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### **Deliverable D 4.7**

#### **OUTCOMES OF THE INTERNAL KNOWLEDGE SHARING WORKSHOP 6**

**Other promising options for CO<sub>2</sub> storage  
Bratislava, Slovakia  
16-17 September 2013**

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Final Version

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## 1. Workshop report

6th CGS Europe Knowledge Sharing Workshop  
**Other promising options for CO<sub>2</sub> storage**  
**Slovakia, Monday 16<sup>th</sup> - Tuesday 17<sup>th</sup> September 2013**

The sixth CGS Europe Knowledge Sharing Workshop “Other promising options for CO<sub>2</sub> storage took place in Slovakia, Monday 16<sup>th</sup> - Tuesday 17<sup>th</sup> September 2013. The workshop was organised by Ludovit Kucharic (SGUDS) and Alla Shogenova (TTUGI, WP 4.2 leader) with the help of sessions chairs Sevket Durucan (CO<sub>2</sub>GeoNet-IMPERIAL), Gyorgy Falus (ELGI) and Zoltan Nemeth (SGUDS).

During the two days of the workshop, participants attended presentations made in SGUDS by project participants and external speakers and visited the underground gas storage (UGS) Gajary – Badenian. The programme of the event is given in annex to this report.

42 participants attended the workshop from 21 CGS Europe countries (Table 1).

Country	N	Country	N
Austria	4	Italy	1
Belgium	1	Latvia	2
Croatia	1	Norway	1
Czech	2	Romania	1
Denmark	1	Slovakia	10
Estonia	1	Serbia	1
Finland	1	Spain	1
France	3	Slovenia	1
Germany	2	Turkey	2
Greece	2	UK	3
Hungary	1		

Table 1: Number of participants per country

During the first day (September 16<sup>th</sup> 2013) at SGUDS Headquarters in Bratislava, presentations were made by the project participants and one online presentation by invited speaker from USA (Jimmy B Randolph - Heat Mining Company LLC, and University of Minnesota). The second online presentation planned to be made by speaker from TNO, was cancelled for technical reasons, but its content is fully available now for the projects partners at the project website.

After the presentations, time was dedicated to discuss the role of CCUS (Carbon Capture, Utilisation and Storage) in the complicated situation arising in Europe after the failure of EEPR supported projects and the NER300 first call (considering CCS) and facing the limited number of CCS proposals in the second NER300 call.

The conclusions reached by the workshop participants are summed up here below.



Figure 1. Presentation on LCA of CCS cycle made during the workshop by Anna Korre



Figure 2. Discussion during day 1.

## 2. Conclusions from the workshop

- Although EHR (Enhanced Hydrocarbon Recovery) technology using CO<sub>2</sub> is feasible, for its wide implementation CO<sub>2</sub> capture in industrial scale is needed. Until now mainly natural CO<sub>2</sub> sources are used, that does not support CO<sub>2</sub> offset and climate change mitigation.
- Efficiency of CBM (Coal Bed Methane) recovery depends on initial coal permeability, wells location (horizontal or vertical), flue or mixed gas applied. The cheaper option is to avoid capture and to use flue gas, as industry is interested in cheaper methane delivery.
- LCA (Life Cycle Analysis) analysis for CCS cycle is compatible with that one for renewables. They are both useful to mitigate climate change.
- CO<sub>2</sub> injection into CH<sub>4</sub> hydrate increases the stability of the storage system. Methane hydrate stability region in deep sea sediments would be a good alternative for the safe storage of CO<sub>2</sub> while producing CH<sub>4</sub>.
- Unconventional shale gas reservoirs could provide new CO<sub>2</sub> storage option and can be combined with enhanced methane recovery.
- Enhanced geothermal recovery using CO<sub>2</sub> (CPG) could provide more efficient energy recovery, and lower temperature and less permeable formations could be considered. CPG also could be combined with EOR, thus minimising electricity costs for EOR.
- LCA for CO<sub>2</sub> mineral carbonation has to be taken into account when selecting a carbonation technic.
- In addition to participating to climate change mitigation, CO<sub>2</sub> mineral carbonation can also be used to produce raw materials or stabilise alkaline wastes, asbestos or waste waters.

### 3. Field Excursion to Plavecký Štvtok village – Day two

Before the actual site visit two presentations introducing the geology of the underground natural gas storage (UGS) Gajary – Badenian and of the proposed site for CO<sub>2</sub> pilot storage Láb (Vienna basin) were done by representatives of Nafta Company. After presentations and short discussion the workshop participants went by bus to UGS Gajary – Badenian managed by NAFTA company. The technical and geological information about UGS were presented by local engineers and managers and excursion took place in the technical rooms and buildings of UGS and outside where all infrastructure were observed (Figs. 3-4).

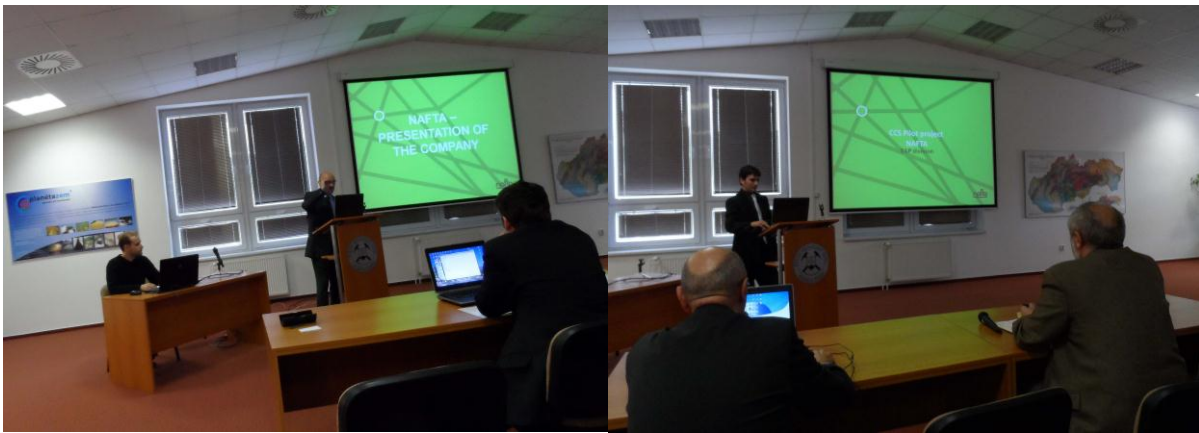


Figure 3. Presentations introducing geology of the UGS Gajary – Badenian and of the proposed site for CO<sub>2</sub> pilot storage Láb (Vienna basin) done by representatives of Nafta Company.



Figure 4. Participants of the field excursion to the UGS Gajary – Badenian facility.

## Annex I – Workshop program, 16-17 September, 2013

16th September, Bratislava, State Geological Institute of Dionyz Stur, Mlynska dolina 1

<b>Session 1: Enhanced Hydrocarbon Recovery – CCS</b> <b>Convener: Sevket Durucan</b>			
10.00	Introduction and practical information	Alla Shogenova, Ludovit Kucharic	
10.10	Introduction on CO <sub>2</sub> -EOR and to experiments on chalk from the Tor and Ekofisk Formations at reservoir conditions	<b>Niels E. Poulsen</b> , Rob Arts and Dan Olsen	CO <sub>2</sub> GeoNet- GEUS, TNO
10.40	Implementation of horizontal wells and flue gas injection for Coalbed Methane (CBM) and Enhanced CBM (ECBM) technology and the assessment of effective CO <sub>2</sub> storage capacity: Experience from a Scottish coalfield	JQ Shi, A Syed, A Korre, <b>S Durucan</b> , C Sinayuc and CE. Imrie:	CO <sub>2</sub> GeoNet- IMPERIAL
11.10	Coffee Break and Posters		
11.40	Full chain life cycle analysis and comparison of gas-fired power plants with CO <sub>2</sub> capture and storage with clean coal alternatives	<b>A Korre</b> , Z. Nie and S. Durucan	CO <sub>2</sub> GeoNet- IMPERIAL
12.10	Discussion on EHR		
12.30	Lunch		
<b>Session 2: CO<sub>2</sub> Storage in Shales and Hydrates</b> <b>Convener: Roberto Martinez</b>			
13.30	Methane hydrate stability regions in deep sea sediments can be an alternative for the safe storage of CO <sub>2</sub>	<b>Caglar Sinayuc</b>	METU-PAL

14.00	Unconventional shale gas resources are going to provide new CO <sub>2</sub> storage mediums: an experimental study	<b>Sukru Merey</b>	METU-PAL
<b>Session 3: Enhanced Geothermal and Hydrocarbon Recovery - CCS (online session)</b> <b>Convener: Ludovit Kucharic</b>			
14.30	CCS and geothermal energy production from Aquifer systems ( <i>Cancelled</i> )	<b>Jan-Diederik van Wees.</b>	CO <sub>2</sub> GeoNet-TNO
15.00	CO <sub>2</sub> -based geothermal heat mining and waste energy recovery for power production in conjunction with CCS and enhanced hydrocarbon recovery operations	<b>Jimmy B Randolph</b> <i>(through video conference)</i>	Heat Mining Company LLC, and University of Minnesota
15.30	Coffee Break and Posters		
<b>Session 4: CO<sub>2</sub> Mineral Carbonation</b> <b>Convener: Zoltan Nemeth</b>			
16.00	CO <sub>2</sub> mineral carbonation – way to mitigate climate change and environmental problems	<b>Alla Shogenova</b>	TTU GI
16.30	Ex-situ mineral carbonation of mining residues: resources, process and environmental assessment (results from the French ANR Carmex project)	<b>Francoise Bodenan</b>	CO <sub>2</sub> GeoNet-BRGM
17.00	Change of carcinogenic chrysotile fibers in the asbestos cement (eternit) to harmless waste by artificial carbonatization: Petrological and technological results	<b>Martin Radvanec,</b> Lubomir Tucek, Jan Derco, Katarina Cechovska, Zoltan Nemeth	SGUDS
<b>17.30-17.55 Discussion and final conclusions</b> <b>Convener: Alla Shogenova</b>			



**17th September, Field Excursion to Plavecký Štvrtok village**

(campus of NAFTA company)

9.30 – 11.00	<p>Presentations at SGUDS, Bratislava</p> <p>Activities of the NAFTA company and short description of the underground gas storage (UGS) Gajary – Badenian Proposed site for CCS pilot project Láb (Vienna basin) Discussion</p>
11.00 – 12.00	Lunch
12.00 – 13.00	<p>Travel by bus to the UGS Gajary – Badenian (Vienna basin – approx. 40 km)</p>
13.00 – 15.00	Excursion at UGS Gajary – Badenian
15.00 – 16.00	Travel by bus to Devín ruins, the 8-th century castle above confluence of rivers Danube and Morava
16.00 – 18.00	Visit of Devín
18.00 – 19.00	Travel to SGUDS, Bratislava