ZEP CCS/CCU Facts & Information Toolkit

There is positive momentum around CCS and CCU in Europe: from new projects and developments, to increased focus from policymakers in the European Commission and Parliament, as well as in EU Member States, with great interest in ZEP's Government Group. Following the successful developments and multitude of projects, media coverage of CCS and CCU technologies is increasing. This will probably continue to increase as the CCUS community sees further developments in projects and possible successes. In order to effectively manage both positive and negative information in the media as well as any inaccuracies around CCS/CCU, there is a need for a coordinated approach and a toolkit with questions and answers and further material.

The CCS/CCU Facts & Information Toolkit aims to take a positive approach and to be proactive, by informing about CCS/CCU technologies and explaining the complementary role of CCS in combatting climate change. The Toolkit will also serve as a point of reference to determine how to react when CCS/CCU is not being accurately presented in the media. Furthermore, the Toolkit provides a basis for unprompted proactive and positive communications around CCS/CCU to a wide audience, with the aim to communicate:

- The role of CCS in the energy transition and industrial transition.
- The role that CCS has to play as a transitional technology and the share of its role.
- To provide balanced points of view.

The CCS/CCU Facts & Information Toolkit is a living document, updated on an ongoing basis.

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Q&As – Questions based on common criticisms and misunderstandings and the answers to provide clarity

Questions	Answers
Technology – What is CCUS? • What is CCUS? • What are CCS technologies? • What is CCU? • How successful/effective are capture rates? • Do we need CCS? • How much CCS is needed? • What is Bioenergy with CCS (BECCS)? • What is Waste-to-Energy with CCS? • What is Carbon Dioxide Removal and how does it relate to CCS?	• ***What is CCUS?*** *CCUS is an abbreviation for Carbon Capture, Utilisation and Storage.* • ***What are CCS technologies?*** *Carbon Capture and Storage (CCS) is a three-part chain. Carbon Capture technologies can be applied to a variety of carbon dioxide (CO_2) emitting processes, where the CO_2 is separated from process emissions by physical and chemical processes. The CO_2 is transported for permanent storage. Storing CO_2 underground uses a natural process that has trapped CO_2, oil and gas for millions of years. (Source: Zero Emissions Platform)* • ***What is CCU?*** *Carbon capture and Utilisation (CCU) applies to a wide range of applications that either use carbon dioxide (CO_2) as part of a conversion process, for the fabrication or synthesis of new products (e.g. methanol, urea, polymers, building materials), or in non-conversion processes, where CO_2 is used (e.g. as a solvent, for food & beverages or in greenhouses). (Source: What is CCU – Zero Emissions Platform)* • ***How successful/effective are capture rates?*** *It is technically feasible to achieve very high capture rates (>95%) with only minor (<3%) efficiency and financial penalties compared to a capture facility capturing at 90%. Capture rates above 99% are possible, and as technologies develop through deployment, capture technology efficiencies are expected to improve. (Source: CO_2 capture – Zero Emissions Platform)* • ***Do we need CCS?*** *To reach net-zero greenhouse gas (GHG) emissions by 2050, Carbon Capture and Storage (CCS) technologies will be an important tool to both deliver needed climate change mitigation and safeguard European industrial competitiveness. CCS will be key in the industrial transition towards net-zero GHG emissions – safeguarding jobs, industrial activity and economic growth. The pathway towards climate neutrality will bring about a major transformation of energy-intensive industries, such as cement, lime, steel and chemicals, that are at the core of the European economy. For these sectors, pathways including CCS represents the lowest-cost route to decarbonisation whilst maintaining industrial activity and preserving jobs. (Source: A CCS industry to support a low-carbon European economic recovery and deliver sustainable growth – Zero Emissions Platform)* • ***How much CCS is needed?*** *Reaching climate neutrality in Europe by 2050 and the increased EU ambition for 55% greenhouse gas (GHG) emissions reduction by 2030 make the role of CCS even more critical. To reach these climate targets in a cost-efficient way, there is a need to support early deployment and establish the foundation for CCS and CCU to become investible technologies during this decade (2020s). 50 $MtCO_2$/yr abated by CCS in 2030 is a preliminary yet well-founded indication based on companies' current plans. Today, this could be seen as an ambitious volume from every point of view, but, given the strongly increased ambitions (and the global development we can now see), this will most certainly be an underestimation of what will really be needed from CCS. (Source: How much CCS and CCU will be needed in 2030? – Zero Emissions Platform)*

	• ***What is Bioenergy with CCS (BECCS)?*** *With bio-CCS, CO_2 is removed from the atmosphere by photosynthesis and bound as carbon in biomass. The biomass is combusted for energy or converted to a product or a gas with the carbon extracted. This carbon as CO_2 is captured and geologically stored. (Source: Europe needs a definition of Carbon Dioxide Removal – Zero Emissions Platform)* • ***What is Waste-to-Energy with CCS?*** *Waste-to-Energy (WtE) plants burn waste of mixed biogenic and fossil origin generated by human activities to produce heat and/or power. This waste should consist of residual, non-recyclable waste fractions that would otherwise go to landfill. Applying CCS to a Waste-to-Energy plant means that CO_2 will be captured from a flue gas that contains a mixture of fossil and biogenic CO_2, for subsequent geological storage. (Source: Europe needs robust accounting for Carbon Dioxide Removal – Zero Emissions Platform)* • ***What is Carbon Dioxide Removal and how does it relate to CCS?*** *Carbon Dioxide Removal involves taking CO_2 out of the atmosphere, where it contributes to climate change, and putting it in a location where it will not affect the climate for an extended period of time. The aim is to reduce the concentration of CO_2 in the atmosphere. This can be achieved through natural and technological means. (Source: Europe needs a definition of Carbon Dioxide Removal – Zero Emissions Platform) CCS is a safe, scientifically proven, cost-efficient technology which can enable CDR through capture and geological storage of CO_2 from biogenic sources and direct air capture and storage. (Source: Europe needs robust accounting for Carbon Dioxide Removal – Zero Emissions Platform)*
Status and development • How long have CCS technologies been in operation? • Where is CCS operational?	• ***How long have CCS technologies been in operation?*** *Commercial, full-chain CCS projects have been operational since the 1980s, with more than 260 million tonnes of CO_2 emissions from human activity captured and stored over 40 years and an overall estimation of around 40 million tonnes of captured and stored CO_2 per year at present. (Source: 2019 Global Status of CCS Report – Global CCS Institute)* • ***Where is CCS operational?*** *Commercial, full-chain CCS projects have been operational since the 1980s, with more than 260 million tonnes of CO_2 emissions from human activity captured and stored over 40 years and an overall estimation of around 40 million tonnes of captured and stored CO_2 per year at present. (Source: 2019 Global Status of CCS Report – Global CCS Institute) There are a number of European market-ready projects. (Source: ZEP CCS/CCU projects map – Zero Emissions Platform)*
How can CCS contribute to mitigating climate change? • Why invest in CCS instead of renewable energy/greener alternatives? • What are the benefits of CCS for the climate? • How can CCS contribute to mitigating climate change?	• ***Why invest in CCS instead of renewable energy/greener alternatives?*** *The pathway towards climate neutrality will bring about a major transformation of energy-intensive industries, such as cement, lime, steel and chemicals, that are at the core of the European economy. For these sectors, pathways including CCS represents the lowest-cost route to decarbonisation whilst maintaining industrial activity (Source: Climate solutions for EU industry – Zero Emissions Platform) and preserving existing jobs. It can capture and store emissions produced during industrial processes, and it also plays an important role in the manufacturing of clean hydrogen which can be used to fuel energy-intensive industries and households. When applied to industrial processes and power plants, CCS can secure jobs and incomes and ensure European industrial competitiveness in international markets while delivering sustainable growth. (Source: A CCS industry to support a low-carbon European economic recovery and deliver sustainable growth – Zero Emissions Platform.)*

• Developing CCS infrastructure takes time – how is CCS contributing to mitigating climate change now?	• ***What are the benefits of CCS for the climate?*** *CCS are proven and cost-efficient technologies, available now and necessary for Europe to reach its target of net-zero emissions by 2050. CCS technologies can make a significant contribution to climate change mitigation. Their potential for carbon emissions abatement and removal is scientifically proven and acknowledged by the European Taxonomy for Sustainable Finance and the 'Clean Planet for All' scenario. (Source: A CCS industry to support a low-carbon European economic recovery and deliver sustainable growth – Zero Emissions Platform.) Commercial, full-chain CCS projects have been operational since the 1980s, with more than 260 million tonnes of CO_2 emissions from human activity captured and stored over 40 years and an overall estimation of around 40 million tonnes of captured and stored CO_2 per year at present. (2019 Global Status of CCS Report – Global CCS Institute)* • ***How can CCS contribute to mitigating climate change?*** *Reaching climate neutrality by 2050 will only be possible if mitigation efforts are supplemented with active removal of CO_2 from the atmosphere. CCS is a safe, scientifically proven, cost-efficient technology which can enable Carbon Dioxide Removal through capture and geological storage of CO_2 from biogenic sources and direct air capture and storage. (Source: Europe needs robust accounting for Carbon Dioxide Removal – Zero Emissions Platform, 2021)*
Cost • What is the cost of developing CO_2 transport and storage infrastructure?	• ***What is the cost of developing CO_2 transport and storage infrastructure?*** *For the European Union, CO_2 infrastructure is a no-regret investment opportunity that would support the production of early, large volumes of low-carbon hydrogen and deliver CO_2 removal, allowing the EU to become a global leader in low-carbon economic growth and paving the way for a clean hydrogen economy. (Source: A Trans-European CO_2 Transportation Infrastructure for CCUS: Opportunities & Challenges – Zero Emissions Platform, 2020)*
Safety and risks: Observations and best practice • How effective is CCS? – From capture rates to a climate change perspective. • How safe is CO_2 storage? • How do we ensure that captured CO_2 is safely and permanently stored?	• ***How effective is CCS? – From capture rates to a climate change perspective.*** *It is technically feasible to achieve very high capture rates (>95%) with only minor (<3%) efficiency and financial penalties compared to a capture facility capturing at 90%. Capture rates above 99% are possible, and as technologies develop through deployment, capture technology efficiencies are expected to improve. (Source: CO_2 capture – Zero Emissions Platform)* • ***How safe is CO_2 storage?*** *Storing CO_2 underground uses a natural process that has trapped CO_2, oil and gas for millions of years. Both oil and gas fields and deep saline aquifers have the same key geological features required for CO_2 storage: a layer of porous rock to absorb the liquid CO_2 and an impermeable layer of cap rock which seals the porous layer underneath, trapping the CO_2. Inside the layer of porous rock, there are three natural trapping methods which make the safety of CO_2 storage generally increase over time: (1) With residual trapping, some of the injected CO_2 is trapped in the tiny pores of the rocks and cannot move even under pressure. (2) Dissolution trapping is a process where a portion of the CO_2 dissolves into the surrounding water. (3) Mineral trapping: Over time, some of the heavy CO_2-rich water sinks to the bottom of the reservoir where it may react to form minerals such as those found in limestone or sandstone. (Source: Storage – Zero Emissions Platform)* • ***How do we ensure that captured CO_2 is safely and permanently stored?*** *(1) Continuous monitoring: All areas of the CO_2 reservoir are kept under close survey at all times: the well, cap rock and adjacent rock formations are monitored for changes in pressure and CO_2 concentration levels. This monitoring takes place during all phases of a CO_2 reservoir's life: at the identification stage and the injection stage up to and after closure. (2) Predicting CO_2 movement: Scientists follow the movement of CO_2 in the reservoir by comparing the monitoring data they receive*

	from simulated predictions which show them how they can expect the CO_2 to move in the reservoir. (3) <u>Monitoring methods</u>: Many of the companies involved in CCS monitoring use systems that have been developed and perfected over decades – principally for the oil and gas industries. (4) <u>EU law requires close and effective monitoring</u>: EU law demands that CO_2 storage is closely monitored and the CCS Directive stipulates that CO_2 storage schemes can only be admitted to the EU's Emissions Trading Scheme if the monitoring and verification of CO_2 storage is carried out with complete satisfaction. (Source: Storage – Zero Emissions Platform)

***Guide** – What to consider when criticism and/or misinformation around CCS/CCU arises and deciding how to respond*

a. *To categorise the source of criticism/misinformation*

b. *To define the severity of the criticism/misinformation*

c. *When and how to respond to criticism/misinformation – Reactive versus proactive communications*

To categorise the source of criticism/misinformation:	**To define the severity of the criticism/misinformation**, depending on:
• First, evaluate if it is criticism. (The best promotion for CCS and CCU technologies will include both positives and negatives.) • What is the source? ○ Direct academic sources (Report, study, research paper, etc.) ○ Media sources (Article, op-ed, interview, etc.) – Does it refer to an academic source? Is it the academic source or the article that is critical? ○ Criticism for political reason ○ Remarks that gain traction (possibly on social media) from general public, policymakers, an influential voice in the energy and climate community, etc. ***Examples of recent articles/reports with CCS criticism:*** • *Report commissioned by Global Witness and Friends of the Earth Scotland* • *Briefing by Greenpeace 'Assessing the role of carbon dioxide removal in companies' climate plans'* • *CAN position on CCUS* • *Article: 'The Gassing Of Satartia' (Huffpost)* • *Article: 'Why carbon capture on waste-to-energy facilities undermines climate action' (EURACTIV)*	• The remarks made – Is there sufficient and correct evidence to support the remarks? • The source of criticism – Is it a reputable source? • The reach of the source – Is there a sizeable audience? • Traction – Is the criticism being shared, spreading on social media, being picked up in other news outlets, etc.? **Defining severity of criticism – what are the trademarks of the criticism?** Neutral/slightly critical: • A balanced argument is presented with both positive and negative remarks. • The statements are presented in a neutral manner, are correctly referenced and from reputable sources. • Balanced and well-supported arguments could be considered neutral/slightly critical regardless of the source and reach. Highly critical: • Highly critical or incorrect remarks made without clear references or sources to support. • Biased, one-sided, or false remarks.

• *[Article](): 'Liebreich: Capturing only 90% of CO_2 emissions in blue hydrogen production 'ain't good enough' (Recharge)* • *[Article](): 'Green groups dispute power station claim that biomass is carbon-neutral' (The Guardian)* • *[Article](): 'Les fausses promesses des technologies de captage du carbone pour réduire les émissions de CO_2' [The false promises of carbon capture technologies to reduce CO_2 emissions] (Le Monde)*	
When to respond? • Immediate follow-up – What would require an immediate reaction? • Delayed response, taking time to prepare – What would require a coordinated, well-prepared response? • Coordinated, joint response – Would a joint response from several stakeholders be suitable and/or have a greater impact? • No response? • First consider: How will a response affect the situation? • Will a response improve the situation? • Would proactive communications be an alternative option?	**How to respond?** If highly critical: • Possibility for both proactive and reactive communications. • An immediate follow-up: Contact the journalist/author/policymaker etc. to discuss concern around the critical remarks. Offer to arrange a meeting to exchange views. • A delayed response, taking time to prepare, can help to ensure the message is communicated clearly. (A joint response from several stakeholders can have a greater impact – consider the time needed to coordinate). • Press quote/press release communicating a positive message and providing clarity on the criticism. If critical: • Opportunity for proactive communications. Reactive communications is optional. • Possibility for a press quote/press release to provide clarity on the criticism. • Communicate prepared messages on CCS through channels. If neutral or slightly critical: • Reaction is optional. Opportunity for proactive communications.

***Communications material** – Short, positive messages communicating the value of CCS/CCU and addressing common critical remarks*

Topics	Messages to communicate
Carbon Capture and Storage (CCS) • *Industrial decarbonisation* • *Jobs*	• ***Industrial decarbonisation:*** *CCS will be key in the industrial transition towards net-zero GHG emissions – safeguarding jobs, industrial activity and economic growth. The pathway towards climate neutrality will bring about a major transformation of energy-intensive industries, such as cement, lime, steel and chemicals, that are at the core of the European economy. For these sectors, pathways including CCS represents the lowest-cost route to decarbonisation whilst maintaining industrial activity and preserving jobs. (Source: A CCS industry to support a low-carbon European economic recovery and deliver sustainable growth – Zero Emissions Platform)* • ***Jobs:*** *CCS can help to both safeguard existing jobs and create new jobs by supporting the decarbonisation of European energy-intensive industries. By providing a low-carbon alternative, existing jobs in industries – such as cement, steel, lime, chemicals – will be preserved. (Source: A CCS industry to support a low-carbon European economic recovery and deliver sustainable growth – Zero Emissions Platform, 2020)*
Carbon Capture and Utilisation (CCU) • *CCU applications*	• ***CCU applications:*** *Carbon capture and Utilisation (CCU) applies to a wide range of applications that either use carbon dioxide (CO_2) as part of a conversion process, for the fabrication or synthesis of new products (e.g. methanol, urea, polymers, building materials), or in non-conversion processes, where CO_2 is used (e.g. as a solvent, for food & beverages or in greenhouses). (Source: What is CCU – Zero Emissions Platform)*
Carbon footprint – How can CCS contribute to mitigating climate change? • *Abatement potential*	• ***Abatement potential:*** *Commercial, full-chain CCS projects have been operational since the 1980s, with more than 260 million tonnes of CO_2 emissions from human activity captured and stored over 40 years and an overall estimation of around 40 million tonnes of captured and stored CO_2 per year at present. (Source: 2019 Global Status of CCS Report – Global CCS Institute)*
Different technologies • *Low-carbon hydrogen with CCS* • *Carbon Dioxide Removal (CDR)* • *Bioenergy with CCS (BECCS)* • *Direct air capture with CCS (DACCS)* • *Waste-to-Energy with CCS*	• ***Low-carbon hydrogen with CCS:*** *Both renewable hydrogen and low-carbon hydrogen from reformation of methane with CCS have important roles to play in an EU hydrogen economy. By fulfilling early hydrogen demand, low-carbon hydrogen will give more time to plan and build the infrastructure required to scale up renewable hydrogen. Without low-carbon hydrogen, 2030 hydrogen ambitions will not be met. (Source: The crucial role of low-carbon hydrogen production to achieve Europe's climate ambition: A technical assessment – Zero Emissions Platform, 2021)* • ***Carbon Dioxide Removal (CDR):*** *Carbon Dioxide Removal involves taking CO_2 out of the atmosphere, where it contributes to climate change, and putting it in a location where it will not affect the climate for an extended period of time. The aim is to reduce the concentration of CO_2 in the atmosphere. This can be achieved through natural and technological means. (Source: Europe needs a definition of Carbon Dioxide Removal – Zero Emissions Platform) CCS is a safe, scientifically proven, cost-efficient technology which can enable CDR through capture and geological*

	storage of CO_2 from biogenic sources and direct air capture and storage. (Source: Europe needs robust accounting for Carbon Dioxide Removal – Zero Emissions Platform) • ***Bioenergy with CCS (BECCS):** With bio-CCS, CO_2 is removed from the atmosphere by photosynthesis and bound as carbon in biomass. The biomass is combusted for energy or converted to a product or a gas with the carbon extracted. This carbon as CO_2 is captured and geologically stored. (Source: Europe needs a definition of Carbon Dioxide Removal – Zero Emissions Platform)* • ***Direct air capture with CCS (DACCS):** Direct Air Capture units remove CO_2 from ambient air, removing it from the atmosphere. The CO_2 is then geologically stored. (Source: Europe needs robust accounting for Carbon Dioxide Removal – Zero Emissions Platform)* • ***Waste-to-Energy with CCS:** Waste-to-Energy (WtE) plants burn waste of mixed biogenic and fossil origin generated by human activities to produce heat and/or power. This waste should consist of residual, non-recyclable waste fractions that would otherwise go to landfill. Applying CCS to a Waste-to-Energy plant means that CO_2 will be captured from a flue gas that contains a mixture of fossil and biogenic CO_2, for subsequent geological storage. (Source: Europe needs robust accounting for Carbon Dioxide Removal – Zero Emissions Platform)*
Public acceptance • *Safety of CO_2 transport* • *Safety of CO_2 storage* • *Where is CO_2 stored?*	• ***How is CO_2 transported?** CO_2 is preferably transported by pipeline, with ships being used when a source of CO_2 is too far from a suitable storage site or greater flexibility is required. (Source: Transport – Zero Emissions Platform) Transportation of CO_2 is technically feasible by pipeline and ship, as demonstrated through operating and upcoming CCS projects. Cross-border CO_2 transportation infrastructure has a major role to play in delivering a cost-efficient transition to a low-carbon economy. Developing shared, cross-border CO_2 transportation infrastructure is essential to enable the decarbonisation of core sectors of the European economy, industry, and power generation to preserve production, safeguard jobs, and create sustainable economic growth. (Source: A trans-European CO2 transportation infrastructure for CCUS – Zero Emissions Platform)* • ***Where is CO_2 stored?** CO_2 is stored underground using a natural process that has trapped CO_2, oil, and gas for millions of years. Both oil and gas fields and deep saline aquifers have the same key geological features required for CO_2 storage: a layer of porous rock to absorb the liquid CO_2 and an impermeable layer of cap rock which seals the porous layer underneath, trapping the CO_2. (Source: Storage – Zero Emissions Platform)* • ***Safety of CO_2 storage:** Storing CO_2 underground uses a natural process that has trapped CO_2, oil and gas for millions of years. Inside the layer of porous rock, there are three natural trapping methods which make the safety of CO_2 storage generally increase over time. These are residual, dissolution and mineral trapping. (1) With residual trapping some of the injected CO_2 is trapped in the tiny pores of the rocks and cannot move even under pressure. (2) Dissolution trapping is a process where a portion of the CO_2 dissolves into the surrounding water. (3) Mineral trapping is when over time, some of the heavy CO_2-rich water sinks to the bottom of the reservoir where it may react to form minerals such as those found in limestone or sandstone. (Source: Storage – Zero Emissions Platform)*