POSITION PAPER

PARIS COP21 - 2015

Climate change and CO_2 management

LOCAL SOLUTIONS FOR THE SHORT TERM, GLOBAL SOLUTIONS FOR THE LONGER TERM

Carbon dioxide emitting industries, energy production groups, research organisations and all members of the Club CO_2 concur as to the anthropogenic origins of climate change and the possible solutions to remedy its effects.

The CCUS technology enabling CO_2 to be captured, transported, used and stored is a key solution to reduce carbon emissions and CO_2 concentrations in the atmosphere.

However, applying this technology on a massive and global scale is faced with a major obstacle. CO_2 capture, which is now technically mature, is being considered today to handle volumes that not only far exceed possibilities for re-using the CO_2 in different industries, but also the capacities that have been confirmed across the world for underground storage of CO_2 in the vicinity of the main emitting regions.

FOCUS ON CLUB CO_2

Club CO_2 is a forum for exchanges of information and initiatives concerning CO_2 capture, transport, underground storage and re-use (CCUS) between industrial, research and local government players in France.

Fore more informations, see the website :
www.captage-stockage-valorisation-co2.fr/en

This is why all the Club CO_2 members suggest three lines of action to the French public authorities :

1. **In order to set up practical projects** of reasonable size with real benefits for the environment and for employment, **synergies must be developed and sustained between bioenergy, geothermal energy, renewable energy and CO_2 capture, use and storage.** The strong regional and local dimension of such projects will firmly anchor the fight against climate change in local areas and reflect the commitment of industries to the circular economy.

2. **In order to slash CO_2 capture costs** well beyond what is achievable by continuing to improve techniques that are already mature, **support to the development of research projects on breakthrough capture technologies** will secure a leading position for French industry in the CO_2 capture domain.

3. **Because of the high degree of uncertainty over the technical and economic feasibility of large-scale underground storage** of CO_2 by 2050, **a worldwide programme must be jointly defined or catalysed** to produce an assessment of capacities and to conduct full-scale, fully secure injection tests in the most promising zones, particularly in deep saline aquifers.

To fight successfully against climate change, Club CO_2 believes that actions must be taken simultaneously through simple projects for both the short and the long term.

Position paper to the french public authorities to support CCUS

The 21st United Nations Framework Conference on Climate Change (COP21), organised in Paris in December 2015, is a crucial opportunity to issue recommendations on CO_2 capture, utilisation and storage (CCUS), which are set out below under 4 headings:

- capture
- storage
- utilisation
- economic, social and regulatory environment

To act on climate change, a portfolio of different technical solutions will need to be deployed. Among these, capturing CO_2 released by fixed emission sources such as power plants and manufacturing industries to store it underground (CCS technology, CO_2 Capture and Storage) could help to achieve emission reduction targets.

According to the International Energy agency (IEA), keeping average global temperature rise below 2°C would require the deployment of CCS technology, which would cut cumulative CO_2 emissions to 2050 forecasted worldwide by 13%.

Globally, the power production and petroleum industries are currently the largest, but not the only, investors in CCS research. France's atypical power production system (low overall CO_2 emissions due to the large share of nuclear power in the energy mix) by no means prevents different players (from all sectors) from becoming involved in CCS.

In France, both industrial and academic players are closely involved in the practical implementation of carbon capture and underground storage projects around the world. France has already hosted several CCS research pilots: an integrated carbon capture, transport and storage project at Lacq-Rousse undertaken by TOTAL, and two pilot carbon capture projects, conducted by EDF/Alstom in Le Havre and by Air Liquide in Port-Jérôme.

In June 2014, Club CO_2 organised meetings in Le Havre between European players to share experience gained through these pilot projects and other operations undertaken in Europe in recent years, with a view to developing recommendations for the emergence of a CCS sector.

In addition to CCS activities, CO_2 can be converted into a source of raw carbon for the manufacture of high added value products or fuels or materials . "CO_2 conversion" currently only applies to 0.5% of the CO_2 released worldwide but the figure could reach 2 to 4% in coming years. This in itself would not resolve the climate problem, but it opens up economic prospects of significant interest.

The new «CO_2 conversion technologies» sector contributes to some of the 10 solutions launched in 2013 by the French President and the Minister for the Economy, Industry and Digital Affairs, such as the «Usine du Futur» (manufacturing industries of tomorrow) and «Nouvelles Ressources» (new resources) initiatives.

In May 2015, as a CCS symposium side event, Club CO_2 organised a workshop at Le Havre for meetings between internationally reputed French experts on the potential for developing new CO_2 conversion technologies. The aim was to identify opportunities and obstacles in the areas of social acceptance, life cycle analyses, regulatory development and industrial ecology.

The «Grenelle 1» Act of 2009 established CCS as one of the options to be developed to reduce carbon dioxide emissions. The ADEME, which in 2008 set out a national CCS roadmap for 2020, issued a revised version in 2011 looking to 2050 and including CO_2 conversion technologies. In 2010, the Ministry for Ecology identified CCS as a strategic industrial sector for the green economy, aiming to establish a market in France and internationally. The «Energies 2050» report issued in early 2012 confirmed the strategic potential of CCS under different scenarios and advocated strengthened R&D efforts and the introduction of incentives to promote its development.

NB : this is a collectively produced document that does not necessarily reflect the individual strategies of the different Club CO_2 members.

Recommendations on CO_2 capture

Since 2000, numerous pilot and demonstrator projects (in France and elsewhere) have proven the technical feasibility of several processes for capturing the CO_2 in flue gases:
- using solvents (amines or refrigerated ammonia) or by adsorption,
- after combustion of a highly CO_2-enriched oxy-fuel mixture,
- via a combined gas cycle with integrated gasification.

Both new and existing installations (after adaptation) have been operating for many thousands of hours, in natural gas processing plants, coal-fired power plants, steel plants and other industrial facilities that release CO_2, enabling assessments of the variations in carbon prices and the carbon footprints of goods produced by carbon-emitting industrial processes when carbon capture technologies are implemented. The carbon footprint drops significantly despite the additional energy consumption of capturing processes.

Some of these carbon capture processes have recently become industrialised, as in the Saskpower Boundary Dam facility in Canada (1 million tonnes of CO_2/year (1Mt/year) captured for storage and enhanced oil recovery), at a coal-fired power plant commissioned in September 2014 and at the Air Liquide CRYOCAPTM facility in Le Havre commissioned in November 2015 (100 000 tonnes CO_2/year (0.1 Mt/year)).

To ensure rapid and large-scale deployment of CO_2 capture, certain activities will need to be implemented very soon:

1 Improve the energy efficiency of carbon capture processes:

Reducing the energy consumption of carbon capture processes will be critical in the coming years. Incremental improvements in current processes should bring progress (through better thermal integration for example) but the most promising avenue is the development of new breakthrough capturing processes involving cryo-technology (cryo-condensation), new chemical solvents, gas separating membranes or oxy-fuel combustion.

2 Improve the energy efficiency of industrial processes:

In high-emission industrial sectors, other possibilities are being explored in addition to carbon capture, such as improved energy efficiency, alternative raw materials, etc.

Recommendations on CO_2, geological storage

A significant number of pioneering projects for CO_2 injection in deep geological layers have demonstrated the feasibility of carbon dioxyde storage, given also the existence of numerous CO_2 fields.

In Europe, the results of pilot CO_2 storage projects for research purposes conducted over recent years (Rousse – France, K12B – Netherlands, Ketzin - Germany and Hontomín – Spain) are all concluding that CO_2 injection and permanent storage in the subsoil is technically feasible provided that appropriate storage reservoirs and site monitoring and safety techniques are used. On the industrial scale, the injection sites at Sleipner (1Mt/year since 1996) and Snøhvit (0.8 Mt/year since 2008) in Norway have demonstrated the safety and reliability of their CO_2 injection operations. Similar experience has also been gained elsewhere in the world: 15 industrial-scale CCS projects are currently operating, injecting each, a total of 1Mt CO_2 per year.

However, in order to contribute significantly to climate change mitigation, CCS needs to be deployed in several thousand storage sites across the world. The needs for CO_2 storage are vast, amounting to 8000 million tonnes per year (Mt/year) by 2050 according to the International Energy Agency (IEA), which will require 2000 times more capture and storage capacities than those currently operating. Most of these storage capacities will be in deep saline aquifers.

To ensure rapid and large-scale deployment of CO_2 storage, certain activities will need to be implemented very soon, with international cooperation to be encouraged:

1 More accurate estimations of storage capacities:

- The development of CCS is highly dependent on storage capacities that can be connected to the main CO_2 emitting regions across the world. According to the CCS roadmap published by the IEA in 2013, about 120 Gt of CO_2 will need to be captured and stored by 2050, including one third in China, one sixth in North America and one tenth in Europe and India.

- A common international framework ensuring accurate and reliable estimations of storage capacities is vital. This would need to guarantee the homogeneity and consistency of the methods used (which currently vary between countries) and must also, unlike existing methods, take the time factor into account, i.e., how much CO_2 can be injected over a given period (e.g. 40 years). International cooperation is therefore essential in order to propose and apply a shared methodology for estimating storage capacity in deep saline aquifers across the world.

- Furthermore, explorations should begin immediately to locate the most favourable zones and define their actual capacities. Because of the time required to complete characterisation studies, from initial surveys to authorisation, the process should be shortened as much as possible by launching the first phases as of now, to allow CCS deployment in the medium term.

2 Increase the number of pilot and demonstration projects to gain more field experience:

- New pilot and demonstration sites are needed to increase experimental feedback on the behaviour of a wider variety of geological sites and thus optimise all project phases, from characterisation to operations and surveillance through to sealing. Pilot sites are set up on a small scale to test specific aspects for research purposes, while full-scale demonstration sites are used to prove the feasibility of large-scale storage operations and to test the technologies under normal operating conditions.

- Only injection operations in actual sites will be able to bring significant technological and methodological progress, quantify uncertainties, reduce costs and implementation times and secure the confidence of investors and citizens.

Recommendations on CO_2 Utilisation

CO_2 utilisation involves a serie of technologies that use carbon dioxide as a raw material. CO_2 is a potential resource for manufacturing processes that require biological or chemical transformation (materials, chemical intermediates, plastics, fuels).

These technologies aim to develop the value of CO_2 for three purposes:
1. Environmental, by reducing fossil fuel consumption and CO_2 emissions.
2. Economic, by promoting the emergence of robust and sustainable business models using CO_2 as a raw material.
3. Social, by creating jobs and promoting better health (use of CO_2 as a substitute for toxic substances).

This paradigm shift will require the deployment of a portfolio of breakthrough conversion technologies. The strength of these technologies lies in the very wide range of applications for products derived from CO_2, in terms of both the geography of world markets and their size (niche as well as mass-market applications).

In 2014, the world market for CO_2 amounted to some 180 million tonnes (excluding EOR [1]), essentially for agri-foods. **While CO_2 recycling alone will not resolve the global issue of CO_2 emissions (37 billion tonnes in 2014),** it complements current strategies and will catalyse the deployment of CO_2capturing technologies.

Long-term forecasts indicate total worldwide CO_2 recycling capacities of 1.5 billion tonnes, particularly through mineral carbonation and as a vector for chemical energy storage.

Club CO_2 is committed to making every effort to develop a new value chain based on CO_2 utilisation.

Club CO_2 sets out the following recommendations to contribute to the emergence of this new sector:

1 Promote an industrial ecology approach:

- In the industrial ecology approach, future industries making use of recycled CO_2 must be established close to the emission sources. Integrating the French industrial network in this way will contribute to the development of a locally-based and circular economy and to the competitiveness of conversion processes.
- The direct use of CO_2 captured from flue gases and appropriately treated should be given priority to keep down the costs of its use : algae production, greenhouses and mineral carbonation are some of the applications to be targeted as a priority.
- The potential for job creation will need to be quantified as soon as possible.
- The deployment of CO_2 conversion technologies would preserve industrial sites in France that might otherwise close down, causing carbon leakage.

2 Differentiate CO_2 utilisation from conventional fossil resource saving :

- While industries under carbon quotas have incentives to reduce their CO_2 emissions, there are no incentives for CO_2 utilisation.
- To develop a value chain for CO_2 utilisation that benefits people as well as the environment, one or more ways of differentiating this value chain or its products from the existing schemes for chemicals, materials or energy will need to be developed.

3 Improve life cycle analyses (LCA) for innovative processes and products:

- A simple, moderately resource-intensive and widely acceptable LCA methodology needs to be developed to assess the environmental impacts of manufactured products involving CO_2 utilisation.

4 Keep on course towards a low-carbon energy policy in France:

- The French energy mix is almost carbon free (108 g CO_2/kWh) and therefore particularly conducive to the development of CO_2 conversion processes.

[1] EOR : Enhanced Oil Recovery

Recommendations on the economic, social and regulatory environment

As emissions from certain processes are virtually unavoidable in some sectors, CCS could be the only viable option for direct emission reductions in industrial sectors in the long term, while also providing for the necessary flexibility.

However, at present the CCS sector is adversely affected by low CO_2 prices on the EU emissions market (ETS), by the low priority given to climate change (especially on the solutions side) and by concerns over the long-term safety of underground CO_2 storage sites.

Club CO_2 sets out the following recommendations to contribute to the emergence of this new sector:

1 Develop a strong position from the public authorities in favour of CCS :

- The population is not generally familiar with CCS. Its merits are in debate and questions are being raised in some quarters as it is linked to fossil resource extraction (scarcities, pollution). Efforts are needed to promote consensus in society and to explain that CCS is essential to reach the emission reduction targets that will keep climate warming below +2°C. This will imply the introduction of a wide-ranging awareness campaign in civil society (through scientific mediation, education, etc.).
- Regarding the concerns over the geological storage of CO_2, it must be made clear that well chosen geological sites can securely trap large quantities of CO_2, as shown by the large number of existing natural CO_2 fields, and that efforts must be intensified to locate and characterise appropriate sites and to refine operational methods for injecting the CO_2 as well as integrated risk management methods.
- A long-term (> 20 years) policy should be anticipated, based on a shared vision within France.
- European policy should be completed by incorporating CO_2 utilisation.
- CO_2 conversion technologies should be encouraged.

2 Promote investments in CCS technologies

Current ETS carbon prices (7-8 €/t CO_2 emissions) are too low in relation to the costs of CO_2 capture, transport, storage and conversion: in general, the cost of capturing, transporting and storing CO_2 varies from €60 to €120 per tonne, including 60% for capture alone.

The emergence of these technologies requires:

- **Stable and attractive CO_2 prices on the ETS and similar markets.**
- Investment support, through zero-interest loans and investment vehicles for infrastructure and networks and process industrialisation.
- An appropriate fiscal policy: Reduced VAT rate; CO_2 saving certificates.

3 Pursue research, development and innovation efforts in order to :

- Lower the costs of CCUS.
- Improve the environmental benefits of the processes and products developed.
- Promote and facilitate research cooperation between the public and private sectors in France, Europe and internationally.

4 Build up a dialogue with all stakeholders :

- To promote and identify the CCUS value chain, there will be a need to identify and build up a network between all stakeholders, including civil society representation. Decision-making is the crucial issue.
- Sharing knowledge in order to organise social consultations effectively and constructively.
- Information and knowledge on climate change, CO_2 and CCUS need to be disseminated through the education system, in civil society and among industries and entrepreneurs in order to assess potential synergies.

5 Define a protocol to determine the size of the financial reserve required to transfer the responsibility of operators for underground CO_2 storage sites to the State:

- An EU directive and a number of regulatory provisions enabling underground CO_2 storage are already in place. Work on international standards (ISO) is under way to define the good practice and performance required at each stage, from capture to transport and storage. The main obstacle identified to date relates to ways of identifying the size of the financial reserve to be provided for when responsibility for the storage site is transferred from the operator to the State. The size of the financial reserve must be determined in accordance with the nature of the project via the definition of the geological risk (drawing on measures already in place in other countries).

6 Covering the geological risk:

- As indicated in the data sheet on storage, further research work is needed to produce accurate and reliable assessments of the potential of storage sites in deep saline aquifers. The geological risk involved in implementing a project needs to be covered by a supporting mechanism (of the risk insurance type). The «geological risk» is related to the substantial initial investments required to cover the high costs of drilling, and to the risk of drilling into rock that does not correspond to the characteristics anticipated and so does not allow the planned operation to proceed. A risk coverage fund that can guarantee partial reimbursement of the costs incurred if results do not meet expectations, similar to the "Heat Fund» introduced to cover the risks of geothermal operations, should be put in place for CO_2 storage.

7 3D planning of subsurface uses:

- It is important to investigate the possible interactions between underground CO_2 storage and other uses of the subsurface such as fossil fuel and geothermal energy production and energy storage, to avoid use conflicts and/or develop synergies between different uses. The foreseeable increase in subsurface uses to support the energy transition will require 3D planning to ensure that they are sustainable and efficient while preserving the quality of the groundwater abstracted for drinking water.

8 Developing synergies with renewable energy production:

- Prospects for coupled CO_2 storage and geothermal heat extraction are promising and should be encouraged.
- Combining CCUS with renewable energy production from biomass (Bio-CCS or BECCS) is another promising avenue, since the CO_2 stored is atmospheric CO_2 absorbed by plants via photosynthesis. This opens the way for capturing CO_2 from the atmosphere to store it underground, leading to what the IPCC refers to as the "negative emission scenarios" that are also needed to keep global warming below +2°C.

- CCUS technology could also play a role in the storage of the surplus electricity produced intermittently by certain types of renewable energy. This «power to gas» concept is one of the possible applications of CO_2 recycling, in this case via water electrolysis to produce hydrogen, which can then be combined with CO_2 to produce synthetic gas or liquid fuels (such as methane, methanol, ethanol or DME) that can be easily transported, stored and distributed, mainly through infrastructure that already exists. These synthetic fuels could then become substitutes for fossil resources. CCUS could thus affect not only fixed emission sources, but also the transport sector.

9 Integrating CCUS into socio-economic activities at the regional and local scales:

- Looking ahead to the transition to green growth, CCUS should be included in the Climate and Energy Plan and in socio-economic activities at the regional and local scales, involving both CO_2 emission sources and users.
- Strategic plans should be set out for the development of CO_2 storage and associated transport infrastructure connecting CO_2 emission sources, users and storage sites.
- At the local level, it is important to organise consultations well upstream and ensure that citizens participate in decision-making, so that the population can contribute to the development of solutions for sustainable development in their local areas.

Members of ClubCO_2:

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To find out more :

Website of Club CO_2: • More informations +

Websites for more information on CCS pilot/demonstrator :

Lacq-Rousse Project • More informations +

Summary of RD and demonstrators projects funded by ADEME • More informations +

CRYOCAPT™ Project • More informations +

K12-B Project • More informations +

Website of CO_2GeoNet association • More informations +