Storing CO_2 in deep saline aquifers as part of integrated territorial energy and climate plans

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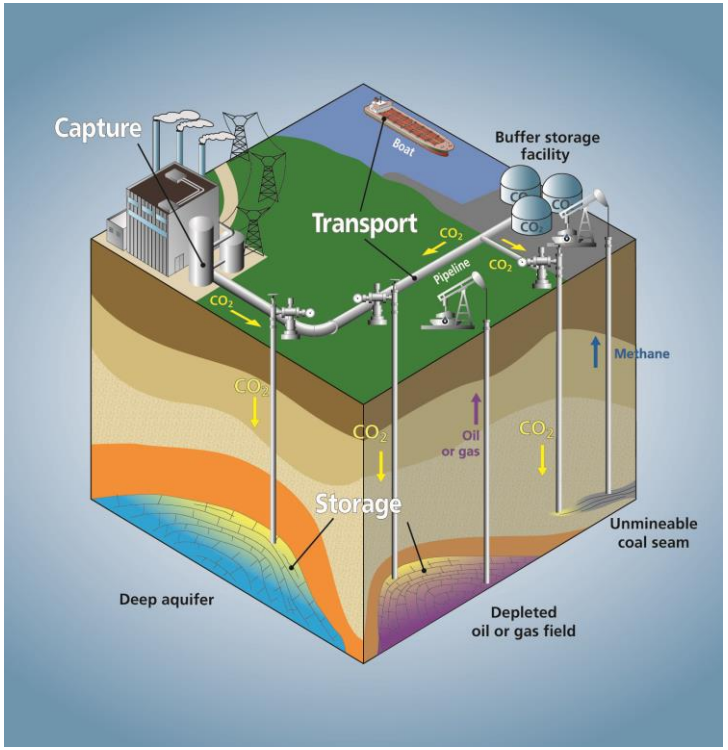
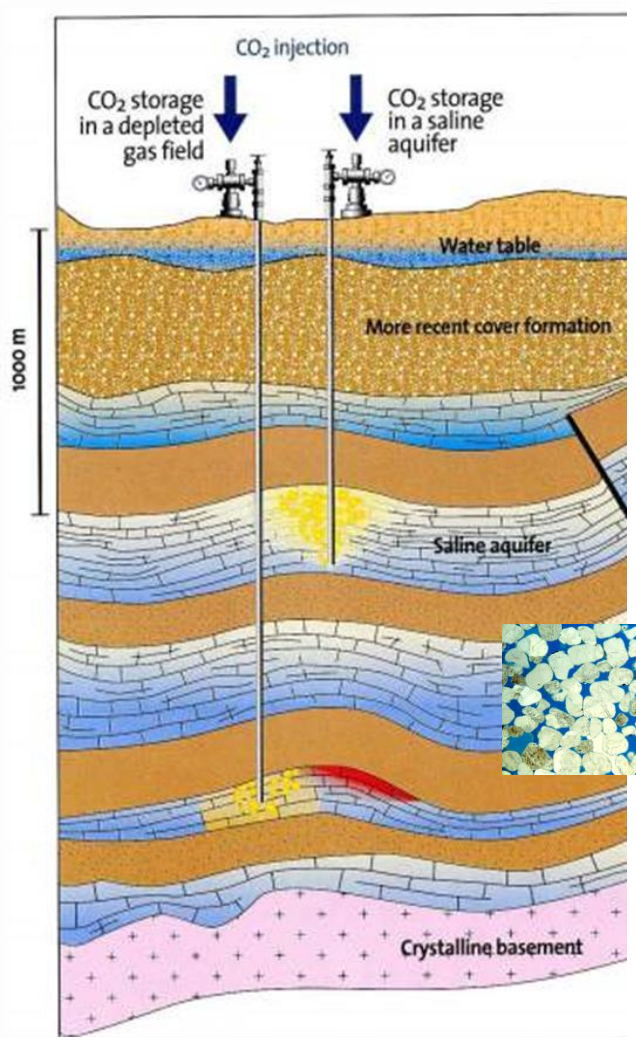
CO_2 Capture and Storage (CCS), a key climate change mitigation technology



3 steps :
- Capture
- Transport
- Storage



> Storing CO_2 underground:

- **to reduce emissions** from fossil-fuel power plants and carbon-heavy industries (steel and cement plants…)
- **to achieve negative emissions**, e.g. where CCS is applied to bio-energy plants, as the growing biomass removed CO_2 from the atmosphere

= Returning the carbon back into the underground!

A high level of confidence: CO_2 storage can be done safely

- Large cooperative research programmes on CO_2 geological storage since 1993
- Studies of many natural CO_2 accumulations in the subsurface
- Pre-existing know-how of the Oil & Gas industry:
  - Enhanced Oil Recovery (EOR) by CO_2 injection
  - Seasonal natural gas storage (CH_4)
- Pioneer large-scale industrial CCS projects: Sleipner (Norway) from 1996, Weyburn (Canada) from 2000, In Salah (Algeria) from 2004, etc.
- Small-scale CO_2 storage pilots: Frio (USA), Nagaoka (Japan), Ketzin (Germany), Otway (Australia), K12B (NL), Lacq-Rousse (France), Hontomin (Spain), etc.
- Development of best practice manuals
- Networking & knowledge-sharing activities at national, European and international levels
- Development of laws and regulations, such as the EU Directive on the geological storage of CO_2 (2009), ISO norm soon

15 large-scale « commercial » CCS projects currently in operation

- Over 20 Mt CO_2 per year are captured and injected in the underground
- Over 50 Mt CO_2 already stored underground

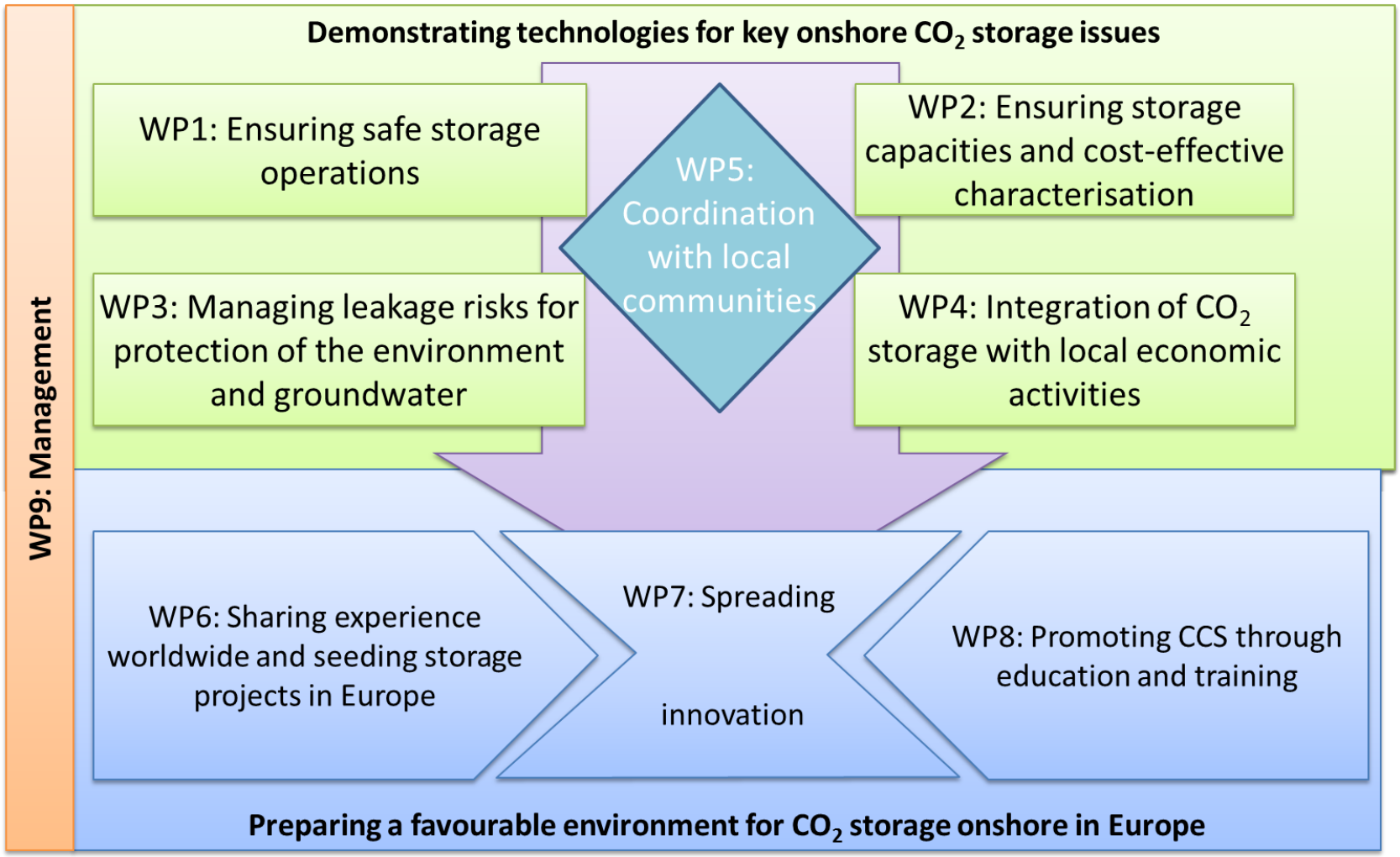
Source: *Large Scale CCS Projects* database, Global CCS Institute (2015)

FP7 project (2011-2015) Understanding the Long-Term fate of geologically stored CO_2

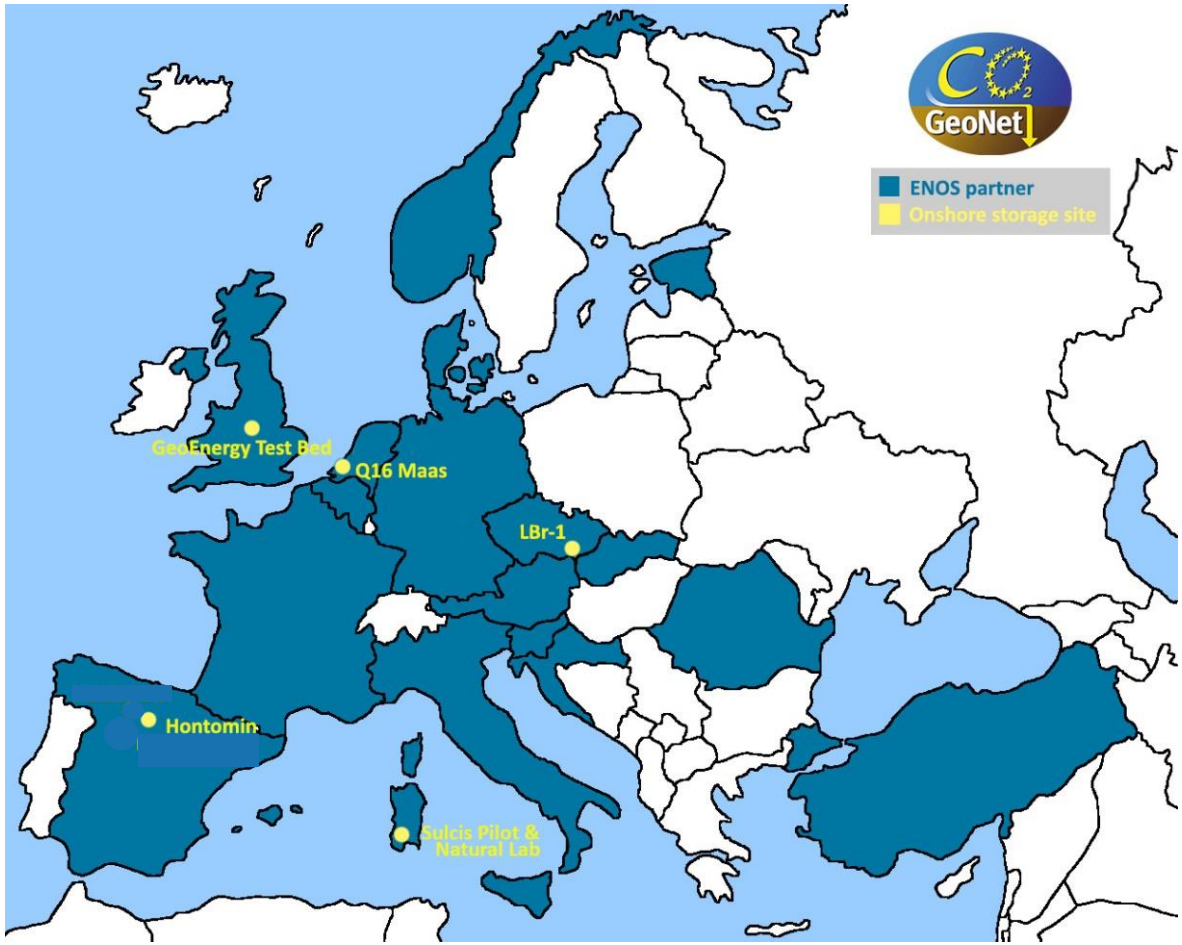
Guidance Report

- Basic scientific facts and generic lessons learned from 4 years of collaborative research amongst 12 partners
- Technical criteria for establishing the conditions under which CO_2 can be permanently stored in the long term
- Context = transfer of responsibility of a CO_2 storage site after site closure, between CO_2 storage operators and the Competent Authority of the Member State
- Relevant for regulators & policy makers, and CO_2 storage operators who need to meet the **3 requirements** to demonstrate permanent containment, as required by the EU CCS Directive:
  1. The conformity of the actual behaviour of the injected CO_2 with the modelled behaviour;
  2. The absence of any detectable leakage;
  3. That the storage site is evolving towards a situation of long-term stability

H2020 ENOS project (Sept.2016 – Aug. 2020)
« ENabling Onshore CO_2 Storage in Europe»



ENOS key characteristics

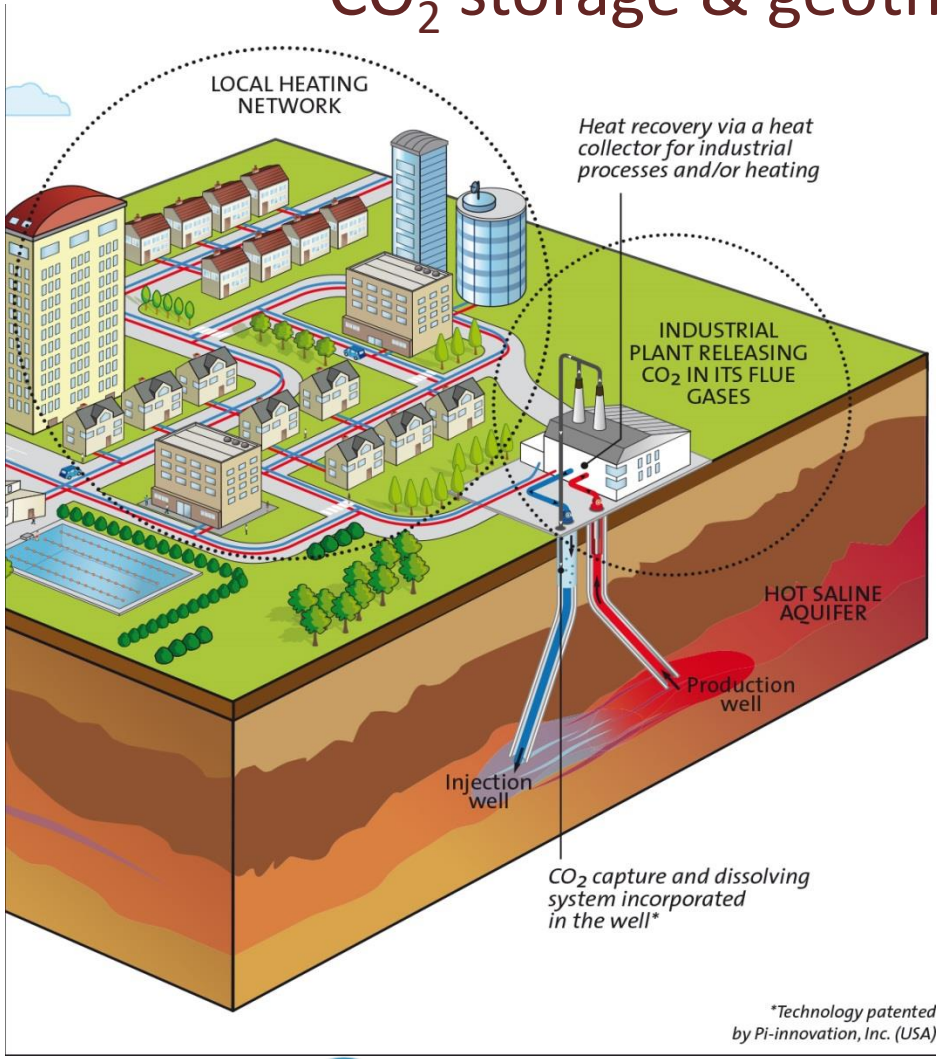


ENOS sites for real-field experiments

- Coordination : BRGM (Marie Gastine)
- An initiative of CO_2GeoNet
- Supported by the EERA CCS Joint Programme
- A pan-European effort with 17 countries involved
- 4 year project started on Sept. 1st, 2016
- H2020 grant: 12.6M€

PILOTE-CO_2Dissolved – a Geodenergies project

Towards a demonstration pilot coupling CO_2 storage & geothermal heat production



- A safer CO_2 storage approach, as CO_2 is stored entirely in a dissolved form
- Economic and environmental benefits from the local use of the extracted geothermal heat
- Applicable only in areas with geothermal potential
- Well suited to small to medium CO_2 emitters (< 150 kt/y) and decentralised solutions
- Complementary to conventional CCS (CO_2 stored in dense form)

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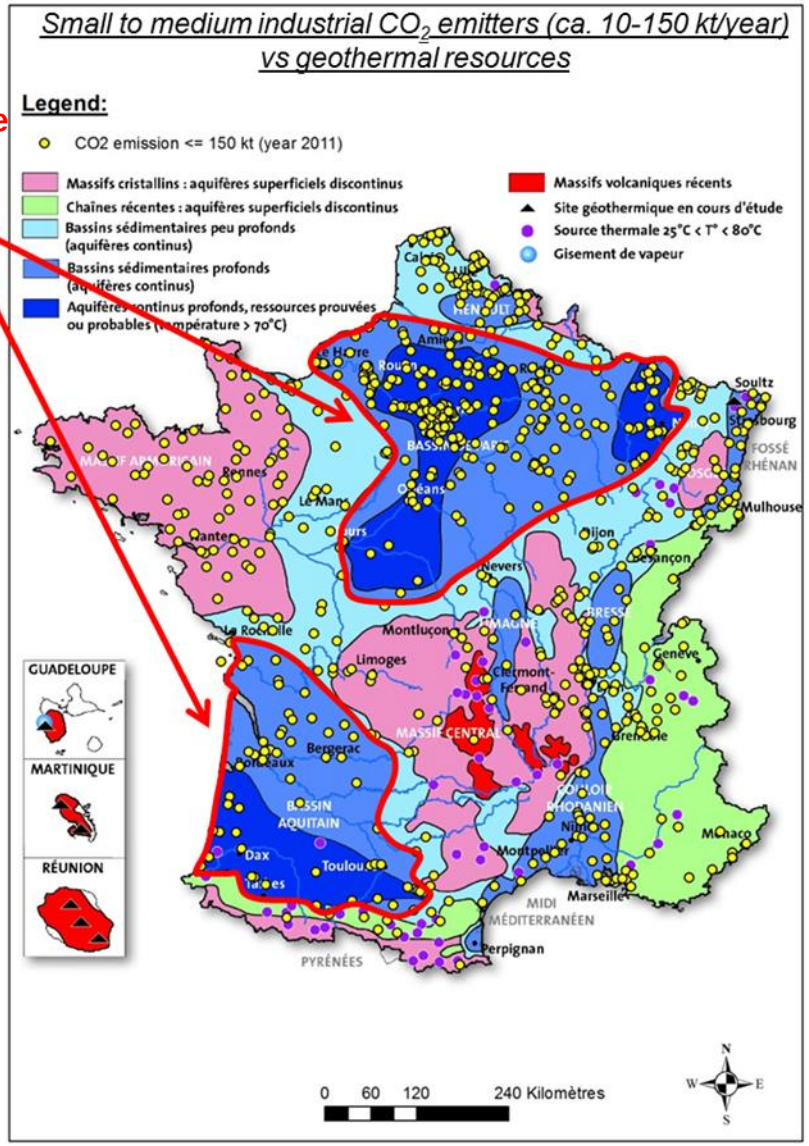
PILOTE-CO_2Dissolved

More than **350 compatible emitters** identified in the Paris basin and in the Aquitaine basin



Main industry sectors concerned:

- Urban heating
- Waste incineration
- Small fossil fuel power plants
- Small cement factories
- Bioenergy production
- Bioethanol refineries
- Breweries
- Etc.

Objectives:

- Team up with an industrial partner among the identified candidates
- Secure additional funding for designing and building the demonstration pilot (to be launched around 2020)

Key figures:

- Started in June 2016
- Duration: 18 months
- 10 partners (4 industry companies – 1 from US, 1 Public Institute, 5 University labs)
- Budget: 2.2 M€

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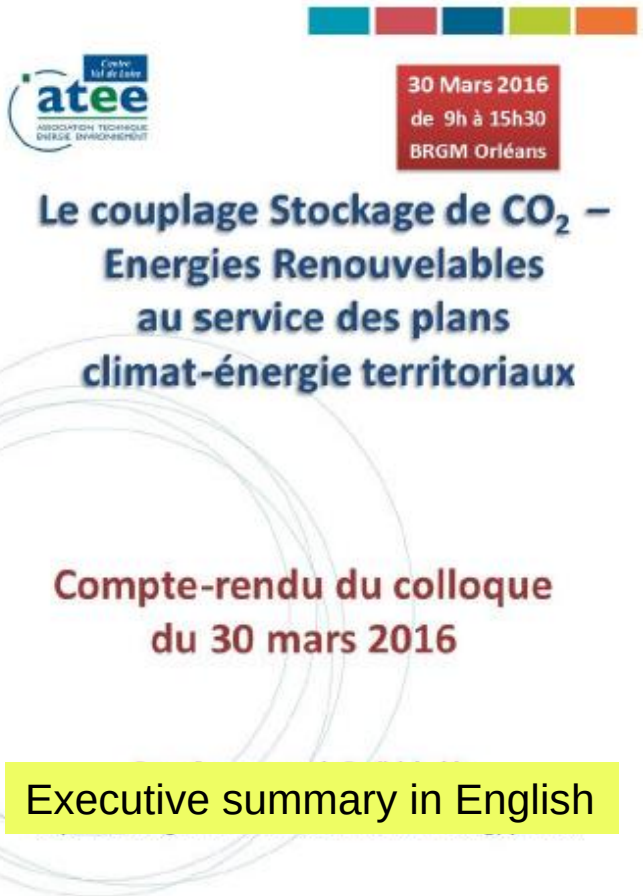
National ATEE workshop, Orléans, 30 March 2016

« Coupling CO_2 storage and Renewable Energy as part of integrated territorial climate and energy plans »



- **RES - focus on:**
  - Geothermal Energy
  - Biomass Energy
- **Case study: Artenay biorefinery close to Orleans**
  - CO_2 emissions : 145 kt/yr with 50 kt/yr from biomass

Report and presentations available at: http://atee.fr/manifestations/le-couplage-stockage-de-co2-energies-renouvelables-au-service-des-pcet

or on CO_2GeoNet website: www.co2geonet.eu

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Conclusions

- CO_2 geological storage is a solution that can be integrated into national and regional climate-energy plans, whether CO_2 is stored in a dense or a dissolved form.
  - already 11 countries out of 187 include CCS in their INDCs (Intended Nationally Determined Contributions) submitted prior to COP21
- CO_2 storage in dissolved form, combined with the production of geothermal heat, is a new concept well suited to small CO_2 emitters and decentralised solutions.
- Coupling biomass energy or direct air capture with CO_2 storage offers a real opportunity to form a carbon sink.
- Whilst awaiting for the socio-economic conditions for CO_2 storage deployment to be in place, pilots and demonstration projects are good drivers for stimulating R&I and enriching the thinking of operators, public authorities, lawyers and citizens.