EUA-EPUE
European Platform of Universities in Energy Research & Education

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EUA-EPUE Response to SET-Plan Consultation

Key Action No. 9: Renewing efforts to demonstrate Carbon Capture and Storage (CCS) in the EU and developing sustainable solutions for Carbon Capture and Use (CCU)

BACKGROUND

This response provides the perspective of the European Platform of Universities in Energy Research & Education (EUA-EPUE) to the consultative process on the European Strategic Energy Technology Plan (SET-Plan) - Key Action No. 9 - Renewing efforts to demonstrate Carbon Capture and Storage (CCS) in the EU and developing sustainable solutions for Carbon Capture and Use (CCU).

EUA-EPUE responds to the consultation from the perspective of the universities' role in society. Universities constitute a significant part of the research capacity in Europe. At the same time, they educate the highly skilled work force of our societies. We consider therefore that setting up the SET-Plan projects with ensured integration of innovative research with education, including industrial partners, will provide a high pay-off towards achieving the energy system transition, which is a major objective of the SET-Plan and the European Union.

RESPONSE

Proposed targets in Carbon Capture and Storage (CCS) and Carbon Capture and Use (CCU)

For the main expected outcome: To make specific recommendations on the priorities/targets proposed in the issues paper(s)

- Do you agree with the targets set in the issue paper?
- Do you think that the level of ambition is correct?
- Are there any standing issue(s) in the way to reaching the proposed targets/priorities?

It may be useful to understand the broader context in which these targets/priorities need to be achieved. If possible, we suggest that the following is addressed as well:

- *What are your specific recommendations on prioritising R&I activities on these issues (and building where appropriate on relevant existing initiatives)?*
- *Who are the best placed actors to implement the targets/priorities (Industry, EU, Member States, regions, groups of countries/organisations/etc.)?*

The Issues Paper No.9 provides a good synopsis of the current situation with respect to CCS technology in Europe. CCS on a large scale, in conjunction with other relevant measures, is necessary in order to reach the climate targets of limiting the increase of global temperature to at least 2° Celsius, as agreed at COP21 in Paris.

- *Main barriers to the implementation of CCS in Europe*

The main barriers to achieve implementation of CCS in Europe on a large scale are a combination of economic, social, and political barriers. To this regard, it should be pointed out that there are no significant technical barriers: CO2 is already captured, transported and injected into the subsurface in Europe, though not as part of an integrated CCS value chain.

Concerning economic barriers, it is crucial to stress that including CCS in a power plant or industrial process will always be more expensive compared to the same plant or process without CCS. In order to overcome the economic barriers, one should realise that a combination of reduced cost of CCS technologies and economic and regulatory measures is required. Indeed, this would permit to estimate in financial terms, the social costs linked to continued emissions. As regards cost competitiveness, CCS is cost-competitive today when the real cost of some renewables (without subsidies) and the electricity storage is taken into account.

With regard to social and political barriers, these include for instance the reluctance from governments to be first movers regarding capturing and storing carbon dioxide. Indeed, as stated above, this option will always be more expensive that simply emitting the CO2 to the atmosphere.

Finally, if a public perspective is taken into account, two main issues can be stressed. On one side, for those people committed to removing the dependence of humanity on fossil fuels, CCS is often seen as a “get out” option for industry and governments who wish to continue to use fossil fuels. On the other side, significant misconceptions exist regarding the potential safety, rather than lack, of storage sites. Generally speaking, decreasing the economic, social and political barriers is key in the process of obtaining social acceptance for CCS.

- *The role of European universities*

European universities, research institutes and companies have for a long time been world leaders in CCS technology development. Europe has a number of world-leading research laboratories and facilities dedicated to researching a broad range of CCS technologies. Many of these laboratories are accessible in universities. It is therefore essential that this world-leading research expertise is harnessed in order to improve current technologies and to develop a new generation of CCS technologies with the objective of decreasing costs. If Europe intends to achieve ambitious targets for CCS, developing stronger research collaborations to draw on the full range of expertise in European research and development communities must be considered. Furthermore, supporting research that addresses the political and economic barriers should also be supported.

- *Educating students in CCS disciplines*

If the human resources dimension is taken into account, it should be mentioned that there is a need for specialisation within areas like mechanical engineering, chemical engineering, civil engineering, geoscience, risk assessment, law, economics and communication. There is also a similar need for continuous education for people in industry and public administration. Consequently, a number of educational programmes are required.

- *Role of Carbon Capture and Use – CCU*

It should be noted that the use of CO_2 (Carbon Capture and Use - CCU) for production of chemicals and fuels can support CCS technology development and keeping CCS technology providers active. It should however be mentioned that this is not likely to contribute to significant reductions of CO_2 emissions to the atmosphere. Moreover, one should also be aware of the fact that using CO_2 and consequently deriving fuels from it, will in the majority of the cases require more energy as an input to the process in comparison to what can be extracted from the product. If that additional energy requirement is ultimately derived from burning fossil fuels, then the net amount of CO_2 emissions into the atmosphere will increase.

- *An example of European CCS laboratory research infrastructure*

As regards to existing projects funded by the European Union`s Horizon 2020 Research and Innovation Programme, a European CCS laboratory research infrastructure (ECCSEL - www.eccsel.org) has been established and is included in the ESFRI Roadmap[1]. The ECCSEL consortium currently operates some 50 research facilities in 9 countries representing a unique and excellent laboratory research infrastructure based within leading European CCS institutions and knowledge centres. ECCSEL aims to advice on and coordinate necessary laboratory infrastructure investments in the range of 100 – 120 million EUROs in the coming 10 years, thereby reducing duplication of efforts and cost at a European scale. It is important for ECCSEL to enable an alignment of the various national strategies for laboratory research infrastructure development. ECCSEL provides funders, operators and researchers with significant benefits by offering transnational access to excellent research facilities that, in many cases, are unlikely for a single institution and even for a single country to support in isolation. This implies creation of synergies and the avoidance of duplication as well as streamlining of funding for research facilities. To attract the best researchers from across the world, ECCSEL has created generous opportunities to carry out scientific research. This includes a commitment to grant effective access pursuant to a sub-set of pre-defined criteria.

- *Specific comments to the text of "Issues paper No. 9" document*

This input paper provides specific recommendations on relevant phrasing of the *"Issues paper No. 9"* document. Main comments are listed below:

<u>Comment no. 1, page 2</u>: "CCS will need to be deployed from around 2030 onwards…".

It is recommended to reformulate to "CCS will need to be ready for large scale deployment from around 2030 onwards…". This sentence would reflect the need to have the technology and infrastructure available by 2030 and therefore the need for demos and setting all the conditions before 2030.

<u>Comment no. 2, page 2</u>: "In order to realise its potential, CCS needs to become a cost-competitive technology and gain public acceptance (mainly regarding storage safety).."

Although gaining public acceptance is a key point for deployment especially in Europe, the actions do not directly tackle this aspect. This needs to be specifically addressed in the paper as well as investigating whether having 3 storage projects might be sufficient to gain public acceptance.

<u>Comment no. 3, page 2</u>: "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, by 2035 CCS starts to contribute on a broader scale to reducing CO2 emissions from industrial processes in the EU".

Given the importance of CCS for the industrial sector, it is recommended to provide a higher level of detail in the issue paper. It should be mentioned that, the quantitative targets and potentials tend to be set for the power sector, while for the industrial sector they are provided in qualitative and more generic terms. In the IEA scenarios the total CCS potential comes from 50% power and 50% industry[2].

<u>Comment no. 4, page 2</u>: "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".

It is recommended to keep the reference to CO2 instead of Greenhouse Gases (GHG), as the sentence may be misinterpreted that GHGs are also abated with CCS.

[1] European Strategy Forum on Research Infrastructures (ESFRI), http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri

[2] http://www.iea.org/publications/freepublications/publication/TechnologyRoadmapCarbonCaptureandStorage.pdf

Comment no. 5, page 2: "Failure to timely demonstrate CCS may therefore call into question new investments in fossil fuel power plants".

On the one hand, this aspect should be further investigated. On the other hand, other factors may be considered such as: (a) investigating on the readiness of CCS power plants in relation to investments in fossil (i.e. gas), as well as availability of transport and storage, in case capture is ensured; (b) researching if future potential investments in carbon intensive industry, combined with strict CO2 mitigation targets, will be haltered by no implementation of CCS.

Comment no. 6, page 2: "in case the 2° Celsius objective is taken seriously, most global investment in the power sector is expected to be renewables (see graph below)"

It is relevant mentioning that the graph in page 3 of the issue paper also shows, in the 2° Celsius scenario, an increase on Bio-CCS, accounting for 50% of the investments on biomass.

Comment no. 7, page 3: "CCS is also necessary in carbon-intensive industries to reduce process emissions that cannot be avoided."

It should be stressed that no other relevant mitigation measures are available so far, although some more expensive possibilities (e.g. replacing coke by biomass in some industrial processes) exist.

Comment no. 8, page 4: "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"

The issue of large scale and long-term storage of CO2 is key when considering mitigation options for EOR. The main concern regards the fact that this option is combined with CCU applications that are either specific applications (high value added chemicals, having therefore a limited market potential) or options with large markets (CO2 to fuels with very short storage time of a couple of days before the CO2 is emitted back into the atmosphere). Although there are clear synergies regarding for instance the decrease of CO2 capture cost and infrastructure development, there are also differences that need to be taken into account. A positive GHG footprint for CCU (chemicals/fuels) should consider preliminary conditions, as for instance:

a) Process availability that requires less energy than the fossil-based product (an alternative may be using energy from renewables). Some concepts are being developed based on the peak power as for instance from Photovoltaic (PV) Solar Energy (assuming that such energy will be freely available) which then have a positive effect on the CO2 footprint of the product. However, once there is a demand for that energy, this will not be freely available. It is relevant mentioning that this will affect the business case. Furthermore, it should also be stressed that if a business case is needed, designing the system on availability of peak energy from PV or setting up a backup system that would provide the energy needed, once PV is not available, should be questioned. It should also be questioned if the backup system would then be fossil-based (e.g. gas power), as this might significantly change the CO2 footprint of the process.

b) A key aspect is to understand what products are being displaced. In many assessments of CCU in literature, diesel or gasoline are assumed to be replaced by the CO2 based fuel. In reality, the CO2 based fuel may compete with other alternative fuels, e.g. biofuels. The benefits of CCU will be very dependent on this.

c) Concerning climate change mitigation, a basic point of departure would be that the CO2 comes from biogenic sources. In this way if the CO2 comes back to the atmosphere, a CO2 neutral system may be available. In case the CO2 comes from fossil fuel sources, the benefits of CCU (in terms of GHG) will be lower.

It is worth stressing that the issue paper does not tackle these aspects. While the paper refers to the techno-economic feasibility of CCU, a systemic analysis of the options should be considered. This should take into account the environmental consequences of CCU options, including the CO2 footprint of the value chain, and the boundary conditions that will be required.

Comment no. 9, page 4: "Also other CO2 utilization options could help improving the economic case for CO2 capture"

This phrasing should also take into account CO2 capture and CO2 transport.

Comment no. 10, page 8 on Annex: Relevant actions of the `Towards an Integrated Roadmap` document of the SET-Plan: "CO2 based products should be recognized as renewable products and benefit from appropriate support"

The fact that a product is based on CO_2 does not mean per se that is "renewable" in the sense of net zero CO_2 emissions (see comment 8). The conditions for this should be clearly established (similar to the certification path for sustainable biomass), otherwise there is a risk of funding products that in terms of value chain (CO_2 footprint, environmental impacts) are not better than petro-chemical counterparts.

Proposed targets in Carbon Capture and Storage (CCS) by 2020

1. At least one commercial-scale CCS demonstration project operating;
2. Completed feasibility studies on applying CCS to a set of clusters of major industrial CO_2 sources (at least 3 clusters in different regions of the EU);
3. At least one additional CCS demonstration project, preferably with an industrial source from which CO_2 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);
4. At least 1 Project of Common European Interest identified for CO_2 transport infrastructure, preferably related to storage in the North Sea;
5. 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 CO_2 storage capacity will be available when needed;
6. At least 3 pilots on promising new capture technologies, and at least one to test the potential of Bio-CCS;
7. At least 3 new CO_2 storage pilots in preparation or operating in different settings;

1. Given the recent withdrawal of £1 billion of CCS support by the British government (November 2015)[3] and the absence of a significantly advanced project elsewhere in Europe in mid-2016, the expectation of having a commercial-scale CCS system operating by 2020 would require more effort by the Member States and the EU.

[3] http://www.theguardian.com/environment/2015/nov/25/uk-cancels-pioneering-1bn-carbon-capture-and-storage-competition

2. Completion of feasibility studies on CCS clusters is easily delivered and should be a priority for the near future.
3. Similar to considerations made in point 1, the expectation of having at least one additional CCS demonstration project by 2020 would require more effort by the Member States and the EU.
4. This target should aim at having a higher degree of ambition.
5. Considering that both Norway and the UK have completed studies to evaluated CO_2 storage capacity, this could now be done for the remainder of Europe. Moreover, it is worth mentioning that the evaluation tools developed by the UK Storage Appraisal Project (UK SAP)[4] can be easily applied in other countries.
6. While capture technology pilots are important to develop, Bio-CCS does not in itself merit separation in terms of liberated emissions. The capture technologies are instead a function of the combustion process.
7. Although the scale separation between 'demonstration' and 'pilot' is not clear, more information on behaviours of different types of storage sites during injection would allow selecting and ranking potential large scale storage sites.

Proposed targets in Carbon Capture and Use (CCU) by 2020

1. Completed feasibility studies for the use of captured CO_2 for fuels and value added chemicals;
2. At least 4 pilots on promising new technologies for the production of value added chemicals from captured CO_2;
3. Setup of 1 Project of Common European Interest for demonstration of different aspects of industrial CCU, possibly in the form of Industrial Symbiosis.

1. The demonstration of CO_2 utilisation for fuel production should be reconsidered, given the huge breakthroughs that are occurring in personal transport (see for example Tesla motor's huge strides, and launch of a basic model for the mass market) and the massive inherent inefficiency in the use of such fuels in internal combustion engines. To this regard, it should be mentioned that it is around 5 times more efficient to charge a battery and then use it to run an electric vehicle than to take the equivalent electricity, hydrolyse water, produce methanol and then burn it in an internal combustion engine.
   Similarly to the Comment no. 8 on page 4 of the issue paper (see page 4 of this input paper), the usage of completed feasibility studies is recommended. This should include GHG life cycle assessments for the use of captured CO2 for fuels and value added chemicals.
2. The proposed imbalance of pilot projects is significantly misrepresented. Indeed, there are 4 pilot projects suggested for CCU, and only 3 for advanced CCS and 3 for storage. Considering that CCU requires, for the most part, a pure stream of CO_2, demonstrating advanced CO_2 capture technologies would benefit the advocates of CO_2 utilisation.
3. Target 3 "Setup of 1 Project of Common European Interest for demonstration of different aspects of industrial CCU, possibly in the form of Industrial Symbiosis" is supported by this evaluation team.

[4] http://www.eti.co.uk/project/uk-storage-appraisal-project/

- As a general comment to proposed targets in CCU by 2020, it should be stressed that the use of CO_2 for Enhanced Oil Recovery (CO_2-EOR) is mentioned in the issue paper as requiring further development while it is not identified as a target for CCU. Furthermore, there is no mention regarding the potential use of CO2 to Enhance Gas Recovery (EGR).[5] Both EOR and EGR would consume (store) a higher amount of CO_2 more quickly than using CO_2 to synthesis new products. This would as well have a positive return to investors, making a significant impact on European energy security.

On the road to 2030

1. 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;
2. 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.
3. 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 CO_2.
4. Further develop the potential of the industrial use of captured CO_2, in particular through a Project of Common European Interest.

- Target 2 "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" should also consider biomass plants and the actions to achieve Bio-CCS goals, besides the ones on capture technology working with CO2 from biomass.

- Generally speaking, EUA-EPUE supports the idea that a high level of ambition is needed in order to reach the proposed targets on the road to 2030.

CONTACT

Dr Lidia Borrell-Damian
Lidia.borrell-damian@eua.be
Director, Research & Innovation
European University Association

Lennart Stoy
Lennart.stoy@eua.be
Project Manager, Research & Innovation
European University Association

Borana Taraj
Borana.taraj@eua.be
Project Officer, Research & Innovation
European University Association

[5] Goudarzi, S. (2016) Numerical modeling of compositional two-phase flow, Application to enhanced gas recovery by CO_2 injection, Unpublished PhD thesis, Durham University, 2016