CO2 Capture Project

Policy Position Paper

Regulatory Treatment of CO_2 Impurities for CCS

The Issue

How to regulate the treatment of impurities in the captured CO_2 stream from an industrial source. Key sub-issues are:

- Whether CO_2 would be defined as a waste
- Whether impurities in the CO_2 stream should trigger waste management or hazardous waste management regulations in a specific regulatory regime.

Background

The combustion of fossil-fuels in power plants, boilers, and process heaters in manufacturing industries leads to the production of flue gases containing a wide variety of compounds, principal amongst which are CO_2, NOx, and volatile organic compounds. Flue gases may also contain a number of other compounds such as SOx, CO, O_2, H_2S, H_2O, carbonaceous particles (soot) and trace metals. CO_2 captured from gas-fired power plants will generally include significantly fewer other chemical compounds than CO2 captured from coal-fired power plants. Depending on the process employed other industrial processes (e.g. chemicals production, refineries) can create flue gases rich in CO_2, accompanied by a variety of other compounds,.

The following table illustrates typical compositions of flue gas from coal-fired (PC) and gas-fired (CCGT) power plants.

CO_2 Capture Project

Typical flue gas constituents from coal and gas fired power plants

Flue gas constituent	PC (% vol)	CCGT (% vol)
Carbon dioxide (CO_2)	14	4
Nitrous oxides (NOx)	80-85	85-95
Sulphur oxides (SOx)	1-3	<0.1
Carbon monoxide	1-3	1-3
Hydrogen sulphide (H_2S)*	-	-
Elemental oxygen (O_2)	1-3	1-3
Elemental nitrogen (N)	< 1%	< 1%
Mercury (Hg)	~60,000 mg / Nm^3	trace
Arsenic (As)	~5,000 mg / Nm^3	trace
Selenium (Se)	1,000 mg /Nm^3	trace
Hydrogen Chloride (HCl)	trace	-
Argon (Ar)	trace	trace
Vanadium (V)	trace	trace
Cadmium (Cd)	trace	trace
Lead (Pb)	trace	trace
Nickel (Ni)	trace	trace
Zinc (Zn)	trace	trace
Manganese (Mg)	trace	trace
Molybdenum (Mo)	trace	trace
Moisture (H_2O)	1-2	1-2
Particulates / dust	1	-

*may be present in reducing conditions under poor operating conditions
Source: ERM, compiled from a range of literature sources.

There is potential for CO_2 to be defined as an air pollutant, as a waste, or even a hazardous waste in a regulatory regime. The health effects of specific levels of CO_2 concentrations, particularly in partially enclosed or non-ventilated environments, for example, are well known and well regulated. To further complicate the issue, the captured CO_2 stream from an industrial or power generating facility containing a variety of other chemical compounds such as SOx, CO, O_2, H_2S, H_2O, carbonaceous particles (soot) and trace metals can be deemed as waste or hazardous waste, depending on their specific health, environmental, and safety effects. Attributes such as flammability, carcinogenicity, flash point, mutagenicity, toxicity, being an irritant, will likely trigger multiple health, environmental, and safe handling requirements in the operations of the capture facility, the transport of the CO_2 stream, and the monitoring of storage. For example, Directive 91/689/EEC sets the framework for management of hazardous waste in the EU. Annex II of the Directive lists constituents of the wastes which render them hazardous when they have the properties described in Annex III. Annex II includes:

C8 arsenic; arsenic compounds;
C9 selenium; selenium compounds;
C16 mercury; mercury compounds;
C19 inorganic sulphides;
C47 substances of an explosive character

Annex III lists wastes classified as hazardous, which are considered to display one or more of the properties as follows.

- Flash point<= 55 deg C
- One or more substances classified as very toxic at a total concentration >= 0.1%
- One or more substances classified as toxic at a total concentration >= 3%
- One or more substances classified as harmful at a total concentration >=25%
- One or more corrosive substances classified as R35 at a total concentration >=1%
- One or more corrosive substances classified as R34 at a total concentration >=5%
- One or more irritant substances classified as R36, R37, R38 at a total concentration >=20%
- One substance known to be carcinogenic of category 1 or 2 at a concentration >=0.1%.
- One substance known to be carcinogenic of category 3 at a concentration >=1%.
- One substance toxic for reproduction of category 1 or 2 classified as R60, R61 at a concentration >= 0.5%.
- One substance toxic for reproduction of category 3 classified as R62, R63 at a concentration >= 5%.
- One mutagenic substance of category 1 or 2 classified as R46 at a concentration >= 0.1%.
- One mutagenic substance of category 3 classified as R40 at a concentration >= 1%.

With the EU Directive on hazardous waste management as an example, H_2S of 3 vol% would trigger the CO_2 stream to be a hazardous waste stream.

CO2 Capture Project

Implications for Industry

The main implications for industry are associated with the different potential regulatory treatment of CO_2 and any impurities that may be present.

Effects of Impurities on Transportation and Storage
Impurities may have corrosive effect on equipment in transport and on the storage reservoir. In transport, corrosiveness of the impurities may require new standards of pipelines and transport equipment. In storage, corrosiveness may either enhance or weaken the trapping and sealing of CO_2 in specific geologic formations. Further, health, environment and safety issues will need to be addressed if leakage of the CO_2 and the impurities occur

CO2 Defined as a Waste
This will trigger regulatory requirements in waste management in many countries. The direct effect of this will likely be increased siting, permitting, and monitoring requirements for pipelines, trucks, and ship transport. Further, the key issues in the international conventions such as OSPAR and the London Convention will focus on CO_2 as a waste, its manner of placement, and its source. Depending on these attributes, CO_2 injection into the deep geological formations under the seabed may be prohibited.

Disincentive for CO_2 Capture and Storage Investment
Widespread deployment of CO_2 capture will likely mean the co-capture of other chemical compounds in the process gas from industrial facilities, in exhaust gas from heaters, boilers, and turbines. To avoid triggering hazardous waste regulations, these constituents in the gas will have to be scrubbed to trace levels that will increase costs significantly for capture plant operators. If the CO_2 stream is not scrubbed, costs may increase for the storage site operators, who may ultimately pass along these costs to the capture plant operators. Alternatively, a special class of CO_2 storage sites regulated as hazardous waste storage sites to handle these other compounds may be more expensive to operate and thus the increased costs are passed directly to the capture plant operators. These increased costs may discourage the early, widespread deployment of CO_2 capture and storage technology.

CCP2 Recommended Principles

The following principles should be considered in responding to regulatory proposals addressing the CO_2 as waste and the CO_2 co-captured with other chemical compounds issue. They are based on the assumptions that CO_2 capture and storage technology should be deployed widely and early at the lowest cost in order to be a significant contributor to global greenhouse gas emissions.

CO₂ Capture Project

CO_2 Defined as a Waste

- CCP2 opposes regulatory proposals that label pure CO_2 as a waste, particularly as a hazardous waste. Consistent arguments can be made based on sound science that CO_2 is a useful feedstock to industrial chemical reactions and a feedstock in biological and chemical processes occurring in nature. If labeled as a waste, CO_2 should not be deemed hazardous in its normal background concentration in ambient temperature and pressure.
- CCP2 supports the inclusion of an assessment of CO_2 transport, injection, and storage as part of any environmental impact assessment that is normally conducted in the permitting process of a project.
- Reservoir modeling, done as part of the siting and permitting of the storage facility, should be used to demonstrate the effectiveness of CO_2 containment.

CO_2 Stream Co-captured with Other Chemical Compounds

- CCS Project operators may be liable under existing tort systems for proven personal injury or property damages a) reported in timely fashion and b) related to the potential adverse direct health and environmental effects of CO_2 and other chemical compounds in the CO_2 stream in concentrations above ambient levels or to catastrophic failure of the storage facility during the operational period.
- CCP2 advocates a position consistent with the protection of health and safety of workers and the local community, and the protection of the environment surrounding the capture, transport, and storage facilities. The concentrations of these compounds in the CO_2 stream should be reduced cost-effectively to levels posing no immediate harm to workers or the local community.

Regulation Development and Administration

- Regulations for impurities co-captured with the CO_2 and the containment of this CO_2 mixture should be developed and administered at the national level to promote compliance efficiency.
- The development of regulations related to impurities co-captured with CO_2 storage should be based on best available technical and scientific understanding and should include the participation of industry and other key stakeholders.