

SET Plan Issues paper No 9 on CCUS

First draft comments from EERA JP CCS per 2016-04-19

General comments

1. What is critical now is concrete policy, financial and strategic planning actions to enable infrastructure and development of clusters.
 - a. Infrastructure must be enabled by 2025 or 2030, between some countries.
 - b. Capture may/should be a national issue.
2. Do not like too many numbers, should be more descriptive targets.
3. Regulation and or policy measures to enforce the implementation of CCS is fundamental. A business case alone is not sufficient.
4. Introduction of CCS starts really late according to this document. E.g. Page 2: CCS will need to be deployed from around 2030... What document is the rather late date based upon. Deployment should be earlier than 2030...
We accept that large-scale deployment will be needed by 2030 but also strongly recommend that more thought is given to how this will be achieved between 2016 and then. There must be targets between now and 2030 to enable CCS to progress.
5. There is not enough progress described for storage. See a.o. Proposed key objectives and targets in CCS and CCU (table on page 5);
 - a. Objectives are missing to create bankable storage capacity and the Issues Paper does not recognize the work being done in a number of countries (especially Norway, Netherlands and UK) on detailed site appraisals for storage. A storage atlas is not enough for building confidence in available storage space. It does not tell you where the pipeline should go nor does it fully leverage the progress already made at a number of strategic future stores (e.g. 'Endurance' in the UK SNS or P18 in Dutch SNS). There should be an additional bullet, for 'a portfolio of storage sites (2-5 sites with potential for cluster development as CO₂ capture increases) close to permitting for storage ('bankable storage'), with a combined storage capacity that is sufficient for the first two decades of storage'.
 - b. Same table, second section, 'On the road to 2030': add
 - i. 'Market maker(s) or policy measures for transport and storage identified in MS'
 - ii. MS preparing further bankable storage capacity, to provide storage space for the next wave of capture projects'
6. Legal constraints are important.
7. ETS will not deliver CCUS. Market pricing will not deliver CCUS. Have to make it mandatory – amendments to laws.

Comment [A1]: I think having specific achievable targets is OK. But I have a problem with the KPIs – see later.

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1 Heading (p.1)



EUROPEAN COMMISSION
 RTD - Energy
 ENER - Renewables, R&I, Energy Efficiency
 JRC - Institute for Energy and Transport
 SET Plan Secretariat



[ISSUES PAPER No.9](#)
[Renewing efforts to demonstrate carbon capture and storage \(CCS\) in the EU and developing sustainable solutions for carbon capture and use \(CCU\)](#)

Comments:

1. We should move away from implying we need to demonstrate CCS now and emphasise the need to initiate CCS deployment.
2. CCU may be important to developing supply chains and catalysing some CCS projects by providing some financial incentives. However, it is considered unlikely to result in significant emissions reductions by itself and therefore should not be emphasised in the Title.
3. Title could therefore read:
 Renewing efforts to deploy carbon capture and storage (CCS) in the EU

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2 Purpose of this document (p.1)

Purpose of this document

This document³ is intended to inform the discussions between the Commission, the Member States and stakeholders regarding the implementation of the actions contained in the SET-Plan Communication ("Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation" (C(2015)6317)), and specifically the actions concerned with the priority number 9 on CCS. It is part of a series of Issues Papers jointly prepared by the EC services. These documents will serve as a starting point for discussions with Member States and stakeholders in the development of new research and innovation cooperation at European and national level, especially as regards activities going beyond the Horizon 2020 programme. Each Issues Paper aims to define (a) the level of ambition (in terms of priorities and targets), (b) the modalities for the implementation and (c) the timing for achieving results and adopting expected deliverables.

Stakeholders are invited to take position on the proposed targets in accordance with the guidelines set out in the paper *The SET Plan actions: implementation process and expected outcomes* and submit their positions to SET-PLAN-SECRETARIAT@ec.europa.eu by 25 April 2016 at the latest. All relevant documents and material are available on the SETIS website <https://setis.ec.europa.eu/>.

Comments:

1. We note that this paper is the starting point for discussions with MS and stakeholders. However, a statement as to the ultimate objective of the whole process should be made here. We propose that this overall objective is:
2. To enable the SET Plan Steering Group to agree on priority actions towards deploying CCS by 2030, in accordance with the Set Plan.

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3 Introduction – CCS (p.1&2)

Introduction – CCS

When assessing how to meet long term decarbonisation objectives, the Energy Roadmap 2050 as well as other reports have shown that fossil fuels might remain part of the global as well as of the European energy mix, not least because they will continue to be used in many industrial processes. CCS is at present one of the key promising technologies that can help reduce CO2 emissions in the power generation sector and the only pathway for very stringent GHG emission reductions from specific energy and/or carbon intensive

industries that generate CO2 as part of their production processes. In order to achieve the greenhouse gas emission reductions needed for keeping the global temperature rise this century well below 2 degrees Celsius as agreed at COP21 in Paris, CCS will need to be deployed from around 2030 onwards also in the fossil fuel power sector. For limiting this even further to 1.5 degrees Celsius, negative emissions may need to be achieved, e.g. by applying biomass conversion technologies with CO2 capture and storage (Bio-CCS).

In order to realise its potential, CCS needs to become a cost-competitive technology and gain public acceptance (mainly regarding storage safety), so that it could start to be commercially deployed and thus contribute to the low-carbon transition of the European economy. The assessments made in the context of the EU's Roadmap for moving to a competitive low carbon economy in 2050 and the Energy Roadmap 2050 see CCS, if commercialised, as an important technology contributing to low carbon transition in the EU, with 7% to 32% of power generation using CCS by 2050, depending on the scenario considered. Furthermore, in these assessments, by 2035 CCS starts to contribute on a broader scale to reducing CO2 emissions from industrial processes in the EU.

Comments:

1. First paragraph here should reflect the many studies that indicate that least cost routes to achieving 2 degrees Celsius is by including CCS. Decarbonisation without CCS is more expensive.
2. Also many scenarios indicate that fossil fuels are *very likely* to remain part of energy mix. First sentence does not make this clear enough.
3. Introduction of CCS starts really late according to this document. E.g. Page 2: CCS will need to be deployed from around 2030... What document is the rather late date based upon? Deployment should start earlier than 2030 e.g. IEA analysis. By stating that deployment is not needed until 2030, it may give the impression that no preparatory actions are needed beforehand and CCS can start to be deployed from this date. In reality, to achieve deployment at 2030 requires many actions beforehand – some of which are described subsequently but not fully reflected in this introduction which present a dange of only partially summarizing the encesary steps to achieve the 2030 target.
4. 2nd paragraph: CCS needs to become a cost-competitive technology *by 2030*.

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4 Why taking actions now on CCS ? (p. 2)

Why taking action now on CCS?

CCS has not yet taken off in Europe for a variety of reasons. However, the need for large scale demonstration, as a necessary step for its commercialisation and deployment, has not receded; on the contrary it has become more urgent. Commercial scale CCS demonstration projects are necessary in order to confirm CCS's technical and economic viability as a cost effective measure to mitigate greenhouse gases (GHG) in the power and industrial sectors. While CCS is not currently projected to significantly contribute to helping reach the EU's 2030 climate and energy targets and objectives, a "lock-in" into an energy infrastructure, which is not in line with the EU's long term decarbonisation objectives must be avoided. Failure to timely demonstrate CCS may therefore call into question new investments in fossil fuel power plants.

An analysis by the JRC (Global Energy & Climate Outlook, <https://ec.europa.eu/jrc/en/geco>) concludes that in case the 2° Celsius objective is taken seriously, most global investment in the power sector is expected to be renewables (see graph below), but average yearly investments of approximately US\$ 100 billion would be in coal and gas power plants with CCS:

Without CCS demonstration projects in Europe, it could prove very difficult or even impossible to reach the agreed climate targets and the EU will not achieve technology leadership in this area and miss out on economic opportunities.

CCS is also necessary in carbon-intensive industries to reduce process emissions that cannot be avoided. Further delays may ultimately result in the need of the European industry to purchase CCS technology from non EU countries in the future. While purchasing CO2 capture technologies is at least possible, this is not an option for establishing the necessary infrastructure for CO2 transport and storage. Many of the existing upstream oil and gas infrastructure in the North Sea will be decommissioned in the coming years. Delaying CCS development would mean precluding possible synergies resulting in higher investment needs in the future. Also the market-penetration of possible fuels and other products from conversion of CO2 (CCU) is a process which needs time and demonstrations should therefore be initiated as soon as possible.

Comments:

1. Ref P2. first para: Need to recognise that North America has made material progress in CCS and Europe risks becoming less competitive as a result of inaction.

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2. Suggest concrete suggestion on collaboration with US and Canada, in order to learn from experience.
3. Suggest more on the coupling between CCUS and RES&H2: Could mean a lot for the public perception. Link to other relevant Issues papers. CCUS is not 'a single island' in the Integrated Energy System.
4. Should we again move away from the need to demonstrate CCS, and move towards recognising the need to build 'catalysing' projects and supply chains? In the past, the arguments for demonstration have failed to deliver CCS. Whilst technology R&D will always be needed, it is not a barrier to deployment, rather investor confidence, lack of bankable storage and perceived costs are barriers which should be addressed.

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5 Overall objectives and targets (p. 3)

Overall objectives and targets

The key technology-related objectives for CCS, both in the short and longer term, are to deliver the commercial-scale demonstration of the full CCS chain, and to reduce the costs of CO₂ capture through Research and Innovation. Demonstration will require maximising the use of strategic EU funds, especially the Innovation Fund, but also, if appropriate, the Connecting Europe Facility - CEF - and the Modernisation Fund. In particular, it will require establishing a reliable long-term business case for operating a CCS installation - based on a reformed Emission Trading System (ETS) but, if necessary, complemented by Member State support instruments. Last but not least, it requires increasing public awareness of the societal benefits of CCS and increased collaboration between EU Member States and Associated Countries.

The estimated overall availability of permanent geological storage capacity in Europe is equivalent to over 300 Giga tonnes (Gt) of CO₂. Total CO₂ emissions from EU power generation and industry are around 2.2 GtCO₂ annually. Therefore, there is no doubt that there are sufficient suitable storage sites to hold the CO₂ captured in the EU for decades to come. Storage capacity in the North Sea alone has been estimated at over 200 GtCO₂. The detailed appraisal of storage capacity in selected regions will be a key facilitator for commercial CCS deployment.

While sufficient storage capacity exists in Europe not all capacity is accessible or located close to CO₂ emitters. Hence a cross border transport infrastructure is necessary to efficiently connect CO₂ sources to sinks. Under the regulation on "Guidelines for Trans European Infrastructure", CO₂ transport infrastructure projects can qualify to become Projects of Common Interest and can eventually be eligible for funding. Nevertheless, initially CCS projects will most often explore CO₂ storage sinks in the vicinity of capture points, hence infrastructure will first have to be developed at national level in order to become the nucleus of a CO₂ hub that can develop into a cross-border network.

Enhanced hydrocarbon recovery, especially enhanced oil recovery (EOR) combined with permanent storage is currently the only available large scale carbon capture and use (CCU) option which would actually remove relevant volumes of CO₂ permanently from the atmosphere. Also other CO₂ utilisation options could help improving the economic case for CO₂ capture, but further research & innovation activities are necessary for them to have a chance to make a meaningful contribution to our greenhouse gas reduction objectives and should therefore be intensified.

Comments:

1. Too much focus on coal and powerplants. Should be more on natural gas and industry.
2. Should include Flexibility and integration -focusing on overall Integrated Energy system. Focus on integration with RES.

Ref: P. 3, first paragraph: "The key technology-related objectives for CCS, both in the short and longer term, are to deliver the commercial-scale demonstration of the full CCS chain..."

This objective is short term. Longer term objective is widescale commercial deployment.

Ref: P. 3, first paragraph: "... to reduce the costs of CO₂ capture through Research and Innovation". There has been some work (e.g. by the Cost Reduction Task Force in the UK) that indicates that cost-reductions may also be found in storage, especially where strategic management of clusters and larger stores can be achieved.

3. Ref: P.3, last paragraph: "...based on a reformed Emission Trading System (ETS) but, if necessary, complemented by Member State support instruments": Make it mandatory. Legal requirements are the only way to

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make CCS happen at pace and volume needed. One specific action: Make new power plants locate to enable them to be CCS-power plants (including proximity to credible stores)

4. Ref P3; Third paragraph: “...CO2 transport infrastructure projects can qualify to become Projects of Common Interest and can eventually be eligible for funding...”
Why will CCS PCIs be eligible eventually and not immediately? Is there some regulatory or legal reason for this?

Ref P3; fourth paragraph: “... Enhanced hydrocarbon recovery, especially enhanced oil recovery (EOR) combined with permanent storage is currently the only available large scale carbon capture and use (CCU) option which would actually remove relevant volumes of CO2 permanently from the atmosphere...”
But life-cycle analysis indicates overall CO₂ reductions are not large. R&D therefore needed to improve this. EIOR is undoubtedly a way of offsetting some of costs but many are sceptical about scale of potential in the North Sea for example (due to low well densities, offshore operating costs etc)

4.: Ref: P.4, second paragraph ‘.. Nevertheless, initially CCS projects will most often explore CO2 storage sinks in the vicinity of capture points, hence infrastructure will first have to be developed at national level: No - wrong assumption- has to be dealt with as a European infrastructure, initiated in a regional context based on national interest.

5. Ref: P. 4, last paragraph: ‘..Also other CO2 utilisation options could help improving the economic case for CO2 capture.but further research & innovation activities are necessary for them to have a chance to make a meaningful contribution to our greenhouse gas reduction objectives and should therefore be intensified. This is clearly thermodynamical unhelpful and will not make a meaningful contribution to climate change. However it is useful for the circular economy and displacing fossil fuels and this should be made explicitly clear.

6 Proposed key objectives and targets in CCS and CCU – By 2020 (p. 5)

Proposed key objectives and targets in CCS and CCU
<p>By 2020:</p> <ul style="list-style-type: none"> • At least one commercial-scale CCS demonstration project operating; • Completed feasibility studies on applying CCS to a set of clusters of major industrial CO2 sources (at least 3 clusters in different regions of the EU); • At least one additional CCS demonstration project, preferably with an industrial source from which CO2 can be easily captured, having taken positive FID, which could be possibly funded from the part of the Innovation Fund available before 2021 (50 million allowances from Market Stability Reserve plus leftover money from NER300); • At least 1 Project of Common European Interest identified for CO2 transport infrastructure, preferably related to storage in the North Sea; • An up-to-date atlas of the geological storage capacity that has been identified by various national authorities in Europe. This will provide additional certainty that the required CO2 storage capacity will be available when needed; • At least 3 pilots on promising new capture technologies, and at least one to test the potential of Bio-CCS; • At least 3 new CO2 storage pilots³ in preparation or operating in different settings; • Completed feasibility studies for the use of captured CO2 for fuels and value added chemicals; • At least 4 pilots on promising new technologies for the production of value added chemicals from captured CO2; • Setup of 1 Project of Common European Interest for demonstration of different aspects of industrial CCU, possibly in the form of Industrial Symbiosis.

General comments:

1. The targets are very ambitious. A mismatch between the targets and KPIs.
2. The KPIs are too many and not useful.
3. Where will the funding come from (for fex the 3 storage pilots) ?

4. There is nothing on funding.
5. Suggest deployment indicators (instead).
6. KPIs should include scale of investment; fex how many MSs need to come together to produce demos.
7. Gas fired power plants around North Sea to happen first and should be mandated to ensure CCS by being appropriately located with proven access to credible stores.

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Comments to 'By 2020':

1. Ref: 'At least one commercial-scale CCS demonstration project operating; Remove the wording 'demonstration'- unless it's useful for state aid rules. Use fex wording 'Commercial project'.
2. Ref: 'Completed feasibility studies applying CCS to a set of clusters of major industrial CO2 sources (at least 3 clusters in different regions of the EU): Delete word 'industrial'. This is a doable target. Should be even more ambitious in term of timing than 2020. Target could be six to eight clusters across whole of Europe.
3. Ref: 'At least one additional CCS commercial project, preferably with an industrial source from which CO2 can be easily captured, having taken positive FID, which could be possibly funded from the part of the Innovation Fund available before 2021 (50 million allowances from Market Stability Reserve plus leftover money from NER300); Cement, waste incinerators ?

Comment [A2]: No real basis for this number but following seems not unreasonable:

NL 1 to 2
DE 2
UK 1
HU/RO 1
IT 1
NO 1
FR/ES 1-2
Baltics 1

Again avoid specifying industrial source

Will there be sufficient funding to achieve this goal? Another option would be to fund a number of FEEDs to create a pipeline for whom significant funds become available.

5. Ref: 'An up-to-date atlas of the geological storage capacity that has been identified by various national authorities in Europe. This will provide additional certainty that the required CO2 storage capacity will be available when needed;' Easy KPI because already LCE26 addressing this, hard thing is the methodology and different quality of the data, The wording should be '.. an up-to-date and mutually accepted atlas..'

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6. Offshore infrastructure should be separated from capture as there are upfront storage appraisal costs and commercial structures needed for storage provision that require distinct actions from developing capture plants. Issues include:
 - a. Risks sharing between parts of the CCS chain
 - b. storage liability costs and liability sharing.
 - c. Creating portfolio of permitted storage (most likely from public MS support)
 - d. Regulations and liability policies to address commercial storage issues.

7. In addition see comments at beginning of this document, copied here:

Objectives are missing to create bankable storage capacity and the Issues Paper does not recognize the work being done in a number of countires (especially Norway, Netherlands and UK) on detailed site appraisals for storage. A storage atlas is not enough for building confidence in available storage space. It does not tell you where the pipeline should go nor does it fully leverage the progress already made at a number of strategic future stores (e.g. 'Endurance' in the UK SNS or P18 in Dutch SNS). There should be an additional bullet, for 'a portfolio of storage sites (2-5 sites with potential for cluster development as CO2 capture increases) close to permitting for storage ('bankable storage'), with a combined storage capacity that is sufficient for the first two decades of storage'.

8.

5. Ref: 'At least 3 pilots on promising new capture technologies, and at least one to test the potential of Bio-CCS': This is a strange KPI because – what is really a pilot ? Need to reflect scale and TRL, j.e. the number of tons CO2. Is challenging. MS will have to gear up efforts. Important now is demo. This is crucial – but not a KPI.

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6. Ref: 'At least 3 new CO2 storage pilots in preparation or operating in different settings':

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New storage pilots should aim at undertaking test injections to prove capacity and injectivity with extended well testing to create bankable storage. This could be focussed at existing or near-term storage options to leverage past site appraisals, rather than starting from scratch and could then act as catalysts for full-scale deployment. This should include (more expensive) offshore tests). Other barriers include pressure management options (use a small compartment to innovate new technologies etc).

Research should also be focussed on cost-reduction as this still a political requirement.

7. Ref: 'At least 4 pilots on promising new technologies for the production of value added chemicals from captured CO2';

This objective and next gives too much weight on this route which is not relevant for fighting global warming- must be scaled according to possible role. Also can a PCEI be set up for CO₂ use?

8. Where is bioCCS and biofuels ? These are important implications of COP21.

9. Where is hydrogen ? COM needs to unlock the H2 JU to become relevant for the energy system of Europe.

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7 Proposed key objectives and targets in CCS and CCU – By 2030 (p. 5)

On the road to 2030:

- MS to deliver on their 2030 nationally determined contributions to the COP21 agreement, and in particular decide on the need for CCS to achieve these targets and make them compatible with the 2050 long-term emission targets;
- MS having prepared plans for retrofitting until 2040 at least 90% of their fossil fuel power plants capacity which they expect to be still operational beyond this date.
- MS having prepared, if appropriate in regional cooperation with other MS, feasibility studies for applying CCS in all major clusters of energy and carbon intensive industries in the EU by 2035, cooperating across border for transport and storing CO₂.
- Further develop the potential of the industrial use of captured CO₂, in particular through a Project of Common European Interest.

Comments to 'On the road to 2030'

1. Ref: 'MS to deliver on their 2030 nationally determined contributions to the COP21 agreement, and in particular decide on the need for CCS to achieve these targets and make them compatible with the 2050 long-term emission targets; Important but seems very late. Could be linked to MS reporting deadline to EnergyUnion – 2021 ?

2. Ref: 'MS having prepared plans for retrofitting until 2040 at least 90% of their fossil fuel power plants capacity which they expect to be still operational beyond this date.' MS will have to comment- note fossil fuel plants - ie both gas and coal. The text is not clear. Problem is national. Feasibility studies must be much before 2030 – fex before 2022. Should not be 90% related to capacity – but to electricity produced/energy delivered, due to new energy system with large RES portion.

3. Ref: 'MS having prepared, if appropriate in regional cooperation with other MS, feasibility studies for applying CCS in all major clusters of energy and carbon intensive industries in the EU by 2035, cooperating across border for transport and storing CO₂. Late- we will miss on the 2050 targets for sure

4. Ref: 'Further develop the potential of the industrial use of captured CO₂, in particular through a Project of Common European Interest : Again - scale and relative importance; CO₂ use in not important in order to fight climate change.'

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Comment [A3]: One option might be to develop a KPI that encourages permanent storage – i.e. KPI could be:
For any CCUS project, >90% of CO₂ captured must be permanently stored regardless of intermediate uses.

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8 Some basic Key Performance Indicators (p. 6)

<u>Some basic Key Performance Indicators</u>			
	Metric	Target 2020	Target 2030
Levelised Cost of Electricity*			
Coal power plant with CCS (post-combustion / oxy-combustion)	€/MWh	70.2 / 66.4	68.2 / 63
NG power plant with CCS	€/MWh	87.4	84
Cost of CO2 avoided*			
Coal power plant with CCS (post-combustion / oxy-combustion)	€/t CO2	26.1 / 20.1	26.3 / 17.8
NG power plant with CCS	€/t CO2	45.3	40.5
Efficiency indicators			
Plant efficiency - coal with CCS (post-combustion / oxy-combustion)		35 / 37	35 / 39
Plant efficiency - NG with CCS		52	55
Average capture rate		85	95
Deployment indicators			
N° of demo projects with positive FID		2	15
Permits for CO2 storage		2	15
CO2 stored	Mt/yr	1	15

*Hard coal: €2.6/GJ; NG: €8.5/GJ; CO₂ transport and storage, and European emissions allowances not included; discount rate 8%; 85% load factor; lifetime: 40 years for coal, 30 years for NG; currency €₂₀₀₈ (data based on the EC report "ETRI 2014 – Energy Technology Reference Indicator projections for 2010-2050").

Comments:

1. Metrics do not allow measurement of progress on targets and should therefore include:
 - a. No. of pilots
 - b. No. of feasibility studies
 - c. No. of full-size projects (not demos)
 - d. Mt/year permanently stored
 - e. MS actions that will lead to x number of CCS clusters.
2. All of the above should include intermediate targets for 2025 as well as 2020 and 2030
3. Cost reductions from storage should also be measured.
4. Welcome KPI on storage permits but this should be coupled with realistic plans to undertake storage appraisals and mechanisms for permit applications, given appraisal could take 5+ years for each project.
5. This is all power.
6. Nothing on transport.
7. Nothing on bioCCS.
8. Very little on industrial emissions.
9. Very scarce on storage. Are already storing ~2m tons CO2 /year at Sleipner and Snohvit.
Storage target is far too low
10. Very risky to bet on figures in the future: A 20% reduction in LCOE is not what will deliver CCS. The 'proof of the pudding' is CO2 stored away from entering the atmosphere.

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9 Some recommendations on financing CCS demonstration and deployment (p. 6)

Some recommendations on financing CCS demonstration and deployment

As regards early demonstration of CCS, the use of the ERA-Net instrument can be a useful tool to facilitate the pooling of the available funding from the EU and Member States to reach a critical mass. This should be considered in particular to enable first-of-a-kind CCS demonstrators.

For large-scale demonstration and deployment, which requires levels of funding surpassing the capacities of Member States and European Research Framework Programmes, the stakeholders (industry and Member States) should set up and agree on a list of potential CO₂ clusters or other projects of national, regional or common interest, which would also serve to prioritise the use of the existing or planned financial instruments like the Innovation Fund. Experience gained in commercial-scale CCS demonstration projects will also serve to prioritise research funding.

Comments:

1. Ref: 'This should be considered in particular to enable first-of-a-kind CCS demonstrators': This is the ROAD ERA Net which is 1 year delayed now- 2018.
2. There is a spectrum of business models that could be used as part of any delivery strategy. What is key, however is that a combination of public and private risk sharing, financing, and underwriting is required that leverages existing public institutional capacity, market transition mechanisms, and public-private investment models. The targets for 2030 should include a requirement that MS develop policies and funding mechanisms that take account of these options to achieve the transport and storage infrastructure.
3. The commercial risks, liabilities and issues associated with full chain CCS projects with multiple operators have been known for over a decade. The UK CCS programmes suggest that the CfD/grant/project contract approach is not fit for purpose as an enduring commercial/financing model for how to solve these problems, especially for the delivery of the transport and storage infrastructure. To move to the delivery of the infrastructure that can serve multiple capture plants (on power and industrial emitters) we need new policy and new financing approaches.
- 4.

10 Annex 1 Relevant actions of the 'Towards an Integrated Roadmap of the SET Plan

Annex: Relevant actions of the 'Towards an Integrated Roadmap' document of the SET Plan

Concrete targeted R&I actions for the long, medium and short term for CCS were proposed by stakeholders in the Annex 1 Part II Heading 4 of the 'Towards an Integrated Roadmap' document⁴. The headings of these actions are listed below. Priorities for future R&I actions will not least depend on the experience gained from commercial scale demonstration projects.

A. Proposed targeted R&I actions

Advanced Research Programme

1. CO2 Capture

Action 1: Basic R&D for supporting pilots and demonstration actions

Action 2: Proof of concept of efficient capture technologies for pan-industrial utilisation

2. CO2 Storage

Action 1: European ATLAS of potential storage sites

Action 2: Improved methods for site characterisation

Action 3: Improved methods for site monitoring

Action 4: Improved methods for safe storage exploitation

3. Competitive Carbon Capture and Storage (CCS) Value Chains

Action 1: Basic R&D and infrastructure for effective design and operation of CO2 transport systems

Action 2: Developing advanced materials for CCS applications and key enabling technologies

4. Conversion of CO2 from Process Flue Gases

Action 1: Advanced olefin production from CO2

Action 2: Demonstration of fine chemicals from CO2

Action 3: Access to competitive CO2 for chemical conversion

Industrial Research and Demonstration Programme

1. CO2 Capture

Action 1: Piloting of promising capture technologies

Action 2: Prove options to utilise the full potential of bio-CCS

2. CO2 Storage

Action 1: Start-up and management of up to six new CO2 storage pilots

3. Competitive Carbon Capture and Storage (CCS) Value Chains

Action 1: CO2 transport pilots for effective design and operation of CO2 transport systems

Action 2: Efficiency improvement and key enabling technology development for CCS

4. Conversion of CO2 from Process Flue Gases

Action 1: Demonstration of industrial scale production of polymers from CO2

Action 2: Demonstration pilot for mineral production from CO2

B. Framework conditions - policy measures

Innovation and market-uptake programme

1. CO2 Storage

Action 1: Start-up and management of CO2 storage demonstration projects

2. Competitive Carbon Capture and Storage (CCS) Value Chains

Action 1: Pan-European transport of CO2

Action 2: Develop tools for understanding integration and cross-cutting issues

Action 3: Demonstrate Large Scale Integrated CCS plants

3. Conversion of CO2 from Process Flue Gases

Action 1: CO2 based products should be recognized as renewable products and benefit from appropriate support

Comments:

1. Ref: 'Concrete targeted R&I actions for the long, medium and short term for CCS were proposed by stakeholders in the Annex 1 Part II Heading 4 of the 'Towards an Integrated Roadmap' document: This is the joint ZEP, EERA and partly SPIRE input from 2 yrs ago.
2. This under-communicates the need to have an CO2 transport research infrastructure on CO2 use within 2020.
3. CO2 transport/Value chains: Difference between short term needs and Longterm needs:
 - a. Short term needs: Demo. Impurities, corrosion, amines.

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- b. Longterm needs: As fossil power plants is getting less important, more focus will be on smaller scale distributed CCUS transport systems, linked to regional systems. And liquid transport on ships.