Greenhouse gas mitigation in Belgium. Status and potential contribution of geological sequestration.

Compilation: Michiel Dusar, April 2003

Status

As a densely populated and highly industrialised country with growing economy, Belgium has a balanced diversification of energy sources. CO_2 emissions grew in the 1990s and reached 127 Mt in 2000, about 7,7% higher than in 1990 and 12,7% above the target level (EEA, 2002). Contrary to other greenhouse gases, CO_2 emissions are still growing 1% annually (Quarterly Newsletter of the Federal Planning Bureau); for the Flanders region, CO_2 emissions rose 13% over the period 1990-2001 (Van Steertegem, 2002). Belgium's Kyoto target is a 7,5% reduction of emissions by 2008-2012 compared to 1990 of which CO_2accounts for 84%.

The federal government ratified the Kyoto protocol in 2001 but effective reduction will depend on actions by the regions, which have a high degree of autonomy in energy policy and are not committed to the same energy efficiency and environmental target. The first Federal Plan for Sustainable Development was published in 2000 and provides a framework for federal schemes, including a National Climate Plan that is still in preparation (Task Force Sustainable Development, 2002). No quantitative policy goals have been set, however. Complexity of the government structure and occasional disparities between federal and regional policy objectives and targets are the main causes for the slow progress of decision-making in key policy issues on greenhouse gas mitigation (Priddle, 2001).

Energy statistics, 2001

	World	Belgium
oil	38,5	41,0
gas	23,7	22,7
coal	24,7	13,2
nuclear (incl. imports)*	6,6	22,1*
renewables incl. hydro	6,5	0,9

SOURCE: http://mineco.fgov.be/homepull_en.htm

Advances in energy efficiency, with the introduction of benchmarking, and partial substitution of coal by gas, have contributed to restraining growth in CO_2 emissions since 1990. Great efforts in increasing energy efficiency have already been made by the key industrial sectors (electric power, metallurgy, petrochemicals, cement), which reduces possibilities for further reduction without threatening the international market position of the industrial sector. The 'dash for gas' has rapidly increased the share of gas at the detriment of coal in the energy supply. Rising gas prices and an uncertain future in a liberalising market has brought this switch to a halt, which may be beneficial in the long term, in view of declining European reserves and the great dependency of the domestic sector in Belgium on gas. Neither renewable energy nor combined heat and power generation, which could limit carbon emissions, can be easily introduced in Belgium, because of higher cost and local resistance, and will not contribute significantly in attaining the Kyoto target. Renewable electricity generation is less then 1% in Belgium (lowest in the European Union), is not growing much faster than the total electricity production and will not reach the 3% active policy goal and thus fall way beyond the 6% indicative target set for 2010 (ECOFYS, 2002). The regions have introduced "green certificate schemes" in an attempt to address this

problem. Geological sequestration is not part of the National Climate Plan, nor included in the green certificate schemes.

It is generally accepted, and conceded by the regional authorities, that the Belgian Kyoto target will not be attained, though opinions on causes and effects strongly differ. Actually, more than 16 Mt of CO_2 have to be avoided annually in Belgium. Greenhouse gas mitigation in a growing Belgian economy can only be achieved by combined action on the four variables: energy efficiency, reduction of carbon intensity, green energy, capture and sequestration.

Kyoto is a first modest step towards stabilisation of CO_2 concentration and is as such not leading to a change of global warming trends. In order to stabilise the atmospheric CO_2 concentration at a level preventing more pronounced human interference with the climate system - as recommended by the UN Framework for Climate Change at 550 ppm - emissions have to be cut by at least 50%. CO_2 sequestration (partial or total capture and storage) is necessary to achieve deep reductions.

Belgium is also committed to phase out nuclear power from 2014. Although this will not affect the already existing difficulties for reaching the national Kyoto target it will be an additional challenge for achieving deep reductions in the future. Nuclear power accounts for almost 60% of electricity generation and for 22% of total energy supply in Belgium. Finding a cost-effective and low-emission alternative for nuclear power is not yet considered, which means that fossil fuels will continue to supply energy for electricity generation for decades to come (AMPERE, 2000 and International Peer Review group, 2001), stressing even more the need for capture and storage of CO_2.

Prevent fossil carbon to be emitted in the atmosphere, capture it and send it back from where it comes in a long-lasting storage is the message for the 21st century (Mathieu, 2002; IEA Working Party on Fossil Fuels, 2002).

Storage potential

The small size of Belgium, about 39.000 km2 including the offshore area, and its complex geology do not offer unlimited choices for geological sequestration. At a depth of 800 m, generally considered as the minimal technical limit for sequestering CO_2, 95% of the territory is occupied by tight Paleozoic rocks. There are no extensive deep saline aquifers, no known oil and gas fields, no salt stocks. The potential for geological storage is restricted to the Dinantian aquifer in the Campine basin, to unmined coal beds and abandoned coal mines in the Hainaut and Campine coal basins.

Aquifer

The Dinantian aquifer in the province of Antwerp, which is already utilised for seasonal storage of natural gas (the Loenhout storage site holds over 1 billion NmÂ³ of gas) has an estimated CO_2 storage potential of 125 Mt in closed structures and under an angular structural trap. Other aquifers in the Campine basin are either insufficiently known or too risky for leakage; the latter problem also affects the Dinantian aquifer in the southern parts of Belgium. Notwithstanding its rather small capacity (compared to some offshore reservoirs) and need for additional seismic reconnaissance, the Dinantian aquifer is interesting because of good injectivity and high completion factor, in relation to nearby sources of CO_2. The best scenario for an early opportunity project is the linking with a pure CO_2 source from an ammonia plant. Other, poorly known potential reservoirs are in Devonian carbonates and Triassic sandstones.

Coal

Storage of CO_2 in unmineable coal seams has a much higher potential, but presents the disadvantage of slow injection rates, requiring many boreholes. The Campine coalfield is able to hold 950 Mt of CO_2. Coal

already contains methane adsorbed to the internal pore surfaces. Generally, CO_2 is preferentially absorbed on coal compared to CH4, and the exchange ratio approximates 2:1. In practice, CO_2 thus will enhance recovery of coal bed methane, still producing green energy as there will be a net carbon reduction. Six anomalous zones in the Campine coal basin could produce 132 billion mÂ³ of methane and store 432 Mt of CO_2. Unmined coal zones, e.g. east of Mons in the Hainaut coal field have a potential for ECBM allowing CH4 production of 1 Mm3/day (Mostade, 1999) and storing all surplus process CO_2 from an ammonia plant nearby (cf. Lysen, 2002). For this reason, the government of the Walloon region decided early 2003 to join the RECOPOL project (Reduction of CO_2 emission by means of CO_2 storage in coal seams in the Silesian Coal Basin of Poland) as an end-user.

Coal mines

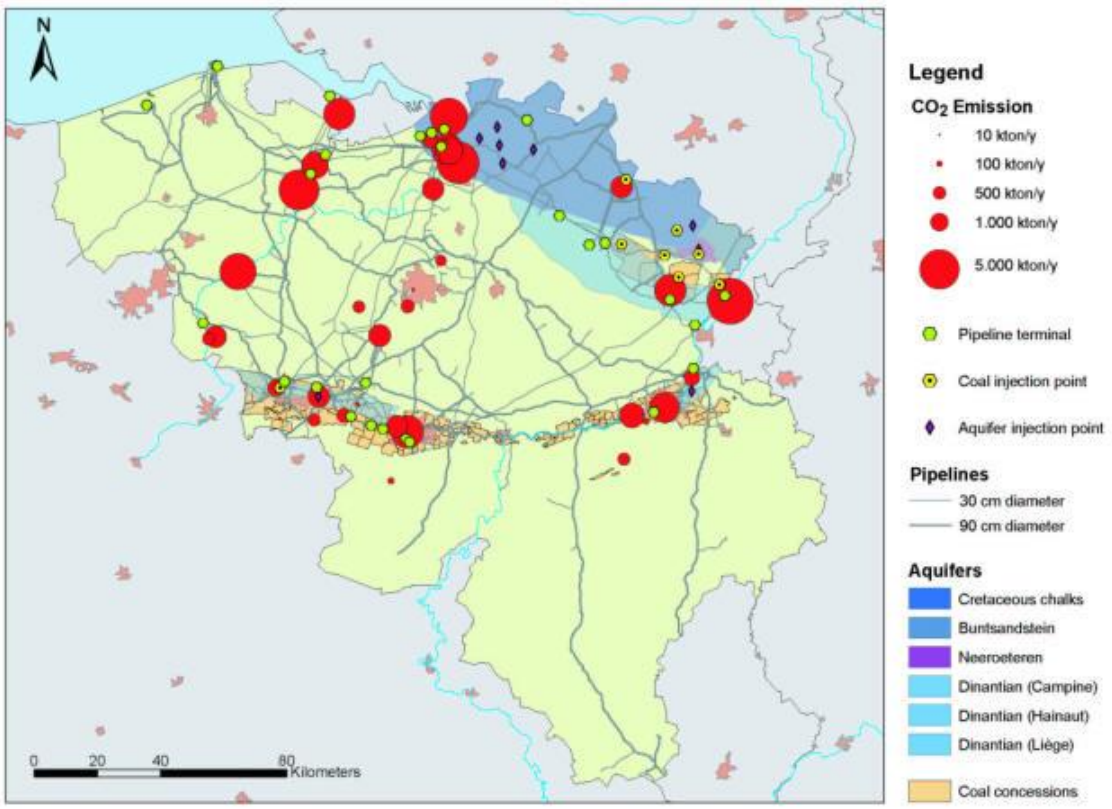
Abandoned coal mines in the Campine and Hainaut coal fields are quite tight and gassy. The Anderlues and PÃ©ronnes coal mines in Hainaut have been temporarily but safely developed as a reservoir for seasonal gas storage. However, long-term storage of CO_2 requires resistance to flooding or else dissolution in deep groundwater, practically limiting the capacity to be stored safely. Because of shallow depth of closure, mines in the Hainaut coal field are not interesting for CO_2 storage unless deep seals are established. The Campine collieries are possibly among the world best for developing new energy systems, starting with methane drainage, continuing with CO_2 sequestration and ending with geothermal exploitation. Total storage capacity is small, ca 35 Mt but high injection rates and possibilities to earn revenues from CH4 recovery, which otherwise would be spilled, make them a good target for early opportunities (possibly in combination with pure CO_2 sources from across the national boundary as part of a transnational pilot project). Re-utilisation of abandoned mines could also provide the learning-time how to develop the larger, yet uneconomical coal reserves in the longer term.

company	**locality**	**production**	**source**	**CO_2 Gg**	**CO_2 %**	**reservoir**	**distance km**
BASF	Antwerp	ammonia	natural gas	288	8	aquifer	25
		" " "	natural gas	690	100		
		ethylene	natural gas	2051	10-15		
		ethylene oxide	natural gas	128	100		
		electric power	natural gas	1132	3		
KEMIRA	Tertre	ammonia natural	gas	169	8	coalbed	20
		" " "	natural gas	696	100		
		dry ice	CO_2	-120	100	Carbodour	
Electrabel	Genk	electric power	coal	3054	15	coal mine	15

CO_2 EMISSION SOURCES IN BELGIUM, USED FOR SCENARIO DEVELOPMENT (LAENEN, 2003; MOSTADE, 1999). DATA SOURCE: ECOFYS DATASHEET FOR GESTCO.

Conclusion

Geological sequestration must be seen in conjunction with other options of greenhouse gas mitigation and should complement but not replace other policy measures to encourage energy efficiency and reduction of carbon intensity. However, in view of the apparent difficulties of Belgium to reach even the Kyoto target, underground storage might be considered as unavoidable. The potential for geological sequestration of CO_2 in Belgium is restricted and does not offer solutions for continuous and unlimited dependency on fossil fuels, but possesses nevertheless opportunities for early application in the Campine basin. The vast coal deposits, both in north and south Belgium offer hopes for future utilisation as a reservoir for energy carriers and repository for derived gases. Ideally, CO_2 sequestration could be integrated in the optimised exchange of energy products between the surface and the subsurface.



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Institutions which can offer further information and assistance

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