



# **Report on the TRM Area #8a CO<sub>2</sub> Utilization, non-EOR**

David Savary (Club CO<sub>2</sub> / France) presented by Didier BONIJOLY

Technical Group Meeting

Regina, Canada

June 15, 2015



# Reminder of TRM 2013

## 3. Assessment of 2013 Situation :

- 3.6: Utilization [non EOR]:
  - CO<sub>2</sub>-enhanced hydrocarbon recovery: enhanced coal bed methane production (ECBM), enhanced gas recovery (EGR), enhanced gas hydrate recovery (EGHR), hydrocarbon recovery from oil shale and the fracturing of reservoirs → @ pilot-scale
  - Geothermal energy systems
  - Carbonate mineralization
  - Red mud neutralization
  - Urea, Methanol, Formic Acid production
  - Utilization in greenhouses
  - Polymers
  - Algae cultivation



## Reminder of TRM 2013

### 4. Identified Technology Needs :

- 4.5.1: Recommendation 8: CO<sub>2</sub> Utilization:
  - **Establish methods and standards** that will increase and prove the permanent storage of CO<sub>2</sub> in EGR, ECBM, EGHR and other geological applications if CO<sub>2</sub> injection becomes more prevalent in these applications.
  - **Research, evaluate and demonstrate carbonation approaches**, in particular for mining residue carbonation and concrete curing, but also other carbonate mineralization that may lead to useful products (e.g. secondary construction materials)
  - **Map opportunities, conduct technology readiness assessments and resolve main barriers** for the implementation of the CO<sub>2</sub> utilization family of technologies including life-cycle assessments and CO<sub>2</sub> energy balances.



## Reminder of TRM 2013

### 4. Identified Technology Needs :

- 4.5.1: Recommendation 8: CO<sub>2</sub> Utilization:
  - **Increase the understanding of CO<sub>2</sub> energy balances** for each potential CO<sub>2</sub> re-use pathways and the energy requirement of each technology using technological modelling.
  - **Address policy and regulatory issues** related to CO<sub>2</sub> utilization, particularly in enhanced hydrocarbon recovery.



# Insights of TRM 2017

- **Assessment of present situation:**

In 2014, the worldwide CO<sub>2</sub> market has reached approximately **180 million tons per year** (Aresta *et al.*, 2013 in Armstrong and Styring, 2014): 114 million tons are used for urea, *circa* 50 million tons for inorganic carbonates and 8 million tons for methanol production. The remaining CO<sub>2</sub> is used for DME (DiMethylEther), TMBE (TertMethylButylEther) and formaldehyde production.

CO<sub>2</sub> Utilization will favor the deployment of the CO<sub>2</sub> capture technologies while reducing concentrated emissions. Long-term forecasts are estimating carbon dioxide uses from **1.5 billion tons per year** (CO<sub>2</sub> Forum, Lyon, Sept. 2014) to **5.3 billion t/yr** (the latter figure for China only) (China, CSLF, 2015).

Who's developing CO<sub>2</sub> Utilization ? Stakeholders are **universities** and national research organizations, startups, **major industrial companies**, public-private **consortia**,...There's also a rising interest from **NGO**. The **biological transformation** and the **chemical transformation** of CO<sub>2</sub> are investigated. Regarding the latter, there are two pathways: on the one hand the **functionalization** of CO<sub>2</sub> (for production of chemicals, construction materials) and on the other hand its reduction into **energy products** (methane, methanol, formic acid, ethers...).



# Insights of TRM 2017

- **Assessment of present situation:**

Many pilot- and demo-scale units, **deployed worldwide**, have just started or are about to start. They're aiming at manufacturing:

- Renewable Methanol, DME, MEG (MonoEthyleneGlycol), Acrylic acid, Secondary Amines, DMC (DiMethylCarbonate), DEC (DiEthylCarbonate), formic acid,
- Polypropylene carbonate, Polycarbonate, Polyols for Polyurethane production
- Mineral aggregates, sodium carbonate

Developments of **Power to Gas/Power to liquid fuels and the development of bioprocesses** will be of a paramount importance in the next decades.

**Recent reviews** of utilization of CO<sub>2</sub> are JRC (2013), ADEME (2014), aiming at assessing economical and environmental benefits of 3 CO<sub>2</sub> Utilization routes, Styring et al. (©2015). A **high number of conferences, summits, workshops** are organized in that area.



# Insights of TRM 2017

- **Identified needs:**

The CO<sub>2</sub> Utilization routes should have a triple value:

- **An environmental value:** a lower fossil fuel consumption, less CO<sub>2</sub> emissions for the new processes or products developed,
- **An economic value** based on strong and reliable bussiness models. CO<sub>2</sub> Utilization is the key for a circular economy based on carbon. It is a valuable raw material,
- **A societal value**, with the development of employment and the protection of human health. CO<sub>2</sub> capture for its utilization will also limit SO<sub>x</sub>, NO<sub>x</sub>, heavy metals and dusts emissions). It should also decrease the health hidden costs.

Recommendations:

- Promote the **industrial ecology**: ecoparks will help companies and industries exchanging raw materials, CO<sub>2</sub>, energy so as to bring **competitiveness** through a **local and circular economy**.
- **Differentiate the CO<sub>2</sub> utilization routes from conventional routes**: as current CO<sub>2</sub>-based products are more expensive, a « premium » should be given to the CO<sub>2</sub>-based products (e.g. label).



# Insights of TRM 2017

- **Identified needs:**

Recommendations:

- Efforts in the field of research, development and innovation should be continued so as to :
  - **Decrease the cost of capture, purification, liquefaction and transportation**
  - **Decrease the transformation cost** of CO<sub>2</sub> (improve the know-how on thermo-kinetics of reactions with or without catalysts)
  - **Improve the environmental impacts** of new processes for CO<sub>2</sub>-based products manufacturing
  - **Promote and facilitate public-private collaborations**
  - **Consolidate** the scientific and technological knowledge for a **clear societal dialogue**
  - All the routes detailed in Slide 5 and 6 should be investigated.



# Insights of TRM 2017

- **Identified needs:**

Recommendations:

- **Life Cycle Assessments:** new routes vs conventional routes for producing a chemical :
  - All the CO<sub>2</sub> Utilization routes don't have the same environmental impacts. That's why a **light methodology must be developed** and accepted by all stakeholders to compare routes.
  - Moreover, LCA results vary, depending if we consider a « cradle to gate » or a « **cradle to grave** » approach.
- **Support investments in the CO<sub>2</sub> Utilization sector:**
  - Carbon pricing must be clarified and generalized, it should have a stabilized and incentive price.
  - 0% loan must be developed.
  - As the processes are capex-intensive, investments must be supported by industrial and third-parties.



# Insights of TRM 2017

- **Identified needs:**

Recommendations:

- **Build the dialogue:**
  - National networks gathering all stakeholders should emerge, bringing together companies, policy makers, regulators, investors, civil society representative, to **create a debate** and **take appropriate decisions**.
  - **Data and knowledge on CO<sub>2</sub> Utilization must be widely spread** : In the educational system, within the civil society, between major companies so as to assess potential synergies.



**Questions ?**