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Policy analysis and recommendations for EU CO_2 utilisation policies

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Abstract

To safeguard the competitiveness of energy-intensive industries, in light of lower-cost energy supplies elsewhere, Europe requires combined resource and energy efficiency technology. Most technical components of CO_2 utilization can in principle be mobilized in Europe in the short term. Nevertheless, infrastructural, logistical, regulatory and business strategic issues must be addressed imminently by all relevant stakeholders. Given the already dense EU policy landscape, industry stakeholders need to assess first the applicability of the current framework and then the impact that policy changes could bring. Notably, connectivity infrastructure requires more analysis and coordination. This paper presents relevant policies to support CO_2 utilisation along the value chain. It outlines the applicability of current policy and benefits of policy enhancements to address barriers to deployment of CO_2-derived products. It also lays out the role of key stakeholders to effect appropriate changes in policy. Finally, it explores the justification for a CO_2 Utilisation Directive, comparable to the Carbon Capture and Storage Directive.

Keywords: CCU, EU Policies, CO_2 Utilisation Directive, Resource Efficiency

1. Introduction

Current trends require Europe to deploy energy and resource efficient technology across the economy. These trends relate to the competitiveness of energy use, production processes and the need to abate carbon emissions. The availability of low-cost hydrocarbons elsewhere puts pressure on the competitiveness of European production processes and on industrial feedstocks. Specifically, inexpensive natural gas has resulted in the availability of low-cost bulk chemical feedstocks such as ethylene and ethane (Garcia, 2013). Another pressure is the need to reduce all-sectors greenhouse gas emissions (GHG), which according to the EU low-carbon economy roadmap should be cut to 80% below 1990 levels, by 2050. Energy intensive industries could cut emissions by more than 80% by 2050. Carbon Capture and Utilization (CCU) is proposed to alleviate the impact of these trends. The European SCO_2T project (Wilson *et al.*, 2016) concluded that CCU can make important contributions such as becoming a significant growth area in the low-carbon circular economy and facilitating the energy transition. Important issues to be clarified to enable CCU include the infrastructural development and legal definitions for various uses, types of feedstocks and public acceptance. In addition, CO_2 reuse has the potential to be a key component of large-scale CCS demonstrations in emerging economies, where there is strong demand for energy and construction materials and low likelihood of the early adoption of carbon pricing (GCCSI, 2011).

1.1 Need for CCU Policy

Three functional areas of policy can enable CCU value chains to continue their development:

- Market regulation
- Support for early development
- Incentives and guidance for deployment

Market regulation allows firms and local governments to define the rules of CCU commercial activity. This ensures that competition and pre-competitive development can take place under fair and stable conditions to foster investment. It is delivered through performance and quality standards as well as criteria to benchmark the sustainability, recyclability and renewable content of products. Support for early development is needed by early value chain participants who are unable to bear the cost or the risk of project infrastructure and other assets that are only amortized in the long term. Therefore, early stage assistance includes infrastructure financing; support for scale-up research and development; and public engagement highlighting problems solved. Incentives and guidance for deployment are most needed when business propositions have not reached commercial maturity and where societal benefits are an important component of the overall impact. Examples of incentives and guidance for deployment are targets towards policy outcomes; Life Cycle Analysis-backed product differentiation; piloting and demonstration; and public procurement. Alongside these functional areas, there are specific objectives to be achieved by CCU policies. They ensure that CCU technologies are attractive from commercial, environmental and public acceptance standpoints. They relate to either sustainability or industrial innovativeness and productivity. The main sustainability objectives include GHG reduction, resource efficiency, energy efficiency and pollution reduction. It is important to regard energy efficiency as separate from decarbonization to illustrate the efficacy of various renewable or nuclear energy-based solutions. The industrial innovativeness and productivity objectives include differentiation of European technology, economic competitiveness of products and infrastructural improvement.

1.2 Application perspectives for CCU policy

There are three application perspectives that can be used to formulate policies to address all aspects of CCU development. The environmental technology literature distinguishes between: (i) policies to address the full innovation cycle; and (ii) policies to address all elements of the value chain. This contribution focuses on policies that address all elements of the value chain and on analysis of the gap between existing policies and additional needs specific to CCU. Full discussion of policies along the innovation cycle requires that all CCU pathways are well defined and widely recognized; then it requires a discussion of how policy instruments that target each developmental stage can be adapted to CCU value chains and their multiple applications. As with other innovations meant to deliver profit and societal benefits, special attention should be paid to the technology valley of death and the commercialization valley of death. The former refers to the uncertain period after initial venture funding has peaked and investors are reluctant to keep funding development due to the high technical and management risks and to long development horizons (Jenkins and Mansur, 2011). The latter refers to the gap between the pilot or demonstration and the commercialization phases and reflects the distinction between the purpose of venture capital and that of later-stage project finance, debt or equity prior to sustained commercial transactions (Jenkins and Mansur, 2011).

2. Policies for the parts of the CCU value chain

CCU technologies are clearly at different levels of maturity and will require specific policy instruments to foster commercial viability and balance emphasis along the stages of the value chain of different CCU pathways. The components of the value chain that merit targeted policies can be grouped into:

- Emission sources – including aspects of treatment and purification
- Conversion and production – including aspects of treatment and purification
- Users and uptake routes for products
- Public acceptance
- Infrastructure development

Figure 1 presents the policy vehicles that can address specific stages of the value chain. Existing policies are typically designed to address specific CCU pathways. This study analyzes how they address the components of the value chain and identifies routes to amend existing policies. In very few cases where a distinct new area is not covered there may be a need to create new policies altogether. For instance, if there were a new incentive for the utilization of CO2 there could be different directives hosting it, but an example of a prominent policy that must be explored fully before creating a new one is the Waste Framework Directive (WFD).

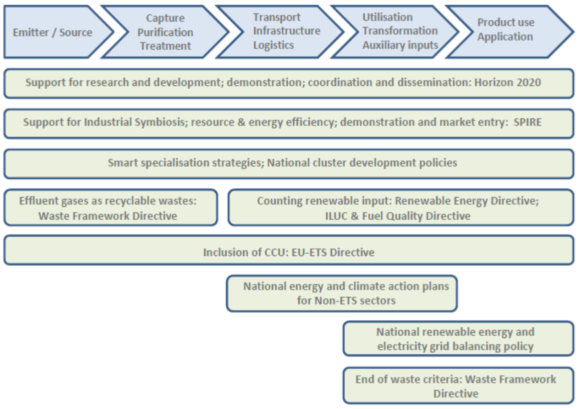

Figure 1. European policies suitable for each stage of the CCU value chain

3. Gap analysis between needs and existing policy

3.1. Waste Framework Directive

Analogous to existing policy for renewable energy, a framework for policies for renewable or recycled materials is missing. As of 2016, the Waste Framework Directive (WFD) considered industrial flue gases from sectors outside the Emissions Trading Scheme (ETS) as emissions and not as waste. The Directorate General (DG) Environment has supported a proposal for the inclusion of gaseous effluents as waste in order to make them eligible for measures under recycling initiatives as well as the circular economy package. This revision was submitted to the European Parliament in the fourth quarter of 2016. Member States, the Commission and parts of Parliament itself can suggest amendments during the revision. No new revisions are considered in the foreseeable future (DG GROW, 2016). There is however an inherent complication of a framework to incentivize recycling of, for instance, CO_2-derived fuels which can lead to a degree of down-recycling (Garcia-Gonzalez *et al.*, 2016). This can occur when a transport fuel such as CCU-methanol is combusted and CO_2 is emitted in a dispersed way accompanied by contaminants. Given that there will always be an overwhelming surplus of localized, fairly concentrated CO_2 emissions with controlled impurities, a second re-use of the CO_2 from CCU fuels is uneconomic and impractical (Garcia-Gonzalez *et al.*, 2016).

3.2. European Emissions Trading Directive

The first difficulty for CCU within the Directive 2003/87/EG on the European Emissions Trading Scheme (ETS Directive) is that it stated, as of 2016, that captured and transferred emissions of fossil CO_2 could be subtracted from a particular installation in the case that they were transferred as inherent component of a fuel onto an installation that is included in the ETS; for instance the supply of CO/CO_2 from a steel mill to a power plant. The transferred emissions are then subtracted from the installation that supplies the CO_2 and they are added to the balance of receiving installation. This procedure does not apply to most CCU routes such as carbonation, algae or ethanol production. This is because the receiving processes are not amongst the most carbon intensive installations and are therefore excluded from the ETS. Thus, the transferred CO_2 has been considered as emitted not as stored making the operation liable for emissions certificates.

3.3. New Entrants Reserve 400

A mechanism within the ETS Directive 2009/29/EG suitable for large scale demonstration projects is the New Entrants Reserve 300 (NER300) and as of 2016 it did not include technologies for CCU value chains (Armstrong *et al*, 2016). The NER300 administers the auction proceeds from 300 million emission certificates for sustainable energy projects including CCS and renewable energy technologies. Its budget can be used for up to 50% of the "subsidizable" costs of a project supplemented by private investment or national governments. Member States do the first evaluation of proposals in their jurisdiction and then submit a selected sub-set to the European Commission (Garcia-Gonzalez *et al*., 2016).

3.4 Directives on Indirect Land Use Change, Renewable Energy and Fuel Quality

The Directive to reduce indirect land use change for biofuels and bioliquids (EU) 2015/1513, known as the ILUC Directive, amends Directive 98/70/EC on the quality of petrol and diesel fuels (known as the Fuel Quality Directive) and Directive 2009/28/EC on the promotion of the use of energy from renewable sources (known as RES Directive or RED). The ILUC Directive mentions amongst the fuels that qualify for double counting carbon capture and utilisation for transport purposes, if the energy source is renewable which refers to the energy source for the production of the fuel not to the source of carbon. The RES Directive Article 3.4 stipulates that the renewable energy proportion in the energy used for transport depends on the amount of renewable energy present in either the energy mix of the EU or of the member state.

3.5 Infrastructure and connectivity

Most CCU-relevant policies so far focus on emission sources, e.g. EU-ETS; or products, e.g. Fuel Quality Directive. This creates an imbalance in the support needed for the crucial element of connectivity. One of the main gaps, where support from governments at regional, national, and European Union level would be beneficial, is in the de-risking of symbiosis or collaboration projects. In these cases infrastructure is required considering the throughput of each one of the partners. This is relevant because neither individual companies nor small local authorities can finance or underwrite the risk of infrastructure to connect emitters and receivers or clustering amongst emitters.

4. Recommendations and conclusions

4.1. Waste Framework Directive

Given the positive displacement impact that can still be achieved by CCU fuels by using surplus CO_2 sources, the down-cycling disadvantage is not too problematic in the short term (Garcia-Gonzalez *et al*., 2016). In the long-term a way to avoid down-cycling would be to deploy CCU fuels as far as possible as industrial additives (Garcia-Gonzalez *et al*., 2016). To achieve End-of-Waste status, products of carbonation or mineralization processes must fulfil the WFD criteria, namely: (a) the substance or object is commonly used for specific purposes; (b) there is an existing demand for the substance or object; (c) the use is lawful; and (d) the use will not lead to adverse environmental or human health impacts. Waste incineration ashes and metallurgic slags as well as construction and demolition waste aggregates passed in 2010 the Joint Research Centre initial threshold assessment to be considered in the development of specific criteria (Villanueva *et al*., 2010). Subsequently, the industrial and research community must provide evidence about the leaching characteristics of aggregates from carbonation and mineralization to the European Joint Research Centre and DG Environment. Widespread progress can be achieved by replicating across Europe the third-party accredited testing procedure that the firm Carbon8 completed with the UK Environment Agency explained by Hills (2016). Further amendments beyond the 2016 WFD revision may not be needed as long as current proposals are adopted; namely, the classification of gaseous effluents as recyclable wastes; and the adaptation of the End-of-Waste specification to allow for the recycling of wastes and by-products by mineralization or other value-adding CCU processes.

4.2. European Emissions Trading Directive

To address the exclusion of CO_2 captured through CCU from ETS there are three options proposed by Garcia-Gonzalez *et al*. (2016) to amend the reporting methods and the relationship to Non-ETS sectors. Option 1 would be to take the outflow of emissions from an ETS source completely out of its ETS reporting total and to include in the reporting of the Non-ETS CCU installation only the amount of CO_2 that was not fixed in the product and thus emitted at the processing site. Several complications arise from this option. First, adding significant emissions to a non-ETS sector might make it more challenging for some countries to achieve emissions reductions in non-ETS sectors according to the targets in Effort Sharing Decision 2009/406/EG. Second, reporting at project level would be necessary since even the same kind of process can exhibit variations across different sites and the reporting effort would need a considerable cost-benefit analysis. Third, the emitter would not have an incentive to seek more efficient technology within its own process. Option 2 would be to include the CCU process in the EU ETS and report within the accounting of the CCU installation the emissions that were not fixed. The first complication of this is that the emitter would not have an incentive to seek more efficient technology. To solve this, administratively costly amendments would be needed to account for emissions even if they are not certificate-liable. In that way the emitter could be benchmarked and required to pay a fee if a certain efficiency standard is not attained. The second complication is the lack of incentives for the emitter to seek a high-fixation CCU partner with good Life-Cycle Analysis (LCA) performance. In this case the CCU installation would have an incentive to deploy the most efficient process possible. It should be borne in mind that most schemes will be shaped by local conditions anyway. Option 3 would be to keep the net CCU emissions within the EU ETS and within the accounting of the emitter. A disadvantage of this option is the cost of monitoring and reporting at project level in the non-ETS sectors affected. However the advantage of this option is that the operating principles of the ETS would undergo minimum alteration. Another advantage is that the emitter would have an incentive to seek efficient technologies for its own process and to look for a good-LCA CCU partner.

4.3 New Entrants Reserve 400

Inclusion of CCU in the forthcoming NER400 for the timeframe 2021-2030 is being recommended by the SCO_2T and the $EnCO_2re$ consortia. CCU demonstrations could be supported if the right criteria are defined in the programme and met by individual projects (Garcia-Gonzalez *et al*., 2016). A series of structured calls for CCU scale-up proposals may be a suitable additional mechanism to accelerate market development of CCU products as they progress along the innovation cycle towards commercial maturity (Armstrong *et al*, 2016).

4.4. Directives on Indirect Land Use Change, Renewable Energy and Fuel Quality

In 2016 DG Energy proposed a RES Directive recast COM(2016) 767. It included an obligation on fuel suppliers, which can reassure investors and encourage development of transport fuels including renewable liquid and gaseous fuels of non-biological origin. This encompasses fuels from waste fossil-derived gases and sets blending percentage obligations on suppliers at the same level in each Member State to ensure consistency in specifications, availability and ease of EU-wide trade. These proposals may be adopted a year after submission. They include CCU technologies such as Power to X, hydrogen, CO_2 and formic acid. Moreover the Fuel Quality Directive 98/70/EC, Article 7a (2), also requires by 31 December 2020 the reduction by at least 6% of the life cycle greenhouse gas emissions per unit of energy.

4.5 Infrastructure and connectivity

Infrastructure de-risking could be assisted through explicit support within demonstration projects and involvement of Urban Planning stakeholders in the discussion of climate, resources and energy policies. Cluster initiatives are plentiful but they seem to be mostly fragmented. However, many technical solutions depend largely on the assistance of coherent cluster formation support (GCCSI, 2011). Regional Research and Innovation Strategies for Smart Specialization (RIS3 strategies) are integrated, local economic transformation agendas that: (i) focus investments on key regional priorities for knowledge-based development; (ii) exploit regional potential for excellence; (iii) stimulate technology and execution innovations and private sector investment; (iv) encourage stakeholder experimentation; and (v) include sound evaluation systems. Regions can configure the RIS3 to prioritize the way they apply for structural development funds. Therefore the RIS3 are instrumental in de-risking industrial connectivity infrastructure. Pipeline infrastructure is a potential natural monopoly subject to land and subsoil rights which are the responsibility of regions. Industry should therefore advocate for including CCU infrastructure in the Connecting Europe Facility (CEF) leveraging parts of the regional strategies. Since January 2014, the Innovation and Networks Executive Agency (INEA) is the gateway to funding under the CEF. INEA implements most of the CEF programme budget, including €22.4 billion for Transport, €4.7 billion for Energy and €0.3 billion for Telecoms.

4.6 Additional recommendations

4.6.1 Dedicated performance measurement and support formula

CCU stakeholders, including some European officials, are interested in creating more clarity across CCU-related policies. It is proposed that to harness the environmental, societal and economic benefits of CCU there must be no distinction between biological CO_2 and other CO_2 streams and policies that encourage inter-sectorial use of CO_2 must be introduced (Ghinea, 2016). A formula and a tabular decision guide would help qualify technologies for CCU support. Conditions for support include that (i) it is verified that state aid is in fact needed and proportionate; and (ii) all cases where double support could emerge must be addressed accordingly (Velkova, 2016). Key criteria to consider are:

- Substitution effects, e.g. fossil fuel displacement
- Amount of CO_2 fixed per tonne of product
- Duration of fixation (strictly in the context of LCA substitution effects)
- Energy storage benefit
- Electricity network balancing
- Reduction of renewable energy curtailment

4.6.2 Creating a dedicated CCU Directive

Due to lack of definition and legal grounding for several CCU processes, most stakeholders consider that a dedicated CCU Directive would be appropriate (Lewis, 2016; Krämer, 2016). Before proposing a new directive it is necessary to acknowledge the already dense policy landscape and the existing CCS Directive (2009/31/EC) and to ascertain whether there is a genuine gap. Moreover, the diversity of CCU technologies due to different sources, value chain options, and economic sectors from petrochemicals to food, imply many possible overlaps and discrepancies, e.g. in double support for some options but not for others. A precedent exists in the consolidation of seven directives, including the Waste Incineration Directive and the Large Combustion Plant Directive, into the Industrial Emissions Directive, which helped to address inconsistencies across sectors. Aspects that justify a separate directive from the CCS Directive include the potential for significant waste recovery and feedstock production. Having a dedicated CCU Directive would provide investors the confidence that there is an established role for CCU technologies.

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