué ha pasado antes?

Tras un desarrollo importante en décadas pasadas, se produce un letargo del desarrollo del CCUS en los últimos 10 años hasta hace aproximadamente dos, debido a:

- El sector energético se gira a las renovables.
- El coste de los derechos de CO_2 fue muy inferior al previsto durante un largo periodo 5-10 euros/t.
- Los proyectos demostrativos y precomerciales exigen inversiones de decenas/centenas de millones de euros.
- Crisis económica.
- Usos limitados del CO_2 que no viabilizaban la inversión. Sólo almacenamiento.

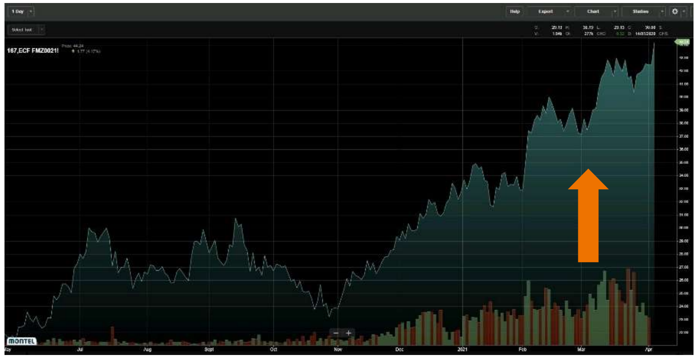
Ahora, la situación está cambiado…

News Article | Site: www.reutersevents.com/sustainability/frontpage | Date: April 8, 2021
Is this breakthrough moment for carbon capture and storage
After decades of stop-start development, the technology looks like it is ready for lift-off as a key enabler for a low-carbon economy. But there are plenty of hurdles remaining, reports Mike Scott When the UK's influential Committee on Climate Chang...

News Article | Site: www.edie.net/news/index.asp | Date: March 8, 2021
Microsoft and Chevron partner on bioenergy and carbon capture project
Microsoft and Chevron partner on bioenergy and carbon capture project Oil and gas major Chevron is collaborating with Schlumberger's New Energy arm and Microsoft to develop a major bioenergy plant with carbon capture and storage (BECCS) in ...

¿Qué pasa ahora?

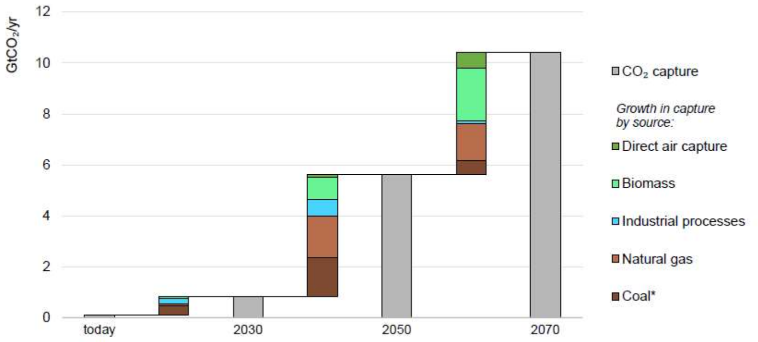
- **Aumento muy significativo del precio de CO2: 45-50 euros/t.**
- **La industria cementera y petroquímica están traccionando el sector.** Es la única solución para descarbonizar determinados procesos industriales.
- Uso extensivo del CO2 en EOR (industria petrolera y de gas).
- Tras una caída del interés del sector energético (CCS aplicado a centrales térmicas) se percibe un aumento del **interés del sector energético relacionado con la cadena del H2.**
- **Gran interés del sector Oil&Gas en su ruta de descarbonización. Grandes proyectos.**
- **Incorporación al portfolio de soluciones de descarbonización de grandes compañías.**
- ¿Fracaso de las ayudas europeas NER300? **Nuevo Fondo de Innovación Europeo. CCS incluido con un papel destacado en los topics junto a las renovables.**
- **Necesidad de proyectos demostrativos de gran tamaño.**. Sin embargo, son tecnologías probadas desde hace 45 años. **Necesidad de apoyo institucional y regulatorio. ¿Creación de un clúster en España? En Europa se están moviendo activamente. ALMACENAMIENTO.**
- **¿Captura desde el aire?** No parece muy razonable, teniendo fuentes concentradas, pero puede tener sus nichos.



Objetivos de descarbonización

Contribución de las tecnologías CCUS

Figure 2.3 Growth in global CO_2 capture by source and period in the Sustainable Development Scenario

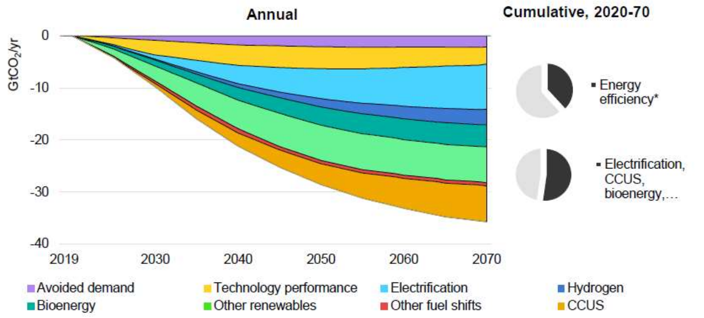


* Including from the use of oil, which represents 2% of total capture to 2070.

In the Sustainable Development Scenario, the role of CO_2 capture shifts from managing emissions from existing assets towards large-scale carbon removal.

Fuente: IEA 2020

Figure 2.1 Global energy sector CO_2 emissions reductions by measure in the Sustainable Development Scenario relative to the Stated Policies Scenario, 2019-70



* Energy efficiency includes enhanced technology performance as well as shifts in end-use sectors from more energy-intensive to less energy-intensive products (including through fuel shifts).

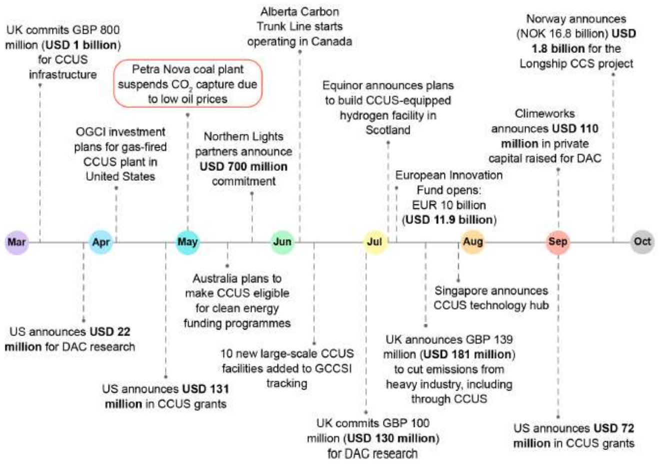
Notes: CCUS = carbon capture, utilisation and storage. See IEA (2020a) and the ETP model documentation for the definition of each abatement measure. Hydrogen includes low-carbon hydrogen and hydrogen-derived fuels such as ammonia.

The contribution of CCUS to the transition to net-zero emissions grows over time, accounting for nearly one-sixth of cumulative emissions reductions to 2070.

La contribución de las tecnologías CCUS es imprescindible para alcanzar los objetivos de descarbonización, incluso muy por encima de otras tecnologías

Actualidad y madurez tecnológica

Figure 1.6 Timeline of CCUS developments, March-September 2020



Fuente: IEA 2020

Figure 3.1 TRL of select technologies along the CCUS value chain

News Article | Site: www.modernpowersystems.com/ | Date: March 16, 2021
Three major firms commit to exploring carbon capture
Three major firms commit to exploring carbon capture 16 March 2021 16 March 2021 Ørsted, Aker Carbon Capture, and Microsoft have signed a memorandum of understanding to explore ways to support the development of carbon capture and storage at biomass...

News Article | Site: www.nytimes.com/pages/science/earth/index.html?partner=rss&emc=rss | Date: April 19, 2021
Exxon Mobil Proposes Carbon Capture Plan
HOUSTON — Under growing pressure from investors to address climate change, Exxon Mobil on Monday proposed a $100 billion project to capture the carbon emissions of big industrial plants in the Houston area and bury them deep beneath the Gulf of Mexic...

News Article | Site: www.cnn.com/app-tech-section/index.html | Date: April 26, 2021
Elon Musk props up carbon removal research with 100 million competition
Austin, Texas (CNN Business) Tesla and SpaceX CEO Elon Musk is putting up $100 million for a new XPrize competition aimed at spurring the creation of new carbon removal technologies and helping to ease the climate crisis. The prize will be the large...

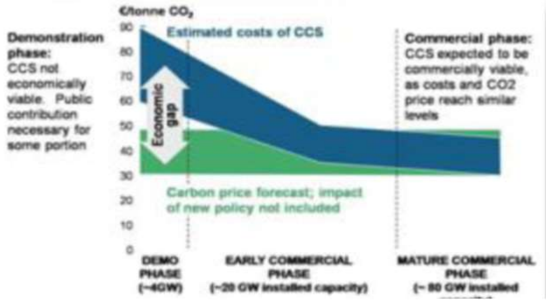
Costes del CCUS
Previsiones PTECO2

- Centrales térmicas:
    - Postcombustión: 63 USD/t carbón y 87 USD/t gas
    - Precombustión: 46 USD/t en (ind. química)
    - Oxicombustión: 81 USD/t
- Industria: 69- 96 USD/t
- Transporte y almacenamiento: + 5 a 10 USD/t

Leeds (UK). Captura de reformado de metano: 40 £/t

- Tecnologías de segunda generación en España. Previsión:
    - Calcinación-carbonatación (postcombustión): 20 USD/t
    - Chemical Looping (oxicombustión) : 6-27 USD/t

Fuente: Trinomics



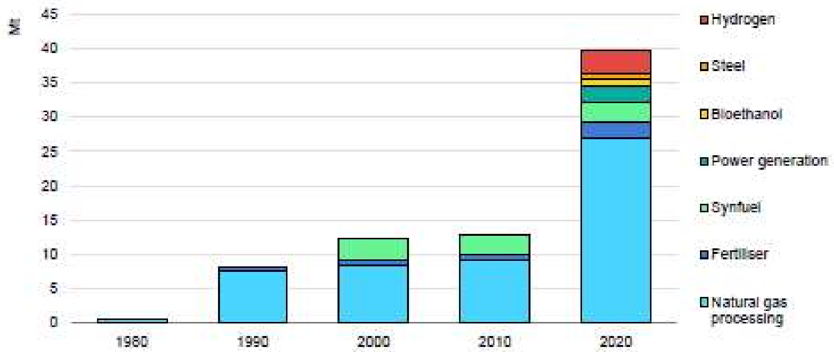
Fuente: PTECO2 presentado en ALINNE

> The IEA has highlighted that as much as 450 Mt of CO_2 could be captured, utilised and stored globally with a commercial incentive as low as US$40 per tonne of CO_2.

Fuente: CCS Status 2018

Dinámicas de mercado. Costes y previsiones IEA 2021

Figure 1.2 Global CO_2 capture capacity at large-scale facilities by source

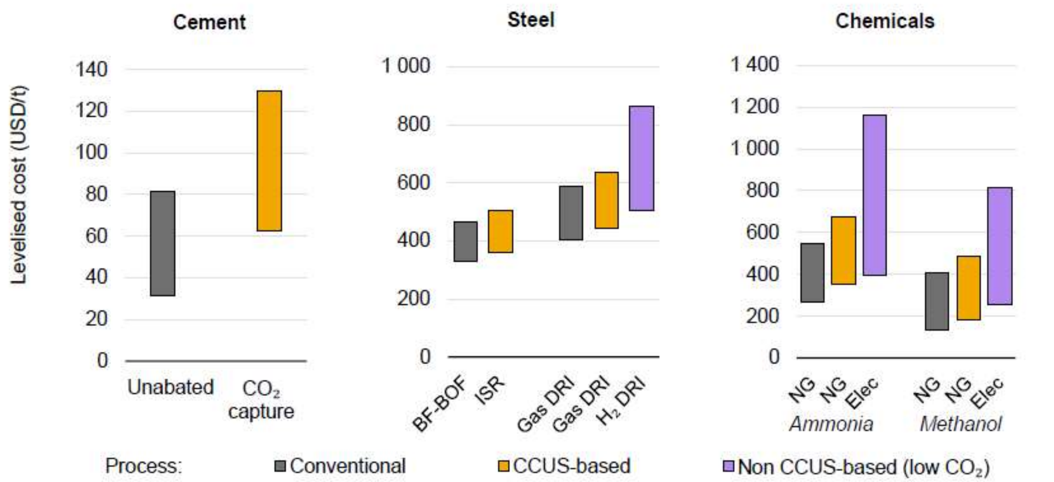


Source: IEA analysis based on GCCSI (2020), Facilities Database, https://co2re.co/FacilityData.

Carbon capture facilities have been operating since the 1970s, with the number and type of applications expanding in the last decade.

Fuente: IEA 2020

Figure 2.9 Simplified levelised cost of producing low-carbon cement, iron and steel, and chemicals for selected production routes



Notes: BF-BOF = blast furnace basic oxygen furnace; ISR = innovative smelting reduction; Gas DRI = natural gas-based direct reduced iron/electric arc furnace (EAF) route; H_2 DRI = 100% electrolytic hydrogen-based; NG = natural gas; Elec = electrolytic; Indicative cost ranges are based on the technical and economic methodology and data in Chapter 4 of IEA (2020a), which reflects varying energy prices and technological uncertainty. The ranges shown

Relación del CCUS, el Hidrógeno y el Gas Natural

HYDROGEN PRODUCTION WITH CCS

The three main technologies used to produce low-carbon hydrogen are:

- gas reforming (mostly from steam methane reforming) with CCS;
- coal gasification with CCS; and
- electrolysis powered by renewables.

Each technology offers its own benefits and will play a role in the global energy transition[97]. The advantages of low-carbon hydrogen production through gas reforming and coal gasification with CCS, centre around the maturity of the technologies, scale and commercial viability.

MATURITY

Low-carbon hydrogen has been produced through gas reforming and coal gasification with CCS, for almost two decades. For example, the Great Plains Synfuel Plant in North Dakota, US, commenced operation in 2000 and produces approximately 1,300 tonnes of hydrogen (in the form of hydrogen rich syngas) per day, from brown coal[98]. Hydrogen produced from coal or gas with CCS is the lowest cost clean hydrogen by a significant margin and requires less than one tenth of the electricity needed by electrolysis. Where renewable electricity is relatively scarce using renewable electricity to displace unabated fossil generation capacity in the grid may deliver more emissions reduction than using it to produce hydrogen in electrolysers.

There are five low-carbon hydrogen production facilities with CCS operating globally and three under construction, with a total production capacity of 1.5 million tonnes[99]. Another three are in advanced development (see Figur

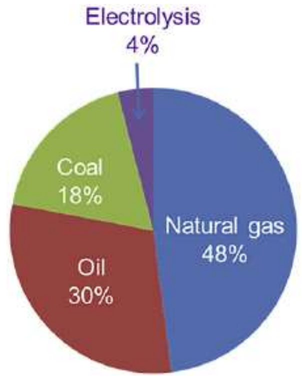
In contrast, production using electrolysis with renewables accounts for only 0.7 per cent[100] of the 70 Mtpa of dedicated hydrogen produced today[101]. If hydrogen demand reaches 530Mtpa by 2050, producing this via electrolysis would require about 25,000 terrawatt hours (TWh)[vii] of electricity from renewable or nuclear generation. This is approximately 2.8 times the total electricity generated from all renewable sources and nuclear combined in 2017[102, viii]. Creating enough renewable energy for both hydrogen production and low emissions electricity is extremely challenging.

COMMERCIAL VIABILITY

Price will be a key decider of whether hydrogen plays a significant role in emissions reduction. Low-carbon hydrogen produced using gas reforming and gasification technologies with CCS is proven, operating at commercial scale and available for deployment right now. Hydrogen produced using coal or methane with CCS costs USD1.70-2.40 per kilogram[103] compared to USD7.45 for hydrogen produced via electrolysis[ix]. CCS hydrogen costs two thirds less.

Action is required now to ensure hydrogen can play its role in the global energy transition, at the scale required to meet emissions reductions targets. Scaling up low-carbon hydrogen production with CCS will require capital grants or incentivising policies from governments[104, viii], a value on carbon and market mechanisms to create demand.

Fuente: The Global Status of CCS 2019

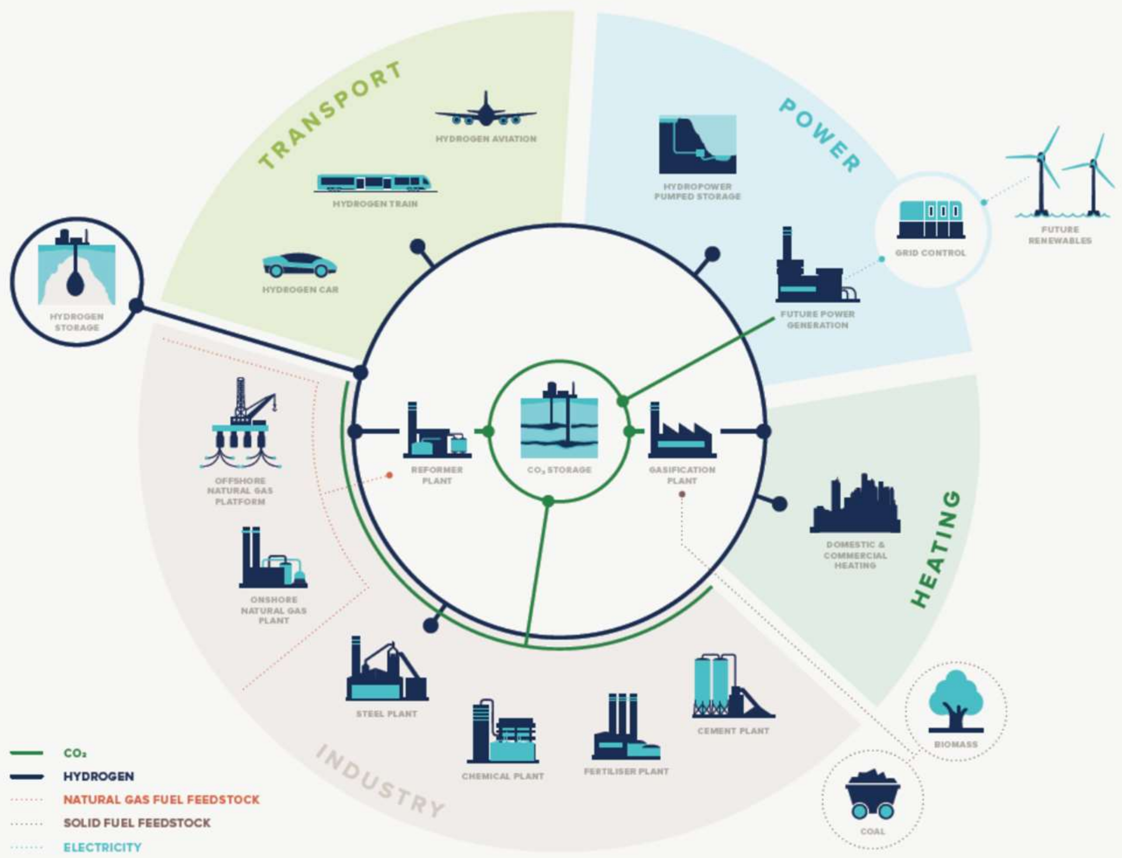


Producción actual de H2 según su origen

Las fuentes principales para producción de hidrógeno son gas natural y carbón (sin CCS) con emisiones de CO2 equivalentes a Indonesia y Reino Unido combinados.

Relación del CCUS, el Hidrógeno y el Gas Natural

Hydrogen with CCS leads the way



If there is one word that has permeated energy and climate change conversations in the past year, it is hydrogen. And right alongside it – CCS.

In 2018, six new large-scale CCS facilities have been added to the Global CCS Institute database. All are in Europe and related to CCS decarbonised hydrogen production:

The UK & Ireland

- H21 North of England
- HyNet North West
- Ervia Cork CCS
- Acorn Scalable CCS Development

The Netherlands

- Port of Rotterdam CCUS Backbone Initiative (porthos)
- Hydrogen 2 Magnum (H2M)

For these eye-catching emerging H_2+CCS developments, there is no barrier for their future deployments. Decarbonised H_2 production by steam methane reforming (SMR)/gasification coupling with CCS has been at scale in commercial practice for decades, with industrial applications in fertiliser production, oil refineries and iron and steel production.

Details of the above new large-scale facilities can be viewed in the Country Case Study section of this report.

Fuente: The Global Status of CCS 2018

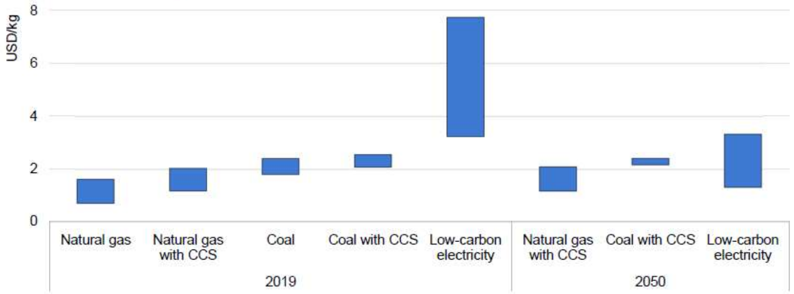
- **Captura de CO2 en reformado a H2.** **BLUE HYDROGEN**
- (h21Leeds y Hynet, Liverpool , UK). **Producción a gran escala de H2 provendrá de reformado de metano.**

- Producción de metano (syngas) en plantas de upgrading de biogás. Uso del CO2 separado.

- Producción de metano (syngas) con excedentes de H2 (Power to Gas). Uso futuro de CO2.

Relación del CCUS, el Hidrógeno y el Gas Natural

Figure 2.14 Global average levelised cost of hydrogen production by energy source and technology

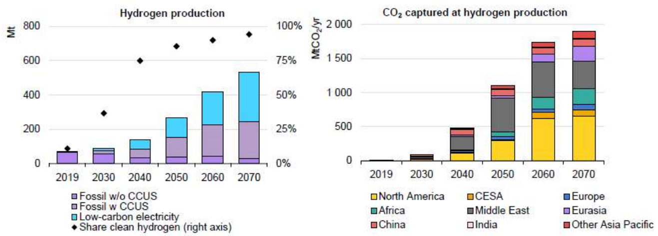


Notes: natural gas = steam methane reforming (SMR); coal = coal gasification. Coal and coal with CCS apply to China only. Electrolysis using low-carbon electricity assumes dedicated renewables-based generation.

Capital expenditure (CAPEX) assumptions: SMR without CCUS – USD 910/kW H_2 (2019 and 2050); SMR with CCS – USD 1 583/kW H_2 (2019) and 1 282/kW H_2 (2050); coal without CCUS – USD 2 672/k W H_2 (2019 and 2050); coal with CCS – USD 2 783/kW H_2 (2019 and 2050); electrolysis – USD 872/kW$_e$ (2019) and USD 269/kW$_e$ (2050).

Operating expenditure (OPEX) assumptions (as % of CAPEX): SMR without CCS – 4.7% (2019 and 2050), SMR with CCS – 3.0 % (2019 and 2050); coal with and without CCS – 5.0% (2019 and 2050); electrolysis – 2.2% (2019) and

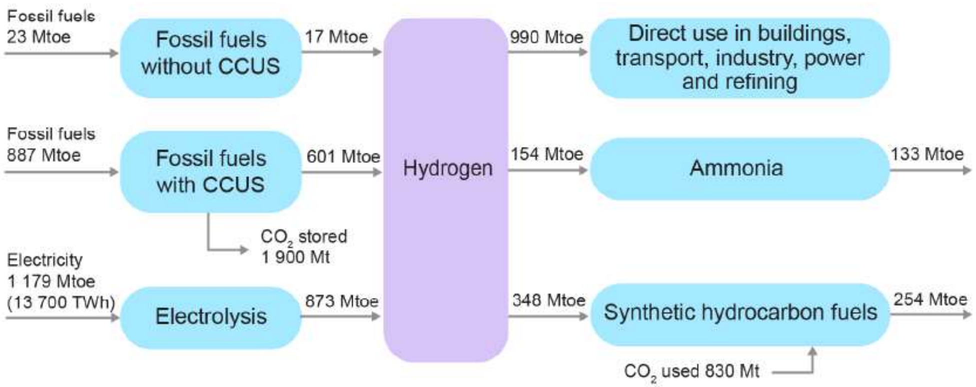
Figure 2.16 Hydrogen production (left) and CO_2 capture by region (right) in the Sustainable Development Scenario



Notes: CESA = Central & South America. Numbers show hydrogen produced in pure form coming from merchant hydrogen plants, industrial ammonia facilities and as a by-product of catalytic naphtha reforming in refineries. CCUS includes both geological storage and CO_2 use in urea production.

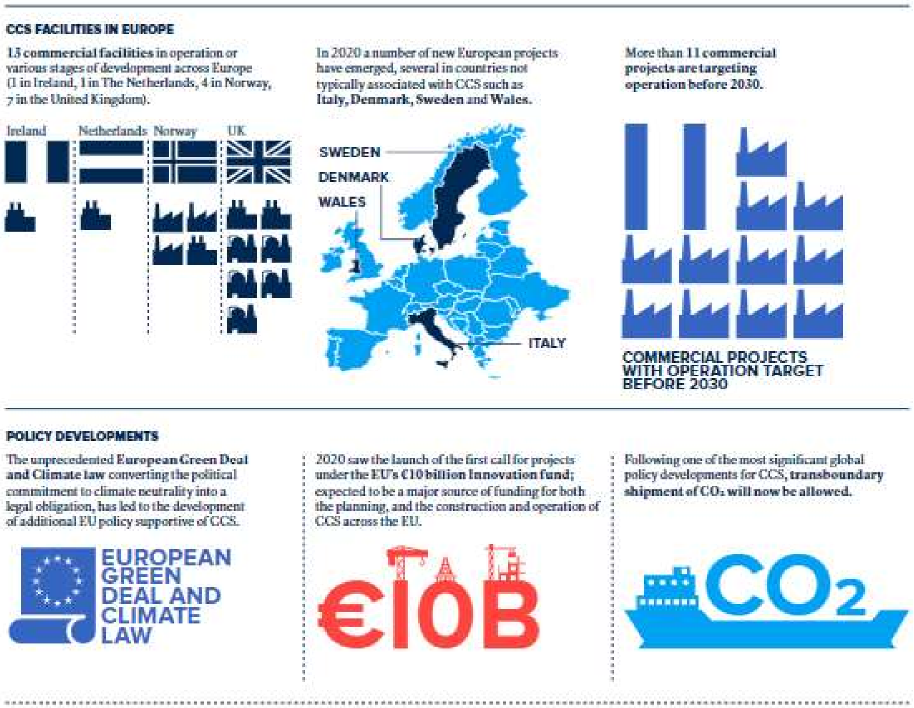
Fossil fuels with CCUS play a critical role in the production of low-carbon hydrogen in the Sustainable Development Scenario, in particular in North America, Asia and the Middle East.

Figure 2.15 CCUS in hydrogen and synthetic fuel production for energy purposes in the Sustainable Development Scenario, 2070



Around 40% of low-carbon hydrogen supply is linked to CCUS in 2070 in the Sustainable Development Scenario

CCUS en Europa



Fuente: The Global Status of CCS 2020

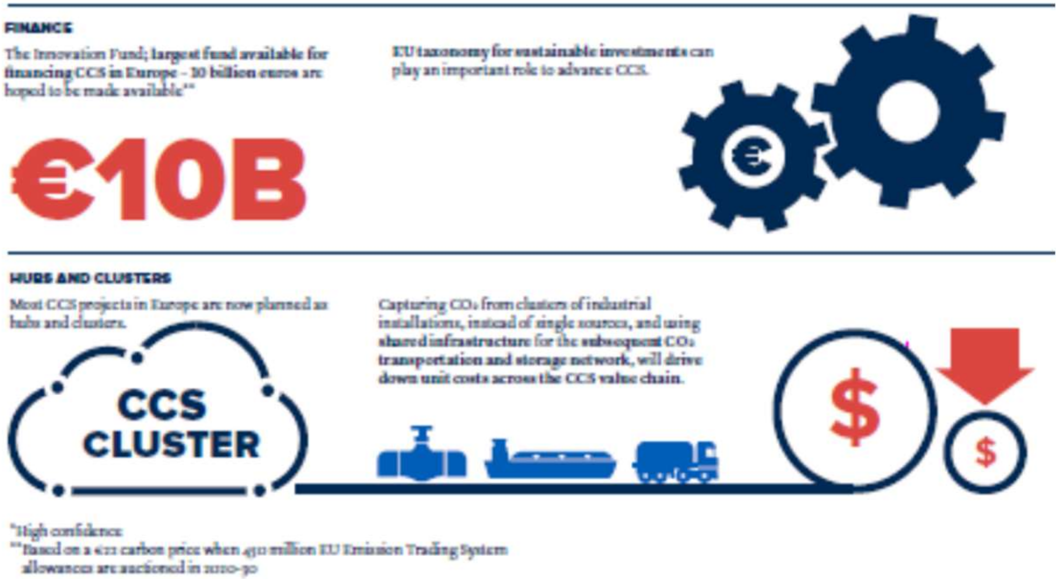
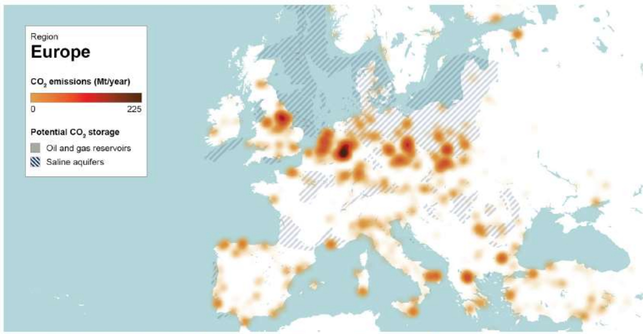


Figure 4.6 Map of CO_2 sources and potential geological storage in Europe



Source: CO_2 storage data based on CO2StoP (2020), European CO_2 storage database, CO_2 Storage Potential in Europe (CO2StoP).

In Europe, 50% of the CO_2 emissions from power and energy-intensive industries is within 50 km of potential CO_2 storage, and 68% of emissions within 100 km.

CCUS en Europa
Hubs y clusters. Noruega

- Holanda. Puerto de Rotterdam y de Amsterdam
- Bélgica. Puerto de Antwerp
- UK. Humber y Tessede
- Alemania. Rurh (futura conexión con Holanda).

- Proyecto Aling-CCUS para crear un desarrollo de cluster en Europa conectados para su almacenamiento en los pozos de Noruega en Mar del Norte.

NORWAY CONTINUES TO ADVANCE ITS EUROPEAN CCS AMBITION

A leading country in CCS development globally, Norway has geologically stored more than 20Mt of CO_2 in the past 20 years. The Sleipner and Snøhvit projects were the first in the world to store CO_2 offshore and are the only operational large scale CCS facilities in Europe.

A planned full scale CCS project will involve capturing CO_2 at multiple industrial facilities, then transporting it for storage. Operated by Equinor with partners Shell and Total, the facility will uniquely use ship-based transport, thus enabling the storage of CO_2 for major sources across North West Europe. The transport and storage element of the project – Northern Lights – will be open access infrastructure.

The initial Norwegian sources of CO_2 – Fortum's Oslo Varme waste-to-energy plant and Heidelberg Cement's Norcem cement plant in Brevik – have performed FEED studies and site testing. A drilling campaign will start soon to study the suitability and capacity of the Johansen formation in the Norwegian Continental Shelf for storing CO_2.

Based on its experience with CCS, the Norwegian Government hopes to use this project as the catalyst for wider deployment of CCS in Europe. The use of sea-based transport means industry across Western Europe can also store and transport their CO_2 through Northern Lights.

In September, the Norwegian Government hosted a high-level CCS conference in Oslo, together with the European Commission. During the event Equinor, on behalf of the Northern Lights partners, signed agreements to develop value chains in CCUS with:

- Air Liquide
- ArcelorMittal
- Ervia
- Fortum Oyj
- HeidelbergCement AG
- Preem
- Stockholm Exergi

The parties will cooperate on CO_2 handling and transport to Northern Lights.

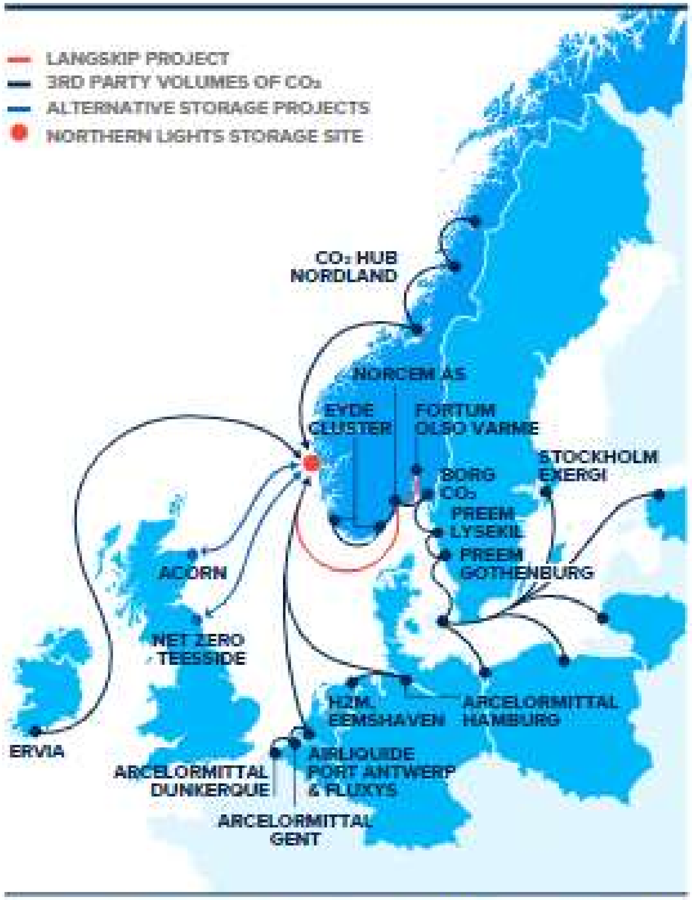


FIGURE 8 NORTHERN LIGHTS PROJECT – POTENTIAL SOURCES OF CO_2[9]

Fuente: The Global Status of CCS 2020

CCUS en Europa

Lobby de los países y compañías de centro-norte Europa

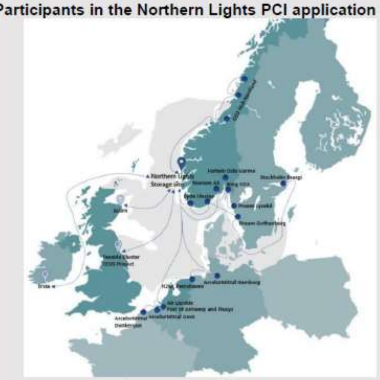
CASE STUDY 10: Northern Lights and The Norwegian full-scale CCS project

The Northern Lights project aims to deliver a ship-based European CO_2 transport and storage network. By importing CO_2 emissions from European industries, the project is looking to achieve economies of scale and lower costs, while also making a larger-scale contribution reducing EU CO_2 emissions. Due to its pan-European approach, standards to promote the interoperability of the CO_2 ships and storage sites with EU Member States will be important.

The CO_2 shipping component of this project received PCI status in 2017. In 2019, the project submitted a request to update the PCI application, which would expand its geographical scope to capture sites located in Belgium, France, Germany, Ireland, the Netherlands, Sweden and the UK.

Equinor, Total and Shell are responsible for the transport and storage parts of the project. The partners are currently conducting FEED studies and aim at final investment decisions in 2020.[90] The Northern Lights CO_2 transport and storage project is then planned to start operating in 2023, and the project's extension to cross-border shipping of CO_2 is expected to take place from 2024-25.

Figure 14: Participants in the Northern Lights PCI application of March 2019



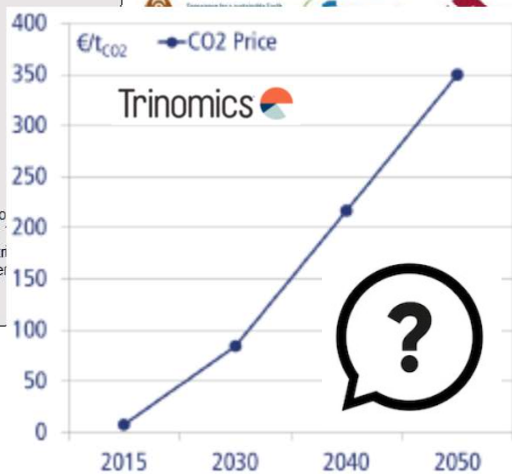
Information provided by Equinor (2019)

The Norwegian full-scale CCS project,[91] of which Northern Lights is the transport and sto
to become the world´s first CCS project receiving CO_2 from several industrial sources.
the Norwegian full-scale CCS project foresees CO_2 capture in two onshore industri
transport by ship to a receiving point in Naturgassparken in Øygarden municipality, wher
through pipelines to injection wells on the Norwegian Continental Shelf.

The potential for CCS and CCU in Europe

REPORT TO THE THIRTY SECOND MEETING OF THE EUROPEAN GAS REGULATORY FORUM 5-6 JUNE 2019

COORDINATED BY IOGP



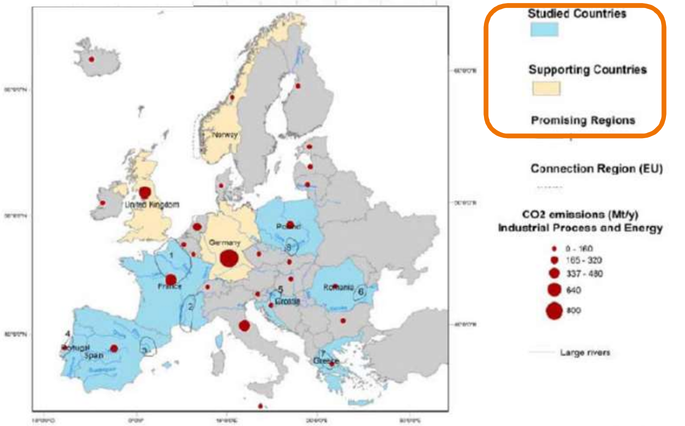
STRATEGY CCUS
A viable solution for a sustainable future

- ✓ Proyecto europeo financiado con 3 millones de euros dentro del H2020
- ✓ 1 mayo 2019- 31 abril 2022
- ✓ 17 participantes de 10 países (7 áreas de interés y 3 supporting countries)

OBJETIVO:

Elaborar planes estratégicos para el desarrollo de CCUS a corto (<3 años), medio (de 3 a 10 años) y largo plazo (>10 años) en el **sur y este de Europa**:

- ❖ A nivel regional en las áreas propuestas (promising star-up regions)
- ❖ A nivel europeo mediante definición de corredores de transporte entre las áreas propuestas y la infraestructura disponible del **Mar del Norte**.



- **Fondo de Innovación Europeo.** Una gran fuente de financiación que puede preparar una transición y sentar las bases de un nuevo sistema energético.

- **¿Producción de H2 por electrólisis o a partir de Gas Natural? El Hidrógeno va a ser clave a partir de 2030 y en 2050.**

Soluciones Naturgy para reducir la huella de nuestros clientes
Decarbo

- Identificación de la hoja de ruta y diferentes acciones para lograr reducir/eliminar la huella de carbono.
- **Necesidad de un mix tecnológico para obtener estos objetivos en el que tendrá que participar la captura de CO2.**
- Incorporación de las tecnologías de captura dentro del portfolio de soluciones de descarbonización para nuestros clientes industriales.

1

Medición Huella Carbono y eficiencia de los procesos.

2

Hoja de Ruta con objetivos técnico-económicos de reducción de emisiones

3

Compensación de las emisiones no evitadas en el proceso.

Eficiencia energética

- Optimizar costes energéticos.
- Obtención de certificados blancos.
- Gestionabilidad Industria 4.0.

Mercados y Trading

- Mercado ETS.
- Mercados Voluntarios (Offsetting)
- GDOs.

Update Tecnológico

- Marco regulatorio.
- Technological Readiness Levels.
- Programs & Grants.

Nuevas inversiones

- Fondos propios.
- Escaladilidad hoja de ruta.
- Update s/marco regulatorio.

Muchas gracias