



European Commission

Research Programme of the Research Fund for Coal and Steel

Technical Group: TGC 1

Project title:

Unconventional Methane Production from Deep European Coal Seams through Combined Coal Bed Methane (CBM) and Underground Coal Gasification (UCG) Technologies

MEGAPlus



Grant Agreement number: 800774-MEGAPlus-RFCS-2017

Deliverable D5.3

Report on the permitting and regulatory requirements of the methane-rich syngas UCG technology and implications for the regulators

WP5 Best Practice Guidelines and implications for regulators

Lead participant for this deliverable:

Główny Instytut Górnictwa (GIG)

30th November 2021

Document Control Page

Deliverable name:	Report on the permitting and regulatory requirements of the methane-rich syngas UCG technology and implications for the regulators
Deliverable / Milestone number:	D 5.3
Work-Package no and title:	WP 5 Best Practice Guidelines and implications for regulators
Work Package Leader:	GFZ
Authors:	
GIG (Poland):	Regina Kościarz, Magdalena Pankiewicz-Sperka, Krzysztof Kapusta
CU (United Kingdom):	Graham Wadelin, Hywel Thomas, Renato Zagorscak
GFZ (Germany):	Thomas Kempka, Natalie Nakaten, Priscilla Ernst, Christopher Otto, Elena Chabab
ICPF (Czech Republic):	Olga Solcova, Karel Soukup
INERIS (France):	Arnaud Carmoille, Stéphane Lafortune
Due date of deliverable:	M42
Actual delivery date:	13th January 2022
Language:	English
Dissemination Level ¹ :	PU
Audience:	<input checked="" type="checkbox"/> public <input type="checkbox"/> restricted <input type="checkbox"/> internal
Status:	<input checked="" type="checkbox"/> draft <input type="checkbox"/> final

Dissemination level:

PU = Public

PP = Distribution restricted to other programme participants

RE = Distribution restricted to a group specified by the consortium

CO = Confidential, only allowed for members of the consortium

Executive Summary

This report presents the results of the activities undertaken as a part of the implementation of Work Package 5, Task 5.2 – Permitting and regulatory requirements of the technology and implications for regulators of project “*Unconventional Methane Production from Deep European Coal Seams through Combined Coal Bed Methane (CBM) and Underground Coal Gasification (UCG) Technologies*” acronym MEGAPIus.

The objective of this report is to review and integrate the EU and selected national Member State regulatory frameworks in order to identify current practices and gaps in legislation concerning Underground Coal Gasification (UCG) and Coal Bed Methane (CBM).

The report is primarily addressed to industry representatives interested in the implementation of new UCG-CBM technology on an industrial scale, as well as to all representatives of the state and local administration responsible for the legal aspects of the implementation of such technologies in life, and to those legal representatives responsible for creating new laws or adaptation of the already existing legal framework to new technologies.

The findings of the analysis will allow for a comprehensive presentation of the state of regulations regarding the above-mentioned technologies, which are in force in the European Union countries (at project partners) and in selected countries outside the EU, e.g.: the USA, Canada, Australia.

The knowledge obtained directly from partners constitutes the seed for further conclusions and recommendations. These conclusions and recommendations are intended to reach the widest possible target audience, including the following groups: plant operators, regulatory/legislative bodies, potential investors and the general public.

The report consists of introduction, two main parts concerned technologies – the first part presents the legal regulations of the UCG technology, the second part contains a review of the legal status of CBM technology. The final section presents conclusions and lessons learned.

The part relating to the UCG technology points out that there is no single document, common for all EU countries, that regulates issues related to the use of this technology. Admittedly, at the EU level, several directives referred to in the report are directly or indirectly concerned with environmental issues, including the impact on both groundwater and water, environmental impact assessments, industrial emissions, waste and finally, essential matters related to safety and health protection. The dispersion of regulations that may apply to UCG technology may, however, constitute a significant barrier to the development of this technology.

Similar conclusions can be drawn from the analysis of the national legislation in force at individual project partners. Most often, with regard to UCG technology, the legal acts applicable

to the mining industry are taken into consideration. For example, in Poland while conducting a large-scale experiment in the field of underground coal gasification at the Wieczorek mine, the regulations relating to the geological and mining law as well as secondary legislation to this act were applied. It should be noted that even the positive results of the experiment did not lead to the commencement of appropriate legislative work or to the enactment of relevant provisions directly related to the UCG. The situation is similar in Germany, where, after the Belgian-German Thulin pilot was carried out in the 1980s, no license was granted and no further activities related to UCG were undertaken. As a consequence, there was not pass appropriate regulations for the UCG. For the time being, the UCG technology could use existing and applicable coal regulations – The German Federal Mining Law and auxiliary acts. The situation is similar also in Czech Republic and France, where there are no precise legal regulations, and regulations based on the mining law could be considered for the application of the UCG. Initially, in the UK, the possibility of developing the UCG was allowed off-shore or under estuaries. But since 2016 there has been support of the UCG technologies from the Government UK due to the strong risk of water contamination and pollution.

For comparison, the report additionally indicates the legal framework in force in countries outside the EU, including the USA, Canada and Australia, where work on the UCG has been carried out. The UCG process has been tested there on a large scale and these countries have a well described, documented and accessible legal framework.

Considering the above, further legislative actions in the EU countries will require obtaining both social approval for the development of UCG technology as well as ensuring environmental safety and health protection.

The partners' project focuses on combining the UCG technology with CBM. For this reason, the report also presents the regulations on CBM. Obtaining methane from fossil fuels meets the current needs of the EU. As with the UCG, there is no single document at the EU level in this respect. When considering the use of this technology, it is also necessary to respect the applicable directives, as well as the strategies adopted at the EU level, including: The European Green Deal, Communication on an EU strategy to reduce methane emissions.

The report also contains information on national regulations in the area of CBM. For example, Poland can be regarded as a country where issues related to methane extraction are directly included in the Geological and Mining Law. At the same time, when using this technology, it is also necessary to take into account also the following acts – Environmental Protection Law, Water Law, the Waste Act and a number of other acts and executive acts. Moreover, there is no specific regulatory framework for CBM in Germany. The regulatory framework for Coal mine methane (CMM) and Abandoned Mine Methane, which regulates exploration and production, can be used for this purpose. The Federal Mining Authority or the Renewable Energy Act are

indispensable when considering the CBM process. In the Czech Republic, CBM gas is explicitly defined in the Mining Law. The Act specifies the conditions for extraction, indicating that extraction is to be rational and economically justified. Additionally, for CBM is possible use the Law on Supported Energy Sources. On the other hand, French legislation aims to end the extraction and utilisation of coal and hydrocarbons by 1st January, 2040. Similarly to the UCG, for comparative purposes, the report examines the legal condition in the USA, Canadian and Australian.

Analysing the current state of legislation in the project countries and making use of the current state of EU law as well as basing on the solutions applied in the countries with extensive experience in the implementation of UCG and CBM technologies (e.g. USA, Canada), some guidelines and recommendations were extracted, which should be taken into account when implementing the technology on an industrial scale.

TABLE OF CONTENTS

1. INTRODUCTION	7
2. UCG TECHNOLOGY – LEGAL FRAMEWORK (NATIONAL LAW, EU AND NON EU COUNTRIES)	8
2.1. UCG IN THE EU DIRECTIVES	8
2.2. UCG IN THE EU COUNTRIES (NATIONAL REGULATIONS)	17
2.2.1. <i>POLAND</i>	17
2.2.2. <i>UNITED KINGDOM</i>	19
2.2.3. <i>GERMANY</i>	21
2.2.4. <i>CZECH REPUBLIC</i>	23
2.2.5. <i>FRANCE</i>	24
2.3. UCG IN THE NON-EU COUNTRIES	25
2.3.1. <i>USA</i>	25
2.3.2. <i>CANADA (Alberta example)</i>	28
2.3.3. <i>AUSTRALIA</i>	29
3. CBM EXTRACTION TECHNOLOGY – LEGAL FRAMEWORK (NATIONAL LAW, EU AND NON EU COUNTRIES)	30
3.1. CBM EXTRACTION TECHNOLOGY IN THE EU DIRECTIVES.....	30
3.2. CBM EXTRACTION IN THE EU COUNTRIES (NATIONAL REGULATIONS).....	33
3.2.1. <i>POLAND</i>	33
3.2.2. <i>UNITED KINGDOM</i>	35
3.2.3. <i>GERMANY</i>	36
3.2.4. <i>CZECH REPUBLIC</i>	38
3.2.5. <i>FRANCE</i>	39
3.3. CBM EXTRACTION IN THE NON-EU COUNTRIES	40
3.3.1. <i>USA</i>	40
3.3.2. <i>CANADA (Alberta example)</i>	41
3.3.3. <i>AUSTRALIA (Queensland example)</i>	43
4. CONCLUSIONS AND LESSONS LEARNT	45
APPENDIX	49

1. INTRODUCTION

Project MEGAPlus aims at evaluation of the use of deep lying methane rich coal deposits for coalbed methane and enhanced coalbed methane recovery using horizontal wells, coupled with subsequent high pressure SNG-oriented UCG through the reuse of the same horizontal wells. In simple terms, the project focuses on combining two technologies: CBM and UCG. One of the barriers to implementing these technologies may be the lack of clear and readable legislation, which may discourage potential investors.

In terms of the development of a regulatory framework and current best practices and identification of gaps in legislation in view of the UCG and CBM technology, it has to be noted that this task requires specialised knowledge of both, technology and legislative aspects.

This report includes an overview of the permitting and regulatory framework requirements of CBM and UCG technologies and considers implications for regulators for future commercialization of these technologies in Europe. The report covers the legal situation in the project partner countries (Poland, Germany, France, United Kingdom and Czech Republic), European Union as well as describes examples of countries outside the EU where the legal framework is clarified and well described.

2. UCG TECHNOLOGY – LEGAL FRAMEWORK (NATIONAL LAW, EU AND NON EU COUNTRIES)

In the era of clean coal technology, the technology of underground coal gasification in combination with other innovative technologies is gaining importance. Thus, there is a growing interest in legal regulations concerning the use of this particular technology. There is no directive at the European level that would comprehensively regulate the issues related to the use of this technology. There is no single piece of legislation as there is for example for the carbon capture and storage of CO₂ (CCS). The legal situation in the European Union and non-EU countries is similar.

2.1. UCG IN THE EU DIRECTIVES

As mentioned above, at the European Union level, there is no directive directly addressing underground coal technology. However, looking through the prism of other technologies used in the European Union, it seems reasonable to check the possibility of appropriate application of other directives. For this purpose, it is possible to analyse directives aimed at the protection of the environment such as: *Water Framework Directive, Groundwater Directive, Strategic Environmental Assessment, Management Waste Directive*, etc.

Water Framework Directive 2000/60/EC establishing a framework for Community action in the field of water policy.

This directive specified rules aimed to stopping deterioration of water. It also specifies how to protect and use water and how to reduce pollution in water.

Referring to Article 1:

“the purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:

- a) Prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;*
- b) Promotes sustainable water use based on a long-term protection of available water resources;*
- c) Aims at enhanced protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;*
- d) Ensures the progressive reduction of pollution of groundwater and prevents its further pollution, and*

- e) *Contributes to mitigating the effects of floods and droughts and thereby contributes to:*
- *The provisions of the sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use*
 - *A significant reduction in pollution of groundwater,*
 - *The protection of territorial and marine waters, and*
 - *Achieving the objectives of relevant international agreements, including those which aim to prevent and eliminate pollution of the marine environment, by Community action under Article 16(3) to cease or phase our discharges, emissions and losses of priority hazardous substances, with the ultimate aim of achieving concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances” [1].*

Groundwater Directive 2006/118/EC on the protection of groundwater against pollution and deterioration.

The aim of the directive is to prevent and combat groundwater pollution. This directive also contains procedures for assessing the chemical status of groundwater, and, how to limit inputs of pollutants into groundwater.

According to article 1:

“this Directive establishes specific measures as provided for in article 17(1) and (2) of Directive 2000/60/EC in order to prevent and control groundwater pollution”.

These measures include in particular:

- a) *Criteria for the assessment of good groundwater chemical status; and*
- b) *Criteria for the identification and reversal of significant and sustained upward trends and for the definition of starting points for trend reversals [2].*

Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment

According to art. 1 of this directive the main objective of the directive is to ensure high level of environmental protection and to contribute to integration to environmental considerations into the preparation and adoption of programmes with a view to promoting sustainable development and, by ensuring that, in accordance with this Directive, an environmental assessment shall be carried out concerning certain plans and programmes which are likely to have significant effects on the environment.

To be more specific, an environmental assessment shall be carried out into the plans and programs concerning:

[1] Directive 2000/60/EC of the European Parliament and of the Council, establishing a framework for the Community action in the field of water policy as of 23rd October 2000.

[2] Directive 2006/118/EC of the European Parliament and of the Council on the protection of groundwater against pollution and deterioration of 12nd December 2006.

“agriculture, forestry, fisheries, energy, industry, transport, waste management, water management, telecommunications, tourism, town and country planning or land use, setting the framework for future development consents of projects listed in Annexes I and II to Directive 85/337/EEC, or which, in view of the likely effects on sites, have been determined to require an assessment pursuant to Article 6 or 7 of Directive 92/43/EEC” [3].

Directive 2004 /35/EC on environmental liability with regard to the prevention and remedying of environmental damage

Article 1 of the Directive contains the subject of its regulation. According to it, the aim is to establish the scope of environmental liability, guided by the basic plans that “*the polluter pays*”. This is to prevent and remedy environmental damage. The Directive includes definitions of: environmental damage, damage, protected species and natural habitats, water, economic operator, emissions, preventive measures and remedial measures.

As a rule, the Directive applies to:

“an environmental damage caused by the pursuit of the occupational activities listed in Annex III, and to any imminent risk of such damage resulting from the said activities;

b) damage to protected species and natural habitats caused by any occupational activities other than those listed in Annex III, and to any imminent threat of such damage occurring by reason of any of those activities, whenever the operator has been at fault or negligent.”

The Directive contains exceptions which are not covered by environmental damage. In addition, the Directive indicates the preventive measures to be taken when the damage to the environment has not yet occurred and the remedial measures to be taken in the event of damage to the environment. It should be emphasized that the cost of remedial and preventive actions are borne by the economic entity [4].

Directive 2008/50/EC on ambient air quality and cleaner air for Europe

This Directive has a direct impact on the protection of air in the EU Member States, promoting the actions of states aimed at preventing and reducing harmful effects on human health and the environment.

Pursuant to Art. 1, the directive lays down measures aimed at, inter alia:

- 1) defining and determining objectives as to the quality of air,
- 2) assessing the air quality in the Member States on the basis of common methods and criteria,
- 3) obtaining information on the quality of the air and monitoring the improvement of the air condition,

[3] Directive 2001/42/EC of the European Parliament and of the Council on the assessment of the effects of certain plans and programmes on the environment of 27st June 2001.

[4] Directive 2004/35/CE of the European Parliament and of the Council on environmental liability with regard to the prevention and remedying of environmental damage of 21st April 2004.

- 4) ensuring that information on air quality is made available to the public,
- 5) maintaining good quality in the scope of air improvement, and air improvement itself,
- 6) promoting cooperation between the Member States in reducing air pollution.

As regards air quality assessment, the Directive contains a number of provisions concerning the assessment system, assessment criteria, measuring points and reference measurement methods. It contains regulations on air quality management, air quality plans, and also addresses the issue of the determination by the Member States of a system of penalties in the event of breach of national regulations [5].

Directive 2006/21/EC on the management of waste from extractive industries and amending Directive 2002/35/EC

Pursuant to Art. 1 of this Directive, the subject matter of its regulation includes measures, procedures and indications aimed at preventing or reducing any adverse effects on the environment, including water, soil, fauna and flora and the landscape, as well as any resulting threats to human health caused by management of waste from the extractive industry. As indicated in Art. 2, this Directive covers waste management from exploration, extraction, processing, and storage of mineral resources and from opencast activities. This article also contains a catalogue of exceptions to which the Directive does not apply. According to the Directive, Member States ensure that the operator draws up a plan aimed at minimizing, treating, recovering, and neutralizing waste, while ensuring sustainable development. The competent authority shall issue a permit for the operation of a waste facility. Such a permit is issued on the basis of national or Community regulations. Public information is essential at an early stage of the authorization process. This can be done by notices or other appropriate means. In addition, the competent authority shall require a submission of a financial guarantee prior to the commencement of activities related to the collection or storage of extractive waste [6].

Directive 2010/75/EU on industrial emission

This Directive lays down rules on integrated prevention and control of industrial pollution. What is more, this Directive also specifies rules aimed at preventing emission into air, water and land, and on failing that, at reducing them and preventing the generation of waste. In Article 2, some exceptions were included. For example, this Directive does not apply to research activities, development activities nor the testing of new products and processes. What is important, in the Annex to the Directive, among the types of activities (referred to in Article 10), point 1 concerns the energy industry, while point 1.4 gasification or liquefaction:

[5] Directive 2008/50/EC of the European Parliament and of the Council on ambient air quality and cleaner air for Europe of 21 May 2008.

[6] Directive 2006/21/EC of the European Parliament and of the Council on the management of waste from extractive industries and amending Directive 2002/35/EC of 15th March 2006.

- coal;
- other fuels in installation with a total rated thermal input of 20 MW or more [7].

Directive 2012/18/EU on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC

The Directive down rules for the prevention of major accidents involving hazardous substances and the limitation of their effects on human health and the environment [8].

Due to the fact that the underground gasification technology affects many environmental aspects such as: water, air, but also work and industry, the following directives may be useful when assessing this technology.

Directives in the scope of environment:

- Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information and repealing Council Directive 90/313/EEC.
- Directive 2003/35/EC of the European Parliament and of the Council of 26 May 2003 providing for public participation in respect of the drawing up of certain plans and programmes relating to the environment and amending with regard to public participation and access to justice Council Directives 85/337/EEC and 96/61/EC.
- Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE).
- Directive 2008/56/ of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).
- Directive 2008/99/EC of the European Parliament and of the Council of 19 November 2008 on the protection of the environment through criminal law.
- Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of eco-design requirements for energy related products.
- Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment.

[7] Directive 2010/75/EU of the European Parliament and of the Council of 24th November 2010 on industrial emission.

[8] Directive 2012/18/EU of the European Parliament and of the Council of 4th July 2012 on the control of major accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC.

Directives in the scope of air and climate

- Council Directive 87/2017/EEC of 19 March 1987 on the prevention and reduction of environmental pollution by asbestos.
- Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC.
- Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air.
- Commission Directive (EU) 2015/1480 of 28 August 2015 amending several annexes to Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the Council laying down the rules concerning reference methods, data validation and location of sampling points for the assessment of ambient air quality.
- Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction on national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 20021/81.

Directives in the scope of water

- Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption.
- Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks.
- Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy.
- Directive 2008/105/ of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council.
- Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy.
- Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning.
- Commission Directive (UE) 2015/1787 of 6 October 2015 amending Annexes II and III to Council Directive on the quality of water intended for human consumption.

- Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption (recast).

Directive in the scope of waste

- Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste.

Directives in the scope of industry and others issue

- Directive 2000/14/EC of the European Parliament and of the Council of 8 May 2000 on the approximation of the laws of the Member States relating to the noise emission in the environment by equipment for use outdoors.
- Directive 2002/14/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise – Declaration by the Commission in the Conciliation Committee on the Directive relating to the assessment and management of environmental noise.
- Directive 2008/68/EC of the European Parliament and of the Council of 24 September 2008 on the inland transport of dangerous goods.
- Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC
- Commission Directive (EU) 2015/996 of 19 May 2015 establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council.
- Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC.
- Directive (EU) 2018/410 of the European Parliament and of the Council of 14 March 2018 amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, and Decision (EU) 2015/1814.

Directives in scope of safety, health and others issues:

- Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work.
- Council Directive 89/654/EEC of 30 November 1989 concerning the minimum safety and health requirements for the workplace (first individual directive within the meaning of Article 16 (1) of Directive 89/391/EEC).

- Commission Directive 91/322/EEC of 29 May 1991 on establishing indicative limit values by implementing Council Directive 80/1107/EEC on the protection of workers from the risks related to exposure to chemical, physical and biological agents at work.
- Council Directive 92/91/EEC of 3 November 1992 concerning the minimum requirements for improving the safety and health protection of workers in the mineral – extracting industries through drilling (eleventh individual Directive within the meaning of Article 16 of Directive 89/391/EEC).
- Council Directive 92/104/EEC of 3 December 1992 on the minimum requirements for improving the safety and health protection of workers in surface and underground mineral extracting industries (twelfth Individual Directive within the meaning of Article 16 (1) of Directive 89/391/EEC).
- Directive 2001/95/EC of the European Parliament and of the Council of 3 December 2001 on general product safety.
- Directive 2003/10/EC of the European Parliament and of the Council of 6 February 2003 on the minimum health and safety requirements regarding the exposures of workers to the risks arising from physical agents.
- Directive 2004/37/EC of the European Parliament and of the Council of 29 April 2004 on the protection of workers from the risks related to exposure to carcinogens or mutagens at work.
- Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2005 on machinery and amending Directive 95/16/EC.
- Directive 2009/104/EC of the European Parliament and of the Council of 16 September 2009 concerning the minimum safety and health requirements for the use of work equipment by workers at work.
- Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings.
- Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC.
- Directive 2013/30/EU of the European Parliament and of the Council of 12 June 2013 on safety of offshore oil and gas operations and amending Directive 2004/35/EC
- Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom.
- Directive 2014/33/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to lifts and safety components of lifts.

- Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres.
- Directive 2014/28/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market and supervision of explosives for civil uses.
- Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment.
- Directive (EU) 2019/130 of the European Parliament and of the Council of 16 January 2019 amending Directive 2004/37/EC on the protection of workers from the risks related to exposure to carcinogens or mutagens at work.
- Directive (EU) 2019/983 of the European Parliament and of the Council of 5 June 2019 amending Directive 2004/37/EC on the protection of workers from the risks related to exposure to carcinogens or mutagens at work.

Other directives:

- Directive 2005/36/EC of the European Parliament and of the Council of 7 September 2005 on the recognition of professional qualification.
- Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection.
- Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006.
- Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings.
- Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC.
- Directive 2013/30/EU of the European Parliament and of the Council of 12 June 2013 on safety of offshore oil and gas operations and amending Directive 2004/35/EC.
- Directive 2014/23/EU of the European Parliament and of the Council of 26 February 2014 on the award of concession contracts.
- Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC.

- Directive 2014/25/EU of the European Parliament and of the Council of 26 February 2014 on procurement by entities operating in the water, energy, transport and postal services sectors and repealing Directive 2004/17/EC.
- Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure.
- Directive (EU) 2016/802 of the European Parliament and of the Council of 11 May 2016 relating to a reduction in the sulphur of certain liquid fuels.

2.2. UCG IN THE EU COUNTRIES (NATIONAL REGULATIONS)

2.2.1. POLAND

As a result of the energy transformation, there has recently been an increased interest in the use of clean coal technologies in Poland. In particular, the technology of underground coal gasification is considered to be promising for the future. It should be emphasized that coal is still the basic raw material used in Poland for energy purposes. In addition, it should be noted that in Poland there are many shallow coal seams, as well as seams located in inaccessible places, the exploitation of which is economically unprofitable or even impossible. These seams could be exploited in the process of underground coal gasification. Currently, Polish legislation, especially the Geological and Mining law, does not contain regulations directly concerning the use of underground coal technology. Conducting experiments by the Central Mining Institute at the Barbara Experimental Mine in Mikołów, as well as the Wieczorek Mine in Katowice, has been possible by way of exception to applicable legal regulations. At the same time, it was necessary to obtain permission to conduct experiments by various authorities, including the State Mining Authority.

The Polish mining act of The Geological and Mining law dated 9 July 2011 (Journal of Laws of 2021 item 1420 consolidated text) a specially in article 1 contains terms and conditions for the launching, conducting and termination concerning the following of activities:

- geological development works,
- extraction of minerals from deposits;
- underground tankless storage of substances;
- underground landfilling of waste;
- underground carbon dioxide storage for the purpose of carrying out a demonstration project of carbon dioxide capture and storage [9].

With reference to the act of The Geological and Mining law, it should be noted, that there are a lot of regulations which are necessary to be take into account:

[9] Journal of Laws of 2021, item 1420, consolidated text;

- The Regulation of the Polish Minister of Energy dated 23 November 2016 on detailed requirements for running underground mining plants [10];
- The Regulation of Polish Minister of Climate and Environment of 8 December 2017 on mining plant operation plans [11];
- The Regulation of Polish Minister of Climate and Environment of 23 December 2020 on other geological documentation [12];
- The Regulation of Polish Minister of the Environment of 30 October 2017 on the collection and sharing of geological information [13];
- Minister of the Environment of 29 January 2013 on natural hazards in mining plants [14].

The remaining list of regulations that can be relevant to the recognized technology is at the point 3.2.1. of this report.

The technology of underground coal gasification, on the one hand, continues to be of interest to coal mining circles, and on the other hand, it raises concerns related to the threat to the environment. In particular, due to the possibility of contamination of surface and groundwater during the gasification process or the deformation of surfaces and soils.

As a result, it is important - among other acts regulating the use of this technology, to take into account the following:

- Environmental Protection Law, dated 27 April 2001 [15];
- The Construction Law, dated 7th July 1994 [16];
- The Water Law dated, 20th July 2017 [17];
- The real estate management, 21st August 1997 [18];
- Planning and spatial development, dated 27th March 2003 [19];
- Protection of agricultural and forest land dated 3rd February 1995 [20];
- Providing information on the environment and its protection, public participation in environmental protection and environmental impact assessment dated 3rd October 2008 [21].

[10] Journal of Laws of 2017, item 1118, consolidated text;

[11] Journal of Laws of z 2017, item 2293;

[12] Journal of Laws of z 2020, item 2449;

[13] Journal of Laws of z 2017, item 2075;

[14] Journal of Laws of z 2015, item 1702, consolidated text;

[15] Journal of Laws of 2020; item 1219, consolidated text.

[16] Journal of Laws of 2020, item 1333, consolidated text.

[17] Journal of Laws of 2021, item 624, consolidated text.

[18] Journal of Laws of 2020, item 1990, consolidated text.

[19] Journal of Laws of 2021, item 741, consolidated text.

[20] Journal of Laws of 2021, item 1326, consolidated text.

[21] Journal of Laws of 2021, item 247, consolidated text.

2.2.2. UNITED KINGDOM

European Directive 2010/75/EU [22] on industrial emissions, better known as The Industrial Emissions Directive (IED) requires an integrated approach to be taken to pollution control, for regulating the most potentially polluting industrial processes, with the objective of protecting human health and the environment. The environmental requirements for both Underground Coal Gasification (UCG) and Coal Bed Methane (CBM) recovery may be subject to this directive.

In England and Wales the legislation derived from the Industrial Emissions Directive is the Environmental Permitting (England and Wales) Regulations 2016 [23] that consolidated and replaced the Environmental Permitting (England and Wales) Regulations 2010. In Scotland, The Pollution Prevention and Control (Scotland) Regulations 2012 (PPC 2012) [24] are the regulations that implemented the Directive and in Northern Ireland it was brought into effect by the Pollution Prevention and Control (Industrial Emissions) Regulations (Northern Ireland) 2013 (the PCC Regulations) [25].

Similar to environmental legislation, some planning requirements for UCG and CBM are derived from European Directives. Directive 2011/92/EU [26], as amended by Directive 2014/52/EU [27], requires that planning applications for certain public and private projects be accompanied by an Environmental Impact Assessment (EIA). Projects requiring EIAs are those deemed to have significant effects on the environment, with UCG and CBM considered such developments. In the UK, the legislation that implements the Directives requirements are The Town and Country Planning (Environmental Impact Assessment) Regulations 2017

[22] Directive 2010/75/EU of the European Parliament and of the Council On industrial emissions (integrated pollution prevention and control) Official Journal of the European Union, Page No. L 334/17 (Dated 24th Nov. 2010)

[23] Statutory Instrument 2016/1154 The Environmental Permitting (England and Wales) Regulations 2016

[24] Statutory Instrument 2012 No.360 The Pollution Prevention and Control (Scotland) Regulations 2012 (PPC 2012)

[25] Northern Ireland Statutory Rules 2013 N.160 Pollution Prevention and Control (Industrial Emissions) Regulations (Northern Ireland) 2013

[26] Directive 2011/92/EU of the European Parliament and of the Council On the assessment of the effects of certain public and private projects on the environment. Official Journal of the European Union, Page No. L 26/1 (Dated 13th Dec. 2011)

[27] Directive 2014/52/EU of the European Parliament and of the Council Amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment. Official Journal of the European Union, Page No. L 124/1 (Dated 16th April 2014)

in England [28], in Wales [29], in Scotland [30] and The *Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2017* [31] for Northern Ireland.

At the outset of the development of the technologies the UK Government announced that UCG could only be carried out off-shore or under estuarial sites which was later extended to deep, thin and/or fractured coal seams that were not economic to mine by conventional methods. In 2012, a Government website also advised that Carbon Capture and Storage (CSS) would be a requirement for UCG. As Government policy was not to allow on-shore storage of carbon dioxide it meant that any capture gas would have to be transported to the North Sea and injected into depleted oil wells. The potential costs associated with the requirements, together with the fact that CCS was unproven technology (and remains so), at the required industrial scale, put any plans for development of UCG into abeyance.

In the UK, Scotland, Wales and Northern Ireland have their own governments whereas the UK Government also acts as the government for England. These governments have also been granted certain devolved powers that include responsibility for the environment and planning. Until recently, the governments with the exception of England had their own policies regarding UCG and CBM that basically opposed developments, due to concern that the technologies could not be undertaken in an environmentally safe manner.

On the 8th December 2016 the UK Government stated it was minded not to support the UCG technique due to the fact that this technology still poses a risk of contamination and pollution [32,33]. It is believed that, due to the use of this technology, mining will be “dirtier” than conventional methods of using coal. In consequence, there is little certainty as to what the government may decide to do with the development of this technology and new solutions are still sought after in the hope that they would comply with the EU environmental protection framework [34].

With policies requiring costly and unproven technology and a lack of support from the devolved governments there is currently no interest for the development of UCG and CBM in the UK.

For more detailed information please check Appendix: The Environmental Permitting and Planning Requirements for Underground Coal Gasification and Coal Bed Methane (Recovery) Facilities in the UK.

[28] Statutory Instrument 2017 No.571 The Town and Country Planning (Environmental Impact Assessment) (England) Regulations 2017

[29] Statutory Instrument 2017 No.567 (W.136) The Town and Country Planning (Environmental Impact Assessment) (Wales) Regulations 2017

[30] Statutory Instrument 2017 No.102 The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017

[31] Northern Ireland Statutory Rules 2017 N.83 The Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2017

[32] <https://corporatetwatch.org/underground-coal-gasification-scrapped-in-the-uk-2/>

[33] <https://www.energylivenews.com/2016/12/09/uk-plans-to-ban-underground-coal-gasification/>

[34] <https://www.theguardian.com/environment/2016/dec/08/underground-coal-gasification-uk-gas-coal>

2.2.3. GERMANY

Germany has significant resources of hard coal and lignite. While the underground mining of hard coal ceased at the end of 2018, surface mining of lignite proceeds. With respect to in-situ gasification, the country had been involved in the Belgian-German Thulin pilot in the mid-1980s, a first test that was performed at great depths, when the technology was considered viable. But after this pilot, no licenses have been applied for and no further activities concerning underground coal gasification were conducted. Consequently, there has no legal regulatory framework specifically for UCG-SNG been developed in Germany. It is anticipated that commercial UCG will only be possible in Germany if this technology will be publicly accepted and proven to be environmentally friendly in terms of greenhouse gas emissions, groundwater pollution, mining wastes, and other environmental and social aspect (SLO – Social license to operate) including the early-stage involvement of affected community and policy. The potential coal license areas in Germany are under the old rights, so called Mine ownership, which will not expire. Most of the rights for hard coal are owned by the German consolidated hard coal company RAG AG. For lignite mining three active production regions still exist: the Rhenish, the Central German and the Lusatian mining areas, where opencast mines are operated by RWE, ROMONTA as well as the Mitteldeutsche Braunkohlegesellschaft (MIBRAG), and the Lausitz Energie Bergbau AG (LEAG), respectively.

For UCG, the actually existing regulatory framework for coal as the resource could be applied. The most important act for this is The German Federal Mining Law (BBergG) – dating back to 13th August 1980 with several subsequent amendments (latest version 27. June 2020) [35] which comprises all mining aspects from exploration via the extraction up to the mine closure. Under the supervision of the Mining Authorities this act may cover the in-situ gasification process and all required surface installations, as well as gas separation. It does not cover the utilization of the produced gas. The act principally distinguishes between mineral resources excluded from and included in freehold ownership. Resources included in freehold ownership are the property of the surface owner and typically mined from surface, mainly non-metallic and non-fuel minerals like e.g. sand, clay and building stones. All other resources are excluded from freehold ownership, and are owned by the state and leased to the operators for a certain time.

Germany's strict environmental standards are based, among others, on European law requirements. In addition, the protection of the environment is the government's responsibility [36]. Germany supports the European “Green Deal”. The gradual phase-out of coal-fired

[35] The German Federal Mining Law (latest version 27. June 2020) ; <http://www.ecolex.org/ecolex/ledge/view/RecordDetails;jsessionid=6E691758A770D5EC4A1FB95B38147D2B?id=LEX-FAOC075676&index=documents>

[36] Deutscher Bundestag, 2019, Basic Law for the Federal Republic of Germany, Article 20a; <https://www.btg-bestellservice.de/pdf/80201000.pdf>

power generation in Germany by 2038 at the latest was passed by the Bundestag and Bundesrat as a law on 3rd July 2020. The remaining coal-fired power plant capacity in Gigawatts is expected to drop for lignite by 2038. For hard coal, capacity is expected to fall to almost zero as early as 2034. Bringing forward all closures after 2030, and thus a completion date of 2035, is feasible. In 2026, 2029 and 2032, it will be reviewed whether the end date for all closures of lignite and hard coal power plants scheduled for 2030 and beyond can be brought forward by three years in each case, so that the exit year 2035 can be achieved. If this decision is made in time - as agreed with the operators of the lignite-fired power plants - the earlier coal phase-out can take place without further compensation.

The elections of the new German Bundestag in September 2021 strengthened the demand of the Green Party in particular to push for an earlier coal phase-out by 2030. Coalition negotiations are currently underway, and it can be assumed that the Green Party will form part of the new German government.

Moreover, to consider the underground coal gasification technology properly, the following environmental, industry and land use planning acts constitute the most relevant legislation:

- Environmental Impact Assessment Act (Gesetz über die Umweltverträglichkeitsprüfung), published in 1990 and amended by an Act of 18 August 1997, with a dedicated Ordinance on the Environmental Impact Assessment of Mining Projects (UVP-V Bergbau);
- Federal Soil Protection Act (Bundes-Bodenschutzgesetz), including regulation pertaining to groundwater [37];
- Water Resources Act (Wasserhaushaltsgesetz) [38];
- Federal Emission Control Act (Bundes-Immissionsschutzgesetz) [39];
- Federal Nature Conservation Act (Bundesnaturschutzgesetz);
- Hazardous Incident Ordinance (Störfall-Verordnung);
- Life Cycle Management Act (Kreislaufwirtschaftsgesetz);
- Greenhouse Gas Emissions Trading Act (Treibhausgas-Emissionshandelsgesetz);
- Carbon Capture Storage Demonstration Act (Kohlendioxid-Speicherungsgesetz);
- State Waste Disposal Act – LabfG [40];
- Recycling and Waste Management Act or the German Circular Economy Law (Kreislaufwirtschaftsgesetz) [41];
- Environmental Damage Prevention and Remediation Act (Umweltschadensgesetz)
- Chemicals Act (ChemG) - law on protection against dangerous substances;

[37] Federal Soil Protection Act; <http://www.elaw.org/node/1469>

[38] Water Resources Act; <http://www.iuscomp.org/gla/statutes/WHG.htm>

[39] Federal Emission Regulation; <http://www.berlin-klimaschutz.de/en/climate-protection-berlin/federal-german-laws-and-regulations>

[40] State Waste Disposal Act; <http://www.umweltbundesamt.de/en/topics/waste-resources/waste-management/waste-regulations>

[41] Recycling and Waste Management Act; <http://www.umweltbundesamt.de/en/topics/waste-resources/waste-management/waste-regulations>

- Chemicals Prohibition Ordinance (ChemVerbotsV);
- Ordinance on Hazardous Substances (GefStoffV);
- Occupational Safety and Health Law (Arbeitsschutzgesetz);
- Environmental Liability Act (Umwelthaftungsgesetz);
- Energy Industry Act (Energiewirtschaftsgesetz);
- Federal Mining Act (Bundesberggesetz) 1980 together with Health and Safety Ordinance, 1995 and the
- Federal General Mining Ordinance 1995, contains detailed provisions on risk assessment of mines and mining activities;
- Land Use Planning Law (Land Mecklenburg-Vorpommern) on land use and regional planning;
- Federal Building Code (Baugesetzbuch) and the Federal Land Utilization Ordinance (Baunutzungsverordnung).

The Seveso III Directive (Directive 2012/18/EU of the European Parliament) that was transposed into German law in December 2016, added necessary regulations and provides additional opportunities for public participation during the approval process for hazardous incident plants and court access.

In Germany, the mining industry observes also several ancillary regulations, standards and ordinances, such as:

- Markscheider Mining Regulation (MarkschBergV),
- General Federal Mining Regulation (ABBergV),
- Health Protection Mining Ordinance (GesBergV) [42],
- Workplace Ordinance (ArbStättV),
- Deep Drilling Ordinance (BVOT) on drillings carried out for the purpose of exploration, exploitation and monitoring are generally subject to mining law.

2.2.4. CZECH REPUBLIC

The regulatory framework for the extraction of mineral deposits in the Czech Republic is generally defined by the Law No. 44 of 1988 (the Mining Law) [43]. The last amendment (so far a total of 44) of the Mining Law was issued in March 2021 (published in the Collection of Laws of the Czech Republic on 1st March 2021). The purpose of this Law is to establish the principles of protection and economic use of mineral deposits, treatment and refining of

[42] Health Protection Mining Ordinance, or Environmental Damage Act;
http://www.cgerli.org/index.php?id=50&tx_vmdocumentsearch_pi2%5BdocID%5D=369

[43] Czech Republic Mining Law No. 44 of 1988, The last amendment in March 2021;
<https://www.wug.gov.pl/download/5391,5499.pdf>

minerals carried out in connection with their extraction, as well as operational safety and environmental protection in these activities. Additionally, the relevant regulations of the European Union are incorporated into this Law.

The conditions for the UCG-SNG itself are not explicitly stated in the law. UCG-CNG were discussed by the Parliament of the Czech Republic only once, in 2013, when an amendment to the Mining Act was proposed banning UCG for coal mining. However, this amendment to the Mining Act was not approved by the Parliament of the Czech Republic.

The Ministry of Industry and Trade of the Czech Republic published in 2017 “Raw Materials Policy of the Czech Republic in the Field of Mineral Raw Materials and their Resources”, which responded to the economic and mining developments in Europe as well as in the world [44]. Alongside, it fulfilled the European Raw Materials Strategy Initiative and related documents. In the framework of this document, in the chapter dedicated to “Unconventional Fuel and Energy Sources”, it is proclaimed that:

“No exploration or the use of UCG is envisaged until the potential environmental risks of using this unconventional method have been thoroughly identified”.

2.2.5. FRANCE

In France, mining is not an important economic sector. In 2015, the aggregated revenues from the mining industry represented EUR6.3 million, or 0.3% of the French gross domestic product [45]. Exploration and extraction of mineral resources are regulated by the French Mining Code and its implementing texts.

Article L111-6 of the French Mining Code was created by law n°2017-1839 of December 30th, 2017 [46]. It promulgated the gradual cessation in France of exploration and exploitation of coal, as well as of liquid or gaseous hydrocarbons, whatever the technique used. France is aiming for a definitive cessation of exploration and exploitation of coal and hydrocarbons on January 1st, 2040.

French mining code defines two administrative regimes regarding the exploration and exploitation of coal, hydrocarbons and ores:

- The *exclusive exploration permit*, which gives the exclusive right to search for either coal, hydrocarbons or ores in a given geographical area and the right to dispose of products extracted during the exploration works, as well as the exclusive possibility of requesting a concession (see 2nd bullet point) in the area of the permit. It is granted

[44] <https://www.mpo.cz/en/construction-and-raw-materials/raw-material-policy/raw-material-policy-minerals-in-the-cr/new-raw-material-policy-for-minerals-and-their-resources---mpo-2017--233052/>

[45] [https://uk.practicallaw.thomsonreuters.com/w-010-8138?transitionType=Default&contextData=\(sc.Default\)](https://uk.practicallaw.thomsonreuters.com/w-010-8138?transitionType=Default&contextData=(sc.Default))

[46] Article L111-6 of the French Mining Code; https://www.legifrance.gouv.fr/codes/article_lc/LEGIARTI000036397272

for a period of up to 5 years, renewable twice at most. See articles L122-1, L122-3 and L142-1 of the French mining code.

- The *mining concession*, which grants the right to mine a substance [47] for an initial duration of up to 50 years. The duration may be the subject of successive extensions, each of less than or equal to 25 years. See articles L131-1, L132-11 and L142-7 of the French mining code.

Should be noted, that there is presently no valid exploration permit and mining concession for coal in France. A UCG project in France would start with an exclusive exploration permit to confirm the presence and characteristics of seams suitable for gasification and would continue with a mining concession for the operational exploitation phase.

Considering article L111-9 of the French Mining Code no longer authorizes to deliver new permits or concessions for coal, the exploitation of coal, including UCG, is now not allowed in France.

2.3. UCG IN THE NON-EU COUNTRIES

Research on underground coal gasification has been conducted in the world since the early 20th century. Till now, more than 50 UCG experiments have been conducted, including more than 30 in the USA. In Australia, a successful trial of continuous underground gasification was conducted (the Chinchilla project, carried out in the years 1998 – 2006). Great interest in UCG technology and exploration works are also conducted in Canada. Due to the long history of this technology, there is a lot of documented information available from these experiments. Report presents the legal framework in the three non-EU countries: USA, Canada and Australia, where works on the UCG process were most advanced and described.

2.3.1. USA

The United States have a long history regarding underground coal gasification process. After World War II, the shortage in energy provoked an interest in new technologies in the United States. UCG tests were conducted in 1947–1958 in Gorgas, Alabama [48]. From 1973–1989,

[47] Article L111-1 of the French mining code lists mineral or fossil substances which are under the legal mining regime. All hydrocarbons and fossil fuels (except peat), whether in solid, liquid or gaseous form are under this regime.

[48] „Research and Technologic Work on Alabama Coals: An Annotated Bibliography” Reynold Quinn Shotts, John B. Gayle. U.S. Department of the Interior, Bureau of Mines, 1963; <https://books.google.pl/books?id=Z7FO8iuox5AC&pg=PA91&lpg=PA91&dq=1947%E2%80%931958+in+Gorgas,+Alabama+underground+coal+gasification&source=bl&ots=5Fejw1wOcu&sig=ACfU3U0oVdyYfWI-DNIm6ZZ0cg2AZ24e8Q&hl=pl&sa=X&ved=2ahUKewjB1pCK4or0AhWVuosKHbtMBZcQ6AF6BAqbEAM#v=onepage&q=1947%E2%80%931958%20in%20Gorgas%2C%20Alabama%20underground%20coal%20gasification&f=false>.

extensive testing was carried out. The United States Department of Energy and several large oil and gas companies conducted several tests. Lawrence Livermore National Laboratory conducted three tests in 1976–1979 at the Hoe Creek test site in Campbell County, Wyoming [49]. Livermore conducted also UCG experiments in 1981–1982 at the WIDCO Mine near Centralia, Washington [49]. In 1979–1981, an underground gasification of steeply dipping seams was demonstrated near Rawlins, Wyoming. The program culminated in the Rocky Mountain trial in 1986–1988 near Hanna, Wyoming [50]. Because previous UCG experiments in the 1970s and 1980s have caused a huge negative environmental impact (groundwater contamination) the UCG process is categorized and regulated by the Environmental Protection Agency (EPA). From the technical point of view the UCG process is in-situ fossil fuel recovery well and it's categorized as Class V underground injections wells [49]. In-situ fossil fuel recovery wells are defined in the existing Underground Injection Control (UIC) regulations, authorized by the Safe Drinking Water Act (SDWA), as “*injection wells used for the in-situ recovery of lignite, coal, tar sands, and oil shale.*” [51, 52]. In 1999, the EPA conducted a report to evaluate the risk posed by all Class V underground injection wells to underground sources of drinking water (USDW) [49, 53]. The EPA notes that differences in operation scale may have significant effects on contamination. In the U.S., “in situ fossil fuel recovery operations have all been at the pilot scale, a scale at which reaction zone temperatures are not able to reach those expected for full-scale operations” [49]. Apart from Safe Drinking Water Act and Underground Injection Control Program (UIC), UCG developers and operators in the United States have to conform to the following regulations [54]:

- Surface Mining, Reclamation and Control Act (1977) [55],
- National Environmental Policy Act (NEPA) (1969) [56],
- Endangered Species Act (ESA) (1973) [57],
- Mineral Leasing Act (1920),
- Antiquities Act (1906),
- Archaeological Resources Public Protection Act (1979).

[49] „Best Practices in Underground Coal Gasification” Elizabeth Burton, Julio Friedmann, Ravi Upadhye. Lawrence Livermore National Laboratory, 2019; <https://www.osti.gov/servlets/purl/1580018>

[50] „Early Ideas in Underground Coal Gasification and Their Evolution” A.Y. Klimenko, *Energies* 2009, 2(2), 456-476; <https://doi.org/10.3390/en20200456>.

[51] Underground Injection Control Regulations (EPA) <https://www.epa.gov/uic/underground-injection-control-regulations>

[52] Safe Drinking Water Act (SDWA) <https://www.epa.gov/sdwa>

[53] <https://www.epa.gov/sdwa>

[54] Kościarz R., Rogut-Dąbrowska A. (2015) “Report on the EU regulatory framework for combined UCG-CCS” report prepared as part of the implementation of the project TOPS: “Technology Options for Coupled Underground Coal Gasification and CO₂ Capture and Storage”

[55] <https://www.govtrack.us/congress/bills/95/hr2>

[56] <https://www.energy.gov/nepa/downloads/national-environmental-policy-act-1969>

[57] <https://www.fws.gov/endangered/laws-policies/>

Some states that are active in UCG develop their own regulations, for example Wyoming state, where most of U.S. UCG tests were conducted (1976-1995). Wyoming developed environmental regulations Wyoming Environmental Quality Act [58] which mentions in-situ technologies (UCG and in-situ uranium mining): surface technologies regulated as Surface Coal Mine [59], and subsurface technologies regulated under Special In Situ Mining Rules and Regulations [60].

There are two pathways for obtaining permits to conduct the UCG process in Wyoming state:

- R&D Testing License (Test Area)
- Permit to Mine (Commercial Area)

Permitting Requirements in Wyoming state [61]:

- Adjudication File: Legal Information and Reclamation Bond
- Supportive Information: Land Use, Archeology, Geology, Hydrology & Water Rights, Vegetation, Wildlife, Wetlands, Alluvial Valley Floors
- Mine Plan: Process Description and Design, Layout, Waste Disposal, Monitoring
- Reclamation Plan: Bond Calculation, Shutdown Procedures, Groundwater Restoration and Monitoring, Surface Reclamation
- Review Process (60 - 180 Days):
 - Completeness Review
 - Technical Review
 - Public Notice
 - Appeals Process

However, it should be noted interest and activities in UCG and coal diminished in the latter years with plentiful oil and gas production from shale gas operations and greater weighting of the impacts from greenhouse gas emissions [62].

[58] <https://law.justia.com/codes/wyoming/2010/Title35/chapter11.html>

[59] <https://deq.wyoming.gov/land-quality/coal/>

[60] <https://www.nrc.gov/docs/ML1423/ML14236A004.pdf>

[61] James R. Covell "UNDERGROUND COAL GASIFICATION U.S. REGULATORY FRAMEWORK" EG&G Technical Services, Inc. URS, Inc. Subsidiary; https://fossil.energy.gov/international/Publications/cwg_june07_covell.pdf

[62] Camp D. "A Review of Underground Coal Gasification Research and Development in the United States" Lawrence Livermore National Laboratory 2017; https://energymining.sa.gov.au/_data/assets/pdf_file/0005/299678/UCG_US_RD_Review_Camp_TR-733952_6-29-2017final.pdf

2.3.2. CANADA (ALBERTA EXAMPLE)

Most of the Canada's coal reserves (over 95 %) are found in Alberta, British Columbia and Saskatchewan [63]. Of those three provinces, Alberta has the largest coal reserves. The Alberta Energy Regulator (AER) considers Alberta as a prime candidate for UCG because of the province's coal quality and quantity. There are two UCG projects: Swan Hills Synfuels Ltd. /Sagitawah Power Project (application in 2007 and approved in 2008) [64] and Laurus Energy Canada Inc. (application in 2009 and approved in 2011) [65].

To 2011, Alberta did not have any specific set of rules to deal with UCG. UCG projects were reviewed and approved under the provisions of section 39 of the the Oil and Gas Conservation Act (OGCA), which deals with experimental gas recovery schemes [66]. In 2011, The Alberta Energy Regulator (AER) adopt a tailor-made regulatory framework for UCG activities [66]. The result was Bill 16 ENERGY STATUTES AMENDMENT ACT 2011 [67], which proposed a series of UCG-specific amendments to various provincial statutes. The new regulatory framework, is based on the Coal Conservation Regulations [68], the Oil and Gas Conservation Act (OGCA) [69] and the Oil and Gas Conservation Rules [70]. The aspects of a UCG project that are related to the coal itself are regulated under the Coal Conservation Act (CCA) [71]. Other activities that are similar or identical to oil and gas development, such as the drilling of wells, are included under the OGCA. The approval for in situ coal schemes is set out in section 29 of the CCA. Wells and other facilities are licensed under the OGCA. The construction of a pipeline at the UCG site is regulated and approved under the Pipeline Act [72]. The amended CCA contains redefined and new terms such as coal, coal seams, evaluation well, observation well, in situ coal gasification, in situ coal liquefaction, in situ coal scheme, synthetic coal gas, and synthetic coal liquid [66]. CCA defines in situ coal gasification as the "thermal or chemical conversion of coal into synthetic coal liquid in an underground coal seam using an industrial process".

⁶³ <https://www.thecanadianencyclopedia.ca/en/article/coal>

[64] <http://shsynfuels.shiff10.com/coal-gasification/demonstration-project/>

[65] https://www.ergoexergy.com/about_us_ourb_projects_laurus.htm

[66] Astrid Kalkbrenner, Underground Coal Gasification: A Regulatory Framework for Alberta, 2014 51-3 Alberta Law Review 525, 2014 CanLII Docs 58; <https://albertalawreview.com/index.php/ALR/article/view/48/48>

[67] BILL 16 ENERGY STATUTES AMENDMENT ACT, 2011; https://docs.assembly.ab.ca/LADDAR_files/docs/bills/bill/legislature_27/session_4/20110222_bill-016.pdf

[68] Coal conservation rules, Alta Reg 270/1981; <https://www.canlii.org/en/ab/laws/regu/alta-reg-270-1981/latest/alta-reg-270-1981.html>

[69] Oil and Gas Conservation Act, RSA 2000; <https://www.canlii.org/en/ab/laws/stat/rsa-2000-c-o-6/latest/rsa-2000-c-o-6.html>

[70] Oil and gas Conservation Rules, Alta Reg 151/1971; <https://www.canlii.org/en/ab/laws/regu/alta-reg-151-1971/latest/alta-reg-151-1971.html>

[71] Coal Conservation Act, RSA 2000; <https://www.canlii.org/en/ab/laws/stat/rsa-2000-c-c-17/latest/rsa-2000-c-c-17.html>

[72] Pipeline Act, RSA 2000; <https://www.canlii.org/en/ab/laws/stat/rsa-2000-c-p-15/latest/rsa-2000-c-p-15.html>

Apart from the above mentioned requirements, the applicant of a UCG project must comply with abundant relevant Energy Resources Conservation Board (ERCB) Directives [66].

Alberta's regulatory framework for UCG activities is based upon long experience with other natural resources extraction and development, especially oil, gas, and coal activities. Due to availability and detailed description Alberta's UCG regulatory framework may be used as a model for other jurisdictions.

2.3.3. AUSTRALIA

In Australia, the initial pilot UCG plant was situated at the Chinchilla site (Queensland). The project at Chinchilla was being developed by Linc Energy Ltd. in December 1999 and ran continuously until April 2002.

UCG process was considered as a mining process and as such were administered in the same way as a coal mining project [73]. As a mining project UCG was regulated through legislation at a state level by the Mineral Resources Act 1989 (MR Act) [74], Environmental Protection Act 1994 (EP Act) [75] and the Environmental Protection and Other Legislation Amendment Act 2000 [76]. In terms of Environmental Impact Statement (EIS) requirements an EIS were triggered at a state level by the requirements of the EP Act, State Development and Public Works Organisation Act 1971 (SDPWO Act) or federally by the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) [73].

During the operation of the Chinchilla project there was no specific reference to UCG in the Mineral Resources Act, however with increasing interest in the technology, the Government subsequently included a clause [77]:

“a product that may be extracted or produced by an underground gasification process for coal or oil shale (mineral (f)) and another product that may result from the carrying out of the process (also mineral (f)),”.

On this basis, coal used for the UCG process has been referred to as a “mineral (f)”.

However, in 2017 the Queensland Government has announced Strong and Sustainable Resource Communities Act which imposes a moratorium prohibiting UCG [78]. Following

[73] A. Beath, S. Craig, A. Littleboy, R. Mark and C. Mallett “UNDERGROUND COAL GASIFICATION: EVALUATING ENVIRONMENTAL BARRIERS” Exploration and Mining Report P2004/5 Prepared for CSIRO Energy Transformed Flagship 2004; <https://publications.csiro.au/rpr/download?pid=legacy:2099&dsid=DS1>

[74] Queensland Mineral Resources Act 1989 <https://www.legislation.qld.gov.au/view/pdf/inforce/current/act-1989-110>

[75] Queensland Environmental Protection Act 1994; <https://www.legislation.qld.gov.au/view/pdf/inforce/current/act-1994-062>

[76] Queensland Environmental Protection and Other Legislation Amendment Act 2020; <https://www.legislation.qld.gov.au/view/html/asmade/act-2020-026>

[77] K.R. Garner and L.K. Walker “UNDERGROUND COAL GASIFICATION. THE FINAL FRONTIER – DEVELOPING A REGULATORY FRAMEWORK” Energy & Environment · Vol. 26, No. 6 & 7, 2015, p. 965- 983.

[78] Strong and Sustainable Resource Communities Act 2017; <https://www.legislation.qld.gov.au/view/whole/pdf/inforce/current/act-2017-028>

trials of the UCG technology and a technical report from the Queensland Independent Scientific Panel for Underground Coal Gasification, the government has concluded that the risks associated with UCG process outweigh any potential benefits [79, 80].

Apart from the fact that the UCG process is banned in Australia, past trials and the widely described legal framework provide a good example for regulators in other countries.

3. CBM EXTRACTION TECHNOLOGY – LEGAL FRAMEWORK (NATIONAL LAW, EU AND NON EU COUNTRIES)

Currently, one of the most important tasks of the European Union is to ensure energy security. To meet this challenge, new solutions which might contribute to the acquisition of low-emission energy sources are sought. It is especially important due to EU's policy on climate and environmental protection, as well as climate neutrality, due by 2050. In relation to the above, the use of clean coal technologies may be an attractive form of obtaining energy. Hence, the technology of underground coal gasification in conjunction with CBM may be a response to the needs of the EU.

It should be noted that the use of methane from fossil fuels is currently a major challenge for entrepreneurs, both in terms of quantity as well as economic efficiency. Hence, both entrepreneurs and states are testing existing technologies in order to use and reduce the emission of methane.

In this regard, especially the oil and gas and coal industries require common regulations and approach, as well as the exchange of good practices. It appears that more reliable data is needed on methane emission sources, technology monitoring, and reliable warning systems informing about potential methane leakage. Hence, especially in the coal industry, improving the use of coal mine methane as well as addressing methane leakage issues in active and closed mines remain an important issue. Measures aimed at providing financial support in the form of subsidies, grants or loans can also help in reducing methane. Also, an appropriate tax system may contribute to the achievement of a positive result.

3.1. CBM EXTRACTION TECHNOLOGY IN THE EU DIRECTIVES

The review of the EU legislation shows that in relation to CBM, there are no legal regulations devoted directly to this issue, nor in the case of underground coal gasification. In this context, the application of the existing EU regulations, including regulations, directives, and

[79] <https://www.hopgoodganim.com.au/page/knowledge-centre/legislation-update/queensland-resources-and-energy-update-september-2017>

[80] <https://www.abc.net.au/news/2015-08-10/linc-energy-secret-report-reveals-toxic-chemical-risk/6681740>

communications of the European Commission, can be considered. Below are selected legal acts that should be properly applied in relation to CBM.

The European Green Deal – a new strategy of the European Union, which aims to contribute to EU's neutrality by 2050. In fact, the European Green Deal is a response to the climate crisis and environmental devastation. In compliance with the assumptions set out in this Communication, the EU should:

- a) become climate neutral,
- b) should establish resource efficient and environmentally friendly economy,
- c) should constitute a fair and prosperous society.

What is important, these assumptions are to be supported by the recently adopted European Climate Law. In addition, The European Green Deal aims to decarbonise the energy system. The EU Commission underlined that the problem of methane emission is to be solved while the climate neutrality is to be achieved, as per the framework of the European Green Deal [81].

European Climate Law – contains objectives that are legally binding for all member states; the first objective states that climate neutrality ought to be reached by 2050, while the second one states that net greenhouse gas emission should be reduced by 2030. As a rule, the provisions of the European Climate Law indicate that all EU strategies and policies, various social groups and each sectors of the economy should ensure that the implementation of the strategy be included in the European Green Deal. These regulations, in turn, will enable greater predictability for economic entities participating in the reduction of emissions and investing in renewable energy sources. In order to ensure direct application of the provisions by all Member States, this law was enacted in the form of a regulation [82].

Communication on an EU strategy to reduce methane emissions – contains a strategy ensuring a significant reduction in methane emissions in the energy, agricultural and waste management sectors both in the EU, and internationally. These activities are to enable the implementation of obligations included, inter alia, in the European Green Deal. The intention is that the Commission should monitor the progress in reducing methane emissions through the EU's greenhouse gas emission balances. Reporting is to be based on the framework set

[81] Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions- "The European Green Deal", COM(2019) 640 final.

[82] Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (C No 401/2009 and (EU) 2018/1999 ("European Climate Law").

out in the United Nations Framework Convention on Climate Change and the United Nations Environment Program [83].

Directive 2015/21/93 on the limitation of emissions of certain pollutants into the air from medium combustion plants – as far as medium combustion sources are concerned, it introduces emission values for sulphur dioxide, nitrogen oxides and dust. It requires operators to obtain an appropriate permit or registration. It also introduces an obligation to monitor emissions. Pursuant to Art. 2 the Directive applies to combustion plants with a rated thermal input of not less than 1 MW and less than 50 MW (hereinafter referred to as “medium combustion plants”), irrespective of the type of fuel they use. In addition, the Directive also applies to fusions of new medium combustion plants, as defined in Art. 4, including fusions where the total rated thermal input is not less than 50 MW, unless the fusion constitutes a combustion plant that falls within the scope of Chapter III of Directive 2010/75/EU. By contrast, the Directive does not apply to, inter alia, research activities, development activities nor the testing of medium combustion plants [84].

Directive 2012/27/EU on energy efficiency – sets the framework for activities to promote energy efficiency in the EU to achieve its target and increase energy efficiency by 20% by 2020, as well as the conditions for improving energy efficiency after that date. It indicates the need to remove barriers on the energy market and to overcome market failures. The directive also specifies national energy efficiency targets for 2020.

In connection with the adopted European Green Deal, there is a plan to amend the Directive in order to achieve the required results in energy efficiency by 2030. The European Commission has submitted an appropriate proposal in this regard, which is part of the “Delivering European Green Deal” package [85].

Directive (EU) 2018/2001 on the promotion of the use of Energy from renewable sources (recast) – establishes a common framework for promoting energy from renewable sources.

The Directive is primarily intended to:

- set a binding overall target on the total share of energy from renewable sources in the EU in 2030,
- establish rules for financial support for electricity from renewable sources and for self-consumption, the use of energy in the heating and cooling sector and in the transport sector,

[83] Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions on an EU strategy to reduce methane emission COM(2020) 663 final.

[84] Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emission of certain pollutants into the air from medium combustion plan.

[85] Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC,

- define sustainability and greenhouse gas emission criteria for biofuels, bioliquids and biomass fuels. This directive is to ensure the development of renewable energy sources and is part of the EU policy focused on reducing greenhouse gases and achieving the EU goal of climate neutrality in 2050. Hence, together with the revised Energy Efficiency Directive, they are part of a package “Clean Energy for all Europeans” [86].

In the remaining scope, the list of directives mentioned in point 2.1. for UCG-SNG in the EU directives, may be applicable.

3.2. CBM EXTRACTION IN THE EU COUNTRIES (NATIONAL REGULATIONS)

3.2.1. POLAND

In Poland, the subject of methane extraction from deposits is becoming more and more attractive. As a rule, Poland has one of the largest hard coal deposits in Europe as far as methane is concerned. Currently, about 5 billion cubic meters of gas is produced annually, which covers part of the domestic demand. Some parts of the gas are imported. Therefore, the production of methane from coal can supplement of domestic demand. The first research works on the acquisition of methane in the conditions of the exploited deposit were carried out in Gilowice in 2016. During the experiment, a lot of focus was part on three important elements:

- increased safety in mines,
- lower operating costs,
- the ecological factor [87,88].

Issues related to the extraction of methane are regulated directly by the Act of June 9, 2011 Geological and Mining Law (Journal of Laws of 2021, item 1420 consolidated text) and the implementing acts to this act.

According to Art. 6 sec. 16 of the Geological and Mining Law - hydrocarbons - constitute crude oil, natural gas and their natural derivatives, as well as methane occurring in hard coal deposits, with the exception of methane occurring as an accompanying mineral.

[86] Directive (EU) 2018/2001 on the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast).

[87] Internet source: <https://ww.pgi.gov.pl> – Methane form coal beds in Gilowice

[88] T. Słoczyński , A.Drozd „Coalbed methane (CBM) – global experience and the prospects of development in Poland, Nafta-Gaz, Rok LXXIII, nr 11/2017

From this point of view Coalbed Methane (CBM) should be considered as:

- main mineral
- accompanying mineral

As per Art. 21 of the Geological and Mining Law, activities in the field of prospecting and exploration of hydrocarbon deposits and the extraction of hydrocarbons from deposits require a concession. Such concessions are granted by the minister responsible for the environment.

In addition to the aforementioned act, the following acts should be taken into account when extracting methane from deposits:

- Environmental protection law (Journal of Laws of 2020, item 1219);
- Act on the provision of information on the environment and its protection, public participation in environmental protection and on environmental impact assessments (Journal of Laws of 2020, item 283);
- Act on mining waste (Journal of Laws of 2020, item 2018);
- The Waste Act (Journal of Laws of 2020, item 797);
- The Water law (Journal of Laws of 2020, item 310);
- Civil Code (Journal of Laws of 2020, item 1740);
- Act on the protection of agricultural and forest land (Journal of Laws of 2017, item 1161);
- Act on land use planning and space management (Journal of Laws of 2020, item 293);
- The Construction Law (Journal of Laws of 2020, item 1333).

List of implementing acts to the Geological and Mining Law:

- Accounting report and templates of information on changes in mineral deposit resources.(Journal of Laws 2021.998 consolidated text);
- Application for the conduct of the qualification procedure (Journal of Laws 2021.73);
- Other geological documentation. (Journal of Laws 2020.2449);
- Mining plant operation plans (Journal of Laws 2017.2293);
- Collection and sharing of geological information (Journal of Laws 2017.2075);
- Detailed scope of the corporate policy on the prevention of dangerous events and accidents (Journal of Law 2017.1975);
- The minimum content of the report on the implementation of the mining plant operation plan (Journal of Laws 2017.1615);
- Specific requirements for operation of underground mining plants (Journal of Laws 2017.1118);
- Mining rescue (Journal of Laws 2017.1052);
- Specific requirements for the storage and use of blasting agents and blasting equipment in the operation of mining plant (Journal of Laws 2017.321);

- Hydrogeological documentation and geological-engineering documentation (Journal of Laws 2016.2033);
- Surveying and geological documentation (Journal of Laws 2015.1941);
- Natural hazards in mining plants (Journal of Laws 2015.1702);
- Tender for the granting of a concession for the exploration of a hydrocarbon deposit and the extraction of the hydrocarbons from a deposit, as well as a concession for the extraction of hydrocarbons from a deposit (Journal of Laws 2015.1171)
- Geological documentation of a mineral deposit, excluding a hydrocarbon deposit (Journal of Laws 2015.987);
- Documentation of geological and investment documentation hydrocarbon deposit (Journal of Laws 2015.968);
- Providing information from current documentation of geological work (Journal of Laws 2015.903);
- Specific requirements for the operation of mining plants extracting minerals through boreholes (Journal of Laws 2014.812);
- Specific requirements for the operation of the opencast mining plant (Journal of Laws 2013.1008);
- Detailed requirements for deposit development projects (Journal of Laws 2012.511);
- Tender for the establishment of mining usufruct (Journal of Laws 2012.101);
- Underground landfills (Journal of Laws 2011.298 item 1771);
- Use of geological information for remuneration (Journal of Laws 2011.292 item 1724).

Regardless of the above, it is worth mentioning that in 2017, the International Centre of Excellence in Coal Methane (ICE-CMM) was established in Katowice at the Chamber of the Gas Industry.

The Polish founders of the ICE-CMM established at the Chamber of the Gas Industry are:

- 1) Polish Oil and Gas Industry (PGNiG), the Polish Geological Institute - National Research Institute (PGI-NRI),
- 2) Oil and Gas Institute - National Research Institute (INiG - PIB),
- 3) Central Mining Institute (GIG).

3.2.2. UNITED KINGDOM

As was mentioned in the Chapter 2.2.2. the environmental requirements for both Underground Coal Gasification (UCG) and Coal Bed Methane (CBM) recovery are defined in

Directive 2010/75/EU [89] on industrial emissions, better known as The Industrial Emissions Directive (IED). Therefore, these two technologies are subject to the same legislation and are discussed together in the chapter 2.2.2.

For more detailed information please check also Appendix I: The Environmental Permitting and Planning Requirements for Underground Coal Gasification and Coal Bed Methane (Recovery) Facilities in the UK.

3.2.3. GERMANY

Natural gas plays a key role in Germany's mix of energy sources, whereby it is the second most important (22.6 %) primary energy source, after petroleum [90]. Germany will continue to be highly dependent on imports of natural gas. In relation to this issue, serious consideration of whether and to what extent any future extraction of natural gas from unconventional deposits (tight gas, shale gas, coal gas - coal bed methane, firedamp - aquifer gas and gas hydrate) would allow to further decrease this share is still not possible at the moment [90].

At the beginning of the 1990s there were attempts to produce CBM in Germany. A consortium of Ruhrkohle AG, Ruhrgas AG and the American Conoco drilled two wells in the "Sigillaria" permit field in Münsterland until 1997, but abandoned the project due to low gas production rates. In the western German state of Saarland, DSK AG also drilled two wells into the Upper Carboniferous. The gas supply was higher than in the Ruhr area, but even in the gas-richest well, the maximum production rate was not economic.

Renewed explorations of CBM potential in Germany were started in 2008 by ExxonMobil Production Deutschland GmbH in Lower Saxony and North Rhine-Westphalia, but were suspended again a short time later due to a German "fracking" moratorium. This moratorium is a major restriction, since even exploratory wells may not be drilled unless hydraulic stimulations can be ruled out for the entire exploration area. More specifically, the agreement issues a ban on what is termed unconventional fracking until 2021 at the earliest. Thereafter, it will be up to the German Bundestag to decide whether or not these regulations should remain in place. That is a comparatively strict agreement, because unless the German Bundestag takes specific action at that stage, the ban will remain in place. Therefore,

[89] Directive 2010/75/EU of the European Parliament and of the Council On industrial emissions (integrated pollution prevention and control) Official Journal of the European Union, Page No. L 334/17 (Dated 24th Nov. 2010)

[90] Federal Ministry of Economic Affairs and Energy;
https://www.bmwi.de/Redaktion/EN/Textsammlungen/Energy/gas.html?cms_artId=255592

unconventional commercial fracking projects will not be permitted in Germany until further notice [91].

Thus, for CBM, no specifically legal regulatory framework has been developed to date. However, the actually existing regulatory framework for Coal mine methane (CMM), also known as Coal Seam Methane (CSM), and Abandoned Mine Methane (AMM) as coal resource, may serve the purpose, regulating exploration, extraction, and utilization of CBM. CMM is released during the process of coal mining. When underground mines cease operations and are abandoned, they still liberate methane for decades to come. This methane is known as AMM [92]. Coal mines capture CMM mostly for safety reasons, but CMM and AMM are also valuable energy resources. Capturing and utilizing methane from active and abandoned mines can increase a country's energy supply [92]. Many countries developed commercial projects to exploit CMM and AMM to supply gas, generate power and heat, or a combination of these. This will not only secure energy for the country but will also significantly reduce GHG emissions.

In Germany, the Federal Mining Act (BBergG) provides a legal framework for ownership issues that defines rules and procedures for all parties [92]. The former coal mine operator has the right of first refusal on the rights to AMM. Since methane emissions that affect the climate are avoided, the generation of electricity and heat from CMM even falls under the Renewable Energy Act [93]. This act provides a feed-in-tariff for previously authorized projects to generate electricity using CMM or AMM. Power grid operators are also obliged to provide priority dispatch to sources run on CMM or AMM [92]. The feed-in-tariff for methane-based power generation under the Renewables Energy Sources Act of 2004 (RESA) has been a primary incentive driving active development of CMM and AMM recovery and utilization projects [94].

The legal framework set by the Federal Mining Act provides rules for the licensing process, transfer of ownership, and royalties. Specifically, the Federal Mining Authority oversees issues related to exploration, extraction, and utilization of the methane [92]. Though Germany is a world leader in CMM/AMM utilization, there has never been endemic disputes over methane rights recorded [92].

[91] Statement of the German Federal Government, 2017. Package of regulations comes into force – No fracking in Germany. Press and Information Office of the Federal Government; <https://www.bundesregierung.de/breg-en/issues/sustainability/no-fracking-in-germany-391340>

[92] Legal and Regulatory Status of Abandoned Mine Methane in Selected Countries: Considerations for Decision Makers, EPA Publication No:430R19003 (2019).

[93] German Renewable Energy Law (EEG 2017) and cross-border renewable energy tenders. German Federal Ministry for Economic Affairs and Energy; <https://www.irena.org/-/media/Files/IRENA/Agency/Events/2017/Mar/8/Bmwi-2017-German-renewable-energy-law-EEG-2017-and-crossborder-renewableenergy-tenders.pdf?la=en&hash=F0B4747F830901A25885C1752FAAE800D84A41A0>

[94] Best Practice Guidance for Effective Methane Drainage and Use in Coal Mines. 2nd edition. ECE ENERGY SERIES No. 47. United Nations Economic Commission for Europe. Geneva, Switzerland, 2017; https://www.unece.org/fileadmin/DAM/energy/cmm/docs/BPG_2017.pdf

The Federal Mining Act treats mine gas as a freely mineable mineral resource [95]. The guidelines also state that electricity from renewable energy sources and from mine gas is to be integrated into the electricity supply system [96]. To explore and extract mineable resources, including methane, companies have to apply for exploration and extraction licenses, respectively. An extraction license grants exclusive rights to extract and acquire ownership to the resources, specified in the license [95]. The law does not have separate rules for AMM or CMM licenses; companies simply follow the regular processes for petroleum licenses. When a coal mine operator obtains a coal license, it automatically includes a license to the gas. Once a mine is abandoned, the former mine operator must re-apply for an AMM license. The former operator does not get the first right of refusal in case multiple companies are interested in the AMM license. The Federal Mining Law provides details on license application procedures as well as reasons for rejecting license applications. The maximum initial duration of exploration licenses is five years while extraction licenses can exceed 50 years [95]. The main points regarding the regulations for AMM extraction are: licenses are given by the regional coal authority; every qualified company can apply for a license; existing facilities can be used by the new license owner; fixed technical regulation for extracting stations [97].

3.2.4. CZECH REPUBLIC

Within the current version of the Mining Law (see Chapter 2.2.4.), CBM gas is defined in Section 3. According to this definition, CBM belongs to the group of technically recoverable gases with the exception of natural gas. In accordance with Section 30 of the Mining Law, deposits of CBM must be exploited rationally and economically. The rational exploitation of exclusive deposits of CBM means their extraction and the treatment and refinement of the extracted gas in accordance with the principles of this Law. Additionally, extraction must take into account current technical and economic conditions. Furthermore, extraction must be in accordance with the principles of the appropriate mining technology. Occupational health and safety are observed as well. Last but not least, unjustified adverse effects on the working and living environment must be avoided.

Another legal act addressing utilization of CBM is Law No 165 of 2012 (the Law on Supported Energy Sources). This Law incorporates the relevant European Union regulations and regulates the support of electricity and heat from renewable energy sources, secondary

[95] Federal Mining Act (BBergG). Federal Ministry of Economic Affairs and Energy; http://www.gesetze-im-internet.de/englisch_bbergg/englisch_bbergg.html

[96] Renewable Energy Sources Act (EEG 2017). Federal Ministry of Economic Affairs and Energy; https://www.bmwi.de/Redaktion/EN/Downloads/E/eeg-2017-gesetz-en.pdf?__blob=publicationFile&v=2

[97] Interessensverband Grubengas IVG e.V., 2020. AMM project development in Germany: regulations, financing, examples of projects; http://www.grubengas.de/used_pics/200225_A-TEC-AMM-Germany-2.pdf

energy sources and high-efficiency combined production of electricity and heat. It also regulates the exercise of state administration and the rights and obligations of natural and legal persons in connection therewith. Moreover, the purpose of this Law is to promote the use of renewable sources, secondary sources and high-efficiency cogeneration of electricity and heat in the interests of climate protection and environmental protection.

According to the definition of this Law, CBM belongs to the category of secondary sources. The support for electricity from these secondary sources applies to electricity produced in combined heat and power plants using secondary sources that meet the minimum energy use efficiency set by the implementing legislation. In the case of electricity production from CBM, the combined production of electricity and heat shall not be a condition for electricity support.

3.2.5. FRANCE

Article L111-6 of the French mining code was created by law n°2017-1839 of December 30, 2017. It promulgated the gradual cessation of exploration and exploitation of gaseous hydrocarbons, as well as of coal and liquid hydrocarbons, whatever the technique used. France is aiming for a definitive cessation of exploration and exploitation of coal and hydrocarbons on January 1st, 2040.

As for UCG, a CBM project in France would start with an exclusive exploration permit to confirm the presence and characteristics of seams suitable for coal bed methane production and would continue with a mining concession for the operational exploitation phase.

There is presently only one valid exploration permit relative to CBM in France, but no concession. This permit concerns the French eastern coal basin, where a drilling programme is undergoing since 2017 in order to study the feasibility to produce methane from unmined seams located between 1,000 and 1,500 meters deep. No stimulation, including fracturing, of the seams and bed rocks can be done as it is forbidden by French law (article L111-13 of the French mining code). After dewatering, CBM is expected to be produced thanks to the pressure gradient and through the already existing natural fractures network in coal. The feasibility study should end in 2022 and could lead to a production phase before the definitive cessation of exploitation of gaseous hydrocarbons planned by French law on January 1st, 2040.

It should be noted, that French law differentiates CBM and CMM. Indeed, the exploitation of coal mine methane (CMM) will be still authorized after January 1st, 2040 according article L111-6 of the French mining code. As defined in article L111-5, CMM is the methane gas located in the previously exploited coal seams, the recovery of which is carried out without interventions other than those made necessary to maintain a low pressure in the mining voids containing this gas in order to produce it.

3.3. CBM EXTRACTION IN THE NON-EU COUNTRIES

3.3.1. USA

The U.S. Geological Survey estimates that there may be over 700 trillion cubic feet of CBM in the U.S. with more than 100 trillion cubic feet economically recoverable [98]. The 2017 production of coalbed methane in the United States was 0.98 trillion cubic feet (TCF), 3.6 percent of all US dry gas production that year. The 2017 production was down from the peak of 1.97 TCF in 2008.

The Bush Administration's national energy policy and other policy statements emphasize expanding U.S. sources of natural gas, including a number of recommendations applicable to CBM development, and have cited CBM as the most promising short term supply of natural gas. To encourage CBM development, the Bureau of Land Management (BLM), has streamlined the permit process for new leases. Similarly, pending energy legislation also addresses CBM development, providing tax incentives and clarifications of legal questions that arguably have hindered investment in additional extraction.

Energy Policy Act of 2003 (S. 2095, 108th Cong. § 1359) would encourage CBM development. Bill would provide a tax credit to CBM developers [99]. Additionally, the energy bill provides for an unconventional natural gas resources program, in which the Secretary of the Interior is directed to carry out an unconventional natural gas research program (§ 941). It also authorizes the Secretary to make grants to "research consortia." (§ 943).

The environmental impacts of CBM development are considered by various governmental bodies during the permitting process and operation.

Federal Act & Regulations:

The Clean Water Act (CWA): Section 404 Regulations (33 Parts 320-330) and 404(b)(1) - Under the CWA, EPA has implemented pollution control programs such as setting wastewater standards for industry.

In terms of CBM technology EPA regulations apply to the two most common methods of handling CBM produced water:

- If the water is discharged to a surface stream, it must be done under an *National Pollutant Discharge Elimination System (NPDES) permit* which regulates the amount of acceptable pollution that a discharger may lawfully release into the nation's waters or a federally compliant state equivalent.

⁹⁸ U.S. Geological Survey, "Coal-Bed Methane: Potential and Concerns," USGS Fact Sheet, FS123-00, October 2000.

[99] Energy Policy Act of 2003; S.2095 - „To enhance energy conservation and research and development and to provide for security and diversity in the energy supply for the American people.”

- If the water is disposed of by underground injection, is subject to *Underground Injection Control (UIC) Program*.

Safe Drinking Water Act (SDWA) for the Underground Injection Control Program (42 U.S.C.300h et seq.)- is the main federal law that ensures the quality of Americans' drinking water.

National Environmental Policy Act:

National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 et seq.) NEPA requires all federal agencies to: 1. Assess the environmental impacts of major federal projects or decisions such as issuing permits, spending federal money, or actions that affect federal lands. 2. Consider the environmental impacts in making decisions. 3. Disclose the environmental impacts to the public.

As natural gas wells, most of the permitting and regulation of coalbed methane is done by state and local governments [100]. Operators are required to obtain building permits for roads, pipelines and structures, obtain wastewater (produced water) discharge permits, and prepare Environmental Impact Statements. As with other natural resource utilization activities, the application and effectiveness of environmental laws, regulation, and enforcement vary with location.

3.3.2. CANADA (ALBERTA EXAMPLE)

The Alberta Geological Survey, has estimated that as much as 14 trillion cubic metres of coalbed methane is present in Alberta. In 2012, nearly all coalbed methane wells drilled in Alberta have targeted the thinner coal seams in the Horseshoe Canyon (ultimate gas in place 179 Tcf) and Belly River coal zones along the Calgary-Red Deer corridor. Wells targeting these seams tend to produce gas with little or no water, with production referred to as "dry CBM". The first commercial production of CBM in Alberta was from these coals, and they constitute the majority of CBM reserves booked.

On August 1991 Alberta Energy and Utilities Board published the Coalbed Methane Regulation (Informational Letter IL 91-11) [101]. According to this regulation The Energy Resources Conservation Board (ERCB) and Alberta Department of Energy (Energy) consider coalbed methane to be a form of natural gas. As a result, all acts and regulations administered by the ERCB and Energy that pertain to natural gas also pertain to coalbed methane. Applicable legislation under the jurisdiction of the ERCB and Energy includes :

[100]

https://web.archive.org/web/20080521091129/http://www.deq.state.mt.us/coalbedmethane/Laws_regulations_permits.asp#state

[101] https://static.aer.ca/prd/2020-07/il91-11_0.pdf

- The Energy Resources Conservation Act, RSA 2000 [102],
- The Gas Resources Preservation Act (updated June 17, 2013) [103],
- The Oil and Gas Conservation Act (June 15, 2020) [104],
- The Mines and Minerals Act (July 23, 2020) [105],

and regulations related to these acts.

The authorities regulate coalbed methane production in the same way that other natural gas operations. The application, exploration, drilling, and production processes are all the same, as are the operational regulations.

Other requirement directives:

Directive 035: Baseline Water Well Testing Requirement for Coalbed Methane Wells Completed Above the Base of Groundwater Protection (May 08, 2006) [106]. This directive details updates to well licence and recompletion requirements to help applicants and licensees meet requirements in the Alberta Environment and Parks' (AEP) "Standard for Baseline Water Well Testing for Coalbed Methane/Natural Gas in Coal Operations" which came into effect on May 1, 2006 [107].

Directive 056: Energy Development Applications and Schedules (October 03, 2019) [108]. This directive contains the technical requirements for applying to construct or operate facilities, pipelines, or wells. Procedural instructions and forms can be found in Manual 012: Energy Development Applications, Procedures and Schedules (March 2020) [109].

Directive 062: Coalbed Methane Control Well Requirements and Related Matters (April 01, 2010) [110]. This directive details requirements and issues specific to the control well process and supersedes any previous AER publication on coalbed methane control well requirements. A control well is established for the purpose of collecting pressure, productivity, and gas content information to allow for an understanding of gas resources in coals.

[102] Energy Resources Conservation Act, RSA 2000, c E-10; <http://canlii.ca/t/kzbn>

[103] <https://open.alberta.ca/publications/g04>

[104] <https://www.qp.alberta.ca/documents/Acts/O06.pdf>

[105] <https://www.qp.alberta.ca/documents/Acts/m17.pdf>

[106] <https://www.aer.ca/regulating-development/rules-and-directives/directives/directive-035>

[107] <https://open.alberta.ca/publications/standard-for-baseline-water-well-testing-for-coalbed-methane-natural-gas-in-coal-operations>

[108] <https://www.aer.ca/regulating-development/rules-and-directives/directives/directive-056>

[109] <https://static.aer.ca/prd/documents/manuals/Manual012.pdf>

[110] <https://www.aer.ca/regulating-development/rules-and-directives/directives/directive-062>

3.3.3. AUSTRALIA (QUEENSLAND EXAMPLE)

Queensland has a long history of conventional oil and gas production. Initially, these developments formed the basis of regulatory approaches, as set out and modified in more recent legislation. The first modern commercial production and sale in Australia began in 1996 in Queensland.

A key Act that has governed the development of CBM in Queensland is the Petroleum and Gas (Production and Safety) Act 2004 [111] that determines the 'compensable effect' for landholders from CBM authorised activities.

The rapid growth of the industry in recent years and its massive expansion have led to various changes from this petroleum-based regulation to one more specifically tailored to CBM issues, with a large number of regulatory instruments specific to the industry introduced in recent years.

These include a :

- Land Access Code (2010) [112],
- Code of Practice for Constructing and Abandoning Coal Seam Gas Wells (2011) [113],
- Code of Practice for CSG Well Head Emissions Detection and Reporting (2011) [114],
- Strategic Cropping Land Act (2011) [115],
- Coal Seam Gas Water Management Policy (2012) [116].

In 2010, Queensland specifically banned BTEX chemicals used in the CBM sector and instituted a Land Access Code intended to support best practices for resource projects (including CBM) on private land.

In March 2014, the Queensland Government passed a Regional Planning Interests Act 2014 [117], intended to recognise and protect four key areas of interest:

- (1) priority agricultural areas;
- (2) priority living areas;
- (3) strategic environmental areas; and
- (4) strategic cropping areas.

[111] <https://www.legislation.qld.gov.au/view/pdf/inforce/current/act-2004-025>

[112] https://www.dnrme.qld.gov.au/_data/assets/pdf_file/0009/193086/land-access-code-2010.pdf

[113] http://www.rlms.com.au/gbof/wp-content/uploads/2013/08/csg_code_of_practice.pdf

[114] http://www.rlms.com.au/gbof/wp-content/uploads/2013/08/code_practice_well_leak_class.pdf

[115] <https://www.legislation.qld.gov.au/view/pdf/inforce/2013-02-01/act-2011-047>

[116] https://environment.des.qld.gov.au/_data/assets/pdf_file/0034/89386/rs-po-csg-water-management-policy.pdf

[117] <https://www.legislation.qld.gov.au/view/html/inforce/current/act-2014-011>

Under this Act, resource development may only occur in areas if proponents reach agreement with a landholder, or if a Regional Interest Development Approval is granted. The Regional Planning Act has mandated the Gasfields Commission with a new statutory role to provide advice to the Government. The legislation has, at least in part, helped to redress the power imbalance between landholders and potential resource developers, by partially giving landholders a say in what will actually occur on their land.

A timeline of the major regulatory developments in Queensland is shown in Figure 1.

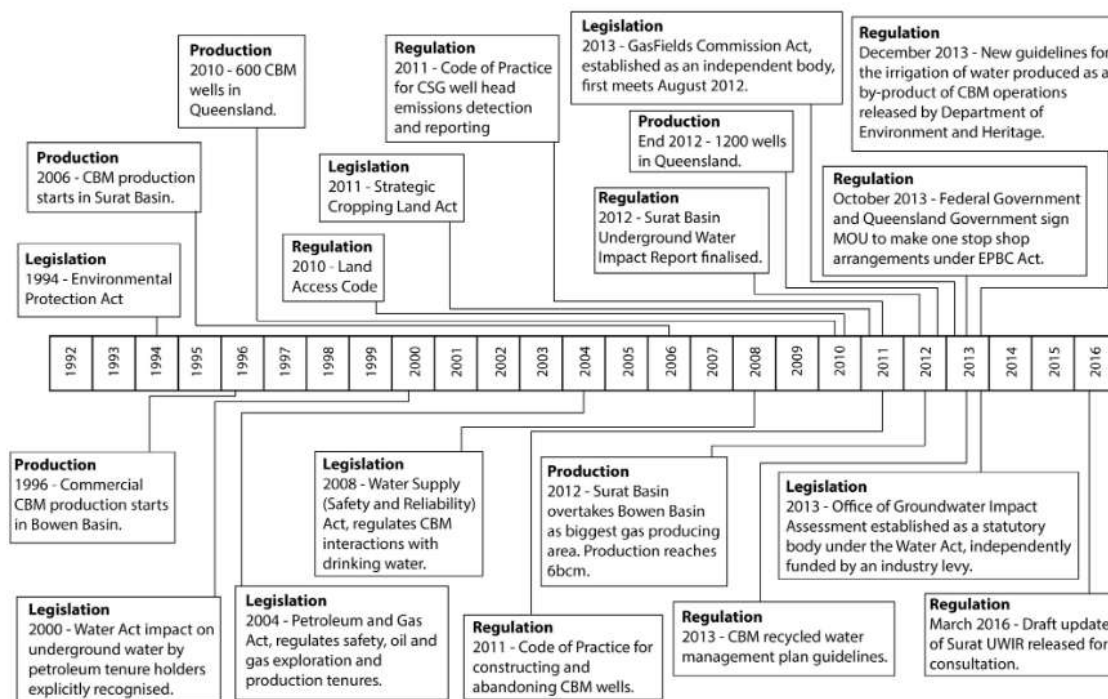


Figure 1 Timeline of the major regulatory developments in Queensland [118].

In summary, the evolutionary path to regulatory oversight in Queensland started with the general use of existing petroleum legislation, then moved quickly to more specific and complex legislation and oversight, with more purpose-designed institutions.

The proliferation of legislation, bodies and regulatory guidelines has been equally rapid, albeit very focussed on the unconventional gas industry, especially CBM [118].

[118] I. Cronshaw, R. Quentin Grafton „A tale of two states: Development and regulation of coal bed methane extraction in Queensland and New South Wales, Australia” Resources Policy 2016 (50), p.253-263

4. CONCLUSIONS AND LESSONS LEARNT

The aim of this report was to provide guidelines and some kind of signposts as to what needs to be done to facilitate the future implementation of the new UCG-CBM combined technology on an industrial scale. In order to achieve this goal, a review of the current state of law in the project member countries and EU has been carried out with regard to the implementation of the UCG-CBM technology. The review of the EU legislation and project partners' national laws shows that in relation to UCG and CBM, there are no legal regulations that directly regulate the use of these technologies. Both at the EU level and in individual EU countries, the regulations that could be used in relation to UCG and CBM are significantly dispersed. Most often, in order to assess the technology and its application, acts related to mining law, environmental protection, fuel, and implementation acts to the former. If the UCG and CBM technologies are to be commercially deployed at a large scales all issues need to be addressed in the regulatory framework. Stable and precise legal regulations will contribute to increased commercial interest in the use of UCG and CBM. Hence, it would be reasonable to develop a common regulatory framework for the mining, energy and chemical industries. The lack of this kind of framework in the future may discourage potential investors.

For the implementation of the UCG-CBM process to be possible, it is necessary to undertake intensive cooperation and dialogue by representatives of the state administration and industrial partners. Their joint activities should aim at providing support for investors in the initial period of technology implementation (e.g. in the form of grants or credits for investors). It is also important to change the regulations in the field of geology and mining. It seems reasonable that the law should recognise the UCG technology as one of the forms of coal mining. Then it will be possible to obtain a concession for the exploitation of the mineral using this technology. Such a solution would make the process of obtaining permits much easier and would encourage potential investors. Consideration should also be given to the fact that the law should give operators a guarantee that a commercial project can be realised in the long term.

The main purpose of UCG is to convert the coal in the deposit into gas. The implementation of this process entails a number of advantages. However, ecological considerations are a significant obstacle and should not be overlooked. Field implementations of the underground coal gasification process are associated with potential environmental hazards. The UCG operation is inevitably related to the formation of hazardous environmental contaminants and the pollution of groundwater is considered to be the most serious possible negative environmental impact of UCG. Hence, there is a strong opposition among ecological communities to the technology. Therefore, the key issue is to reconcile this technology with meeting the requirements related to environmental protection. For this purpose, it is necessary to solve environmental issues and broaden social awareness of the UCG and CBM technology itself, as well as its benefits. A review of current EU legislation has shown

that the European Union has a number of standards and directives relating to environmental protection.

In the times of energy crisis and the geopolitical situation in the world, independence of energy sources can be extremely appealing. Interest in the clean coal technologies (including also UCG-CBM) is growing, partly due to the fact that the new technology is expected to be less harmful to the environment. Companies from the mining industry perceive the underground coal gasification technology as an alternative method of mining small coal seams located at large depths, where traditional mining is unprofitable or even unfeasible. Hence, planning further research and investment projects could influence the development of these technologies and confirm their technical and economic profitability. Synergistic close cooperation is necessary on the part of administrative bodies, regulatory bodies as well as representatives of industry and the world of science.

It is difficult to pinpoint specific actions because of the different degree of advancement of legislative work in the project countries as well as the different attitudes of state administrations towards coal based energy production. Countries such as France or the UK are completely abandoning the use of coal as a source of energy. Countries such as Poland, for example, are looking more favourably on new coal technologies.

The UCG process can be described as a remote underground mining method. It is therefore appropriate to consider the regulation of UCG operations as an extension of the existing legislation and the regulation for mining activity (in exploration and resource utilization). The treatment/processing and end use of produced syngas is covered by the legislation which regulates surface activity (specifically Occupational Health and Safety – OH&S), and existing legislation for environmental management and control. As in the case of Australia, existing mining regulations can be readily adapted to provide the necessary development framework.

For the regulation of the environmental impacts, it is possible to follow a similar approach. The principles embodied in mining and environmental legislations will require little modification to accommodate the UCG and CBM process. In relation to UCG and CBM, both activities can be regulated as “Unconventional Gases” by European Directive 2010/75/EU on industrial emissions, better known as The Industrial Emissions Directive (IED). This Directive requires an integrated approach to be taken to pollution control, for regulating the most potentially polluting industrial processes, with the objective of protecting human health and the environment.

Alberta’s UCG and CBM regulatory framework may be also used as an example. Also, a good solution seems to be the establishment of one institution/legal body which would issue the necessary jurisdictions and control the whole process. An example of this can be The United States of America Environment Protection Agency (US EPA). The US EPA is responsible for assisting persons and entities with compliance and compliance monitoring to detect breaches in environmental laws and regulations (through civil administrative actions,

civil judicial actions and criminal actions). In addition the US EPA sets national standards, which act as the minimum standards for State laws.

In addition to legal and economic considerations, much attention should be paid to public opinion and awareness-raising campaigns. The UCG-CBM technology may be viewed negatively by the general public due to, for example, the famous environmental contamination which occurred in Australia. This may raise great concerns in the public. It is therefore important that a lot of attention should be paid to conducting information campaigns and public consultations in order to dispel doubts. It is important to emphasise that the UCG-CBM process can be carried out in a controlled and safe manner using modern technological solutions and taking into account all environmental requirements. Furthermore coal gasification is a technology that is recognised as one that can enhance energy security and contribute to economic development by relying on domestic energy resources for power generation and the chemical sector. This is especially important for countries where coal is the key and main source of energy, such as Poland or Hungary. This is because it not only manages the coal it already possesses, but also guarantees its profitable and ecological use and thus to meet EU requirements on reducing greenhouse gas emissions, while using hard coal as the primary energy source.

Summarizing all considerations, the key issues regarding the UCG and CBM regulatory framework can be concerned in the following aspects:

- Coal concessions for alternative methods of extraction (clean coal technologies).
- Supporting the introduction of new technologies by the authorities.
- Environmental impact aspects.
- Financial and Investment support for investors.
- Regulatory conflict of interest.

After discussing these issues, it is necessary to evaluate the current legislation and then provide a realistic framework that could be considered for implementation in the individual countries. In order to achieve the above-mentioned and effective solutions, it is necessary to undertake the following actions:

1. Preparation of transparent regulations at the EU level and bottom-up in the use of UCG and CBM technologies, including those that regulate licensing issues and the environmental impact.
2. Expanding of public awareness to enable the acceptance of the proposed UCG and CBM technology.
3. Conducting further research, experiments and promotional activities for the development of innovative technologies.
4. Making the results of the project available to entrepreneurs and experts who represents the mining, energy, chemical industries and other potential investors

and/or experts. This will enhance interest in the results by government and regulatory bodies.

5. Commercial implementation of the technology.

The Environmental Permitting and Planning Requirements for
Underground Coal Gasification and Coal Bed Methane
(Recovery) Facilities in the UK.

Dr. Graham Wadelin

GDW 26/10/2020

Executive Summary

This report has considered the environmental permitting and planning requirements for Underground Coal Gasification (UCG) and Coal Bed Methane (CBM) technologies in the UK. While it is possible to meet all the legislative requirements for permitting and planning, the UK and its devolved governments all have policies that oppose the construction and operation of these facilities. Government consensus is that the facilities cannot be operated in an environmental safe manner but without their consent it is difficult to envisage any development of this type gaining approval. However, the report describes how the procedures would function in practice, if the embargo were to be lifted.

Government opposition to UCG and CBM recovery has led to the author's enquiries about permitting, licensing and planning being treated by the authorities as an academic exercise, without any belief that the facilities will actually achieve approval. However, with the damage to the economy and jobs losses created by Covid-19 this position may change, due to the opportunities for displacing natural gas imports, job creation and fuel security arising from exploitation of the UK's own coal reserves. A change of government policy might also be forthcoming if the image of UCG could be improved and this matter is discussed in an addendum to the report.

Introduction

The environmental requirements for both Underground Coal Gasification (UCG) and Coal Bed Methane (CBM) recovery are defined in Directive 2010/75/EU [1] on industrial emissions, better known as The Industrial Emissions Directive (IED). This Directive requires an integrated approach to be taken to pollution control, for regulating the most potentially polluting industrial processes, with the objective of protecting human health and the environment. This protection is achieved by the requirement that all emissions from regulated processes are prevented (as far as practicable), and that any emission that cannot be prevented be rendered harmless, prior to discharge. Operators are required to install the Best Available Techniques (BAT) to control their processes and guidance as to what constitutes BAT can be found in BAT Reference Documents (BREFs), published by both the European Commission and the UK's environmental regulators.

As European Directives require particular results to be achieved, without dictating the means of achieving them, they have to be transposed into member states own legislation. The European Commission ensures that not only the requirements of a Directive but also its spirit are implemented. In this way the EC ensures a "level playing field" and that no member state achieves an unfair advantage by avoiding costly requirements that might have been installed by other states, which might lead to a distortion of trade. Therefore, *the environmental legislative requirements for UCG and CBM should be the same for each member state.*

In England and Wales the legislation derived from the Industrial Emissions Directive is the Environmental Permitting (England and Wales) Regulations 2016 [2] that consolidated and replaced the Environmental Permitting (England and Wales) Regulations 2010. In Scotland, The Pollution Prevention and Control (Scotland) Regulations 2012 (PPC 2012) [3] are the regulations that implemented the Directive and in Northern Ireland it was brought into effect by the Pollution Prevention and Control (Industrial Emissions) Regulations (Northern Ireland) 2013 [4] (the PCC Regulations).

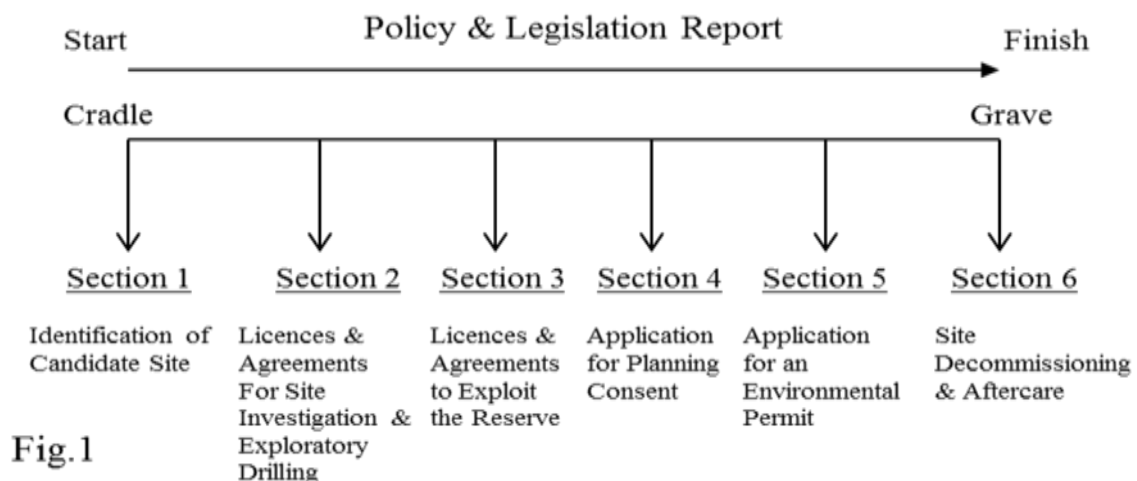
Similar to environmental legislation, some planning requirements for UCG and CBM are derived from European Directives. Directive 2011/92/EU [5], as amended by Directive 2014/52/EU [6], requires that planning applications for certain public and private projects be accompanied by an Environmental Impact Assessment (EIA). Projects requiring EIAs are those deemed to have significant effects on the environment, with UCG and CBM considered such developments. In the UK, the legislation that implements the Directives requirements are The Town and Country Planning (Environmental Impact Assessment) Regulations 2017 [7] in England, The Town and Country Planning (Environmental Impact Assessment) (Wales) Regulations 2017 [8] in Wales, The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017 [9] in Scotland and *The Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2017 [10] for Northern Ireland. To assist UCG and CBM developers both the European Commission and the regulators have published a series of documents on the subject of EIA, which are discussed in Section 4.*

As legislative requirements are the same in all member states it raises the question of why progress on implementing UCG and CBM technologies has stalled in the UK. At the outset of the development of the technologies the UK Government announced that UCG could only be carried out off-shore or under estuarial sites which was later extended to deep, thin and/or fractured coal seams that were not economic to mine by conventional methods. In 2012, a Government website also advised that Carbon Capture and Storage (CSS) would be a requirement for UCG. As Government policy was not to allow on-shore storage of carbon

dioxide it meant that any capture gas would have to be transported to the North Sea and injected into depleted oil wells. The potential costs associated with the requirements, together with the fact that CCS was unproven technology (and remains so), at the required industrial scale, put any plans for development of UCG into abeyance.

In the UK, Scotland, Wales and Northern Ireland have their own governments whereas the UK Government also acts as the government for England. These governments have also been granted certain devolved powers that include responsibility for the environment and planning. Until recently, the governments with the exception of England had their own policies regarding UCG and CBM that basically opposed developments, due to concern that the technologies could not be undertaken in an environmentally safe manner. The UK Government allowed limited development, to establish whether the unconventional sources of gas could be safely exploited but on the 8th December 2016 the Government stated it was minded not to support the UCG technique. On the 2nd November 2019, following a number of earthquakes at an exploration fracking site for shale gas in England, it announced that fracking will not proceed until new evidence shows the technology is safe.

With policies requiring costly and unproven technology and a lack of support from the devolved governments there is currently no appetite for the development of UCG and CBM in the UK. However, the legislation and policy pertaining to such developments in the UK is explained in a cradle to grave approach (Fig.1) below.



The Oil & Gas Authority Regulatory Road Map should also be studied before proceeding:

<https://www.gov.uk/government/publications/regulatory-roadmap-onshore-oil-and-gas-exploration-in-the-uk-regulation-and-best-practice>

Section 1: Identification of Candidate Site

As mentioned in the introduction, during the development of UCG, the UK Government announced that the technology could only be practiced off-shore or beneath estuarial sites, which it later extended to deep coal seams that were uneconomic to mine by conventional means. None of these sites would be attractive to developers for UCG or UCG with CBM and, as it appeared unlikely that the UK's coal reserves would ever be conventionally mined, enquires were made to the Coal Authority as to whether more appropriate sites were now available. The Coal Authority owns the vast majority of unworked coal in the UK, as well as former coal mines, and is also responsible for licensing coal mining operations. Unfortunately, this action yielded no information as the author was quickly referred to the Government's moratorium on UCG and unconventional gas development [11].

The *British Geological Survey (BGS)* and the *Coal Authority* have produced a map showing the distribution of UK *coal* resources, both onshore and offshore [12]. If developers advise BGS of their requirements then BGS will identify suitable sites for exploration. In doing so developers should be aware of the requirements of the environmental regulator and planning authority, otherwise undesired compromises may have to be agreed for a chosen site. For instance, environmental regulators would be interested in coal seam depth and proximity to aquifers while planners would be concerned about impacts on the local community e.g. lorry movements, hours of working, noise and aesthetic issues.

Once a site has been selected the next stage will be to undertake investigative work, including the drilling of boreholes.

Section 2: Licences and Agreements for Site Investigation and Exploratory Drilling

There will be a need to carry out exploratory work, including drilling at the candidate site. This will also require a licence or an agreement with a number of parties, including the Landowner, Coal Authority (CA), Environmental Regulator, Health & Safety Executive, Petroleum Exploration and Development Licence (PEDL) Holder and the Mineral Planning Authority. The Mineral Planning Authorities are generally the District Planners (in England the Unitary Authorities) and the National Parks Authorities for the Parks.

The mineral rights to oil, gas, coal, gold and silver are in the ownership of the Crown in the UK (excluding Northern Ireland). PEDL rights are auctioned off from time to time so a developer would either have to purchase a PEDL or reach an agreement with an existing holder. Securing the right to explore and extract minerals does not necessarily provide access to the land under which they lie. To obtain access for exploration and ultimately extraction, agreement must be reached with the landowner, otherwise charges of trespass may ensue.

Under the Coal Industry Act 1994, any well entering or passing through a coal seam requires the agreement of the Coal Authority. Requirements for entering and provision of information includes, accurate plans and full well logs, including the method of drilling and method of treating and sealing of wells. Also, a record of equipment left in the well.

An application for an environmental permit (see Section 4) would need to be made to the environmental regulator for the management of the extractive waste (the operation of a UCG/CBM would need a separate permit). The developer must also serve notice on the regulator of the intention to "construct a boring for the purposes of searching for or extracting minerals". A Groundwater activity permit may also be required, unless the regulator is satisfied that there is no risk of inputs to groundwater.

Exploratory Drilling into coal seams without the requirement for fracking avoids the need for Mineral Planning Authority approval, as there is deemed consent for 28 days, provided a list of conditions is met. Deemed consent may be obtained for longer periods, provided a stricter set of conditions can be adhered too. To understand deemed consents and the conditions attached see:

<https://www.legislation.gov.uk/ukxi/1995/418/schedule/2/made>

The Health and Safety Executive are responsible for enforcement of legislation concerning drilled well design and construction. Before design and construction, operators must assess and take account of the geological strata, and fluids within them, as well as any hazards that the strata may contain.

Drilling to a depth of more than 300 meters to reach a coal seam also requires the consent of the PEDL Holder.

Section 3: Licences and Agreements to Exploit Reserve

UCG requires a licence from the CA and the forms, guidance notes and model documents for a UCG licence may be found at:

<https://www.gov.uk/government/publications/underground-coal-gasification-licences>

A PEDL grants exclusive rights to search and bore for, and get, petroleum within a specified area (a PEDL block). A PEDL covers the various stages of a development cycle from exploration to appraisal, production and eventually decommissioning of the wells. A PEDL does not remove the need for permission for specific operations that are required by law. Additional consents from the Landowner, Local Planning Authority, Environmental Regulator and Health & Safety Executive (HSE) are also required. Extraction from a particular block can only proceed with the agreement of the PEDL Holder.

It is a requirement that British Geological Survey be notified by the licensee of the intention to undertake drilling and, upon completion of drilling, it must also receive drilling records and cores

While securing the necessary licences for UCG and CBM recovery at a site, it does not necessarily provide a right of access and this matter will need to be negotiated with the Landowner.

Section 4: Application for Planning Consent

Developers must seek consent from the Planning Authority for all surface works associated with the UCG and CBM facility. As planning is a devolved power the developer will require consent from the planning authority local to the chosen site. In all cases the appropriate legislation for each national government is the 2017 Planning Regulations, referenced in the Introduction. The regulations require that for certain processes, including UCG and CBM, an Environmental Impact Assessment (EIA) together with an Environmental Statement (ES) are submitted with the application for Development Consent. The ES describes the written material submitted to the planning authority in fulfilment of the EIA regulations.

To assist developers, the European Commission has published a series of EIA guidance documents explaining Screening [13], Scoping [14] and preparation of an EIA report [15].

The UK Government has also provided guidance for oil and gas activities that covers far more than just the EIS:

<https://www.gov.uk/guidance/minerals#planning-for-hydrocarbon-extraction>

Environmental Regulators are consultation bodies for the Planning Regulations 2017 that require the competent authority to carry out mandatory consultation with the statutory consultees, to identify the issues that should be addressed in an EIA. They generally respond to scoping opinion requests and to applications accompanied by an ES. Advice may also be offered on likely significant effects and the suitability of the site for the proposed development.

The environmental requirements of planning authorities should only be concerned with the impacts associated with the site, from the initial groundwork to completion of construction. Any environmental requirements, associated with commissioning and operation of the facility, are the responsibility of the environmental regulatory and will be contained within the facilities Environmental Permit, once approved.

Section 5: Application for an Environmental Permit

Environmental powers are devolved to the UK National Governments, who each have their own environmental regulator responsible for legislative control of the most potentially polluting industrial processes, including UCG and CBM facilities. The regulators are the Environment Agency (EA) for England, Natural Resources Wales (NRW) for Wales, the Scottish Environmental Protection Agency (SEPA) for Scotland, and the Northern Ireland Environment Agency (NIEA) for Northern Ireland.

An application for an Environmental Permit must be submitted to the environmental regulator of the appropriate jurisdiction. The application must demonstrate that the planned operation can be carried out without causing damage to human health and the environment. The developer will also have to show that BAT will be employed and applied to achieve this objective.

It should be appreciated that the application must include not just the UCG/CBM systems but also any above ground activities associated with the facility. This may include gas cleaning, gas modification (reformation, methanisation, methanol production) gas stenching, process water treatment, etc. All these activities will have to employ BAT with the environmental standards and requirements applicable contained within the environmental permit, once issued. However, the regulator will not issue a permit until it is satisfied that the BAT proposed, for the development as a whole, will protect both human health and the environment.

To assist the developer the regulators have published their own sector guidance (Combustion Activities) as to what constitutes BAT, although the European Union has also produced similar BREF notes. However, there is currently uncertainty about the status of the regulatory guidance that has been withdrawn and not replaced in England but still available on the other national websites.

Following the UK government policy statement that CCS would be required for UCG, clarification was sought by industry. It was eventually established that CCS was only applicable where UCG syngas was used for electrical power generation, in facilities of 50MW_e and greater, but not for any other use of syngas. It is believed that the demand for CCS arose due to earlier government policy requiring CCS for any new coal burning power station. However, it was later appreciated a legislative loophole had arisen that would allow coal to continue to generate electricity on a large scale by way of UCG syngas, where there had been no requirement for CCS.

The paradox is that the environmental legislation only requires the use of best available techniques with “available” being defined as a proven technique at the industrial scale required and procurable by the operator. CCS is not proven technology at the required industrial scale and cannot be currently considered BAT. Reference to CCS as an emerging technique may also be discounted as representing BAT at this time. It is presumed that this is the reason why according to the regulators that any new coal burning power station development must be built CCS ready.

What will happen if and when an application is duly made to the regulator for a UCG or a combined UCG/CBM facility, with or without a CCS requirement, is unknown at this juncture. Although the regulators strongly recommend seeking pre-application discussions,

prior to applying for a permit, they have also advised at the same time there is no support for UCG in the UK!

Developers should be aware it is an offence to operate a UCG/CBM facility without the requisite permit.

Section 6: Site Decommissioning and Aftercare

The developer must include within the environmental permit application how the facility will be decommissioned and the aftercare regime that will be applied. Environmental Permits contain the details of the decommissioning and restoration plans that were submitted as part of the application. Sometimes the regulator will require an escrow financial arrangement to be put in place, to ensure that if the operator ceases trading sufficient funds will be available for site restoration and its ongoing management.

Escrow funding has already been applied by the environmental regulators to some waste management permits. Given the huge environmental restoration costs associated with the decommissioning of UCG reactors in Queensland Australia, and the arguments over who pays, it might be anticipated similar funding will be required of UCG developers in the UK.

Addendum

Improving the Image of UCG

If it could be demonstrated that UCG was the solution to certain environmental problems rather than the cause of problems its image might be enhanced, particularly in the UK. The current worldwide means of producing bulk hydrogen is the steam reformation of natural gas, with a yield of 1 tonne of hydrogen for every 10.8t CO₂e (LCA cradle to factory gate, GaBi database EU dataset). Therefore, it seems environmentally irresponsible to burn the hydrogen in UCG syngas once produced, rather than separating it by low energy molecularly sieving for bulk hydrogen supply*. It is also suggested that not only would 10.8 tonnes of carbon dioxide equivalent be saved for each tonne of hydrogen supplied, it would also be a more profitable use of hydrogen than combustion for electrical generation. There is also an opportunity to adjust the underground parameters to maximise the yield of hydrogen, if it becomes the intended goal rather than methane production.

A further opportunity that might eventually prove patentable is the injection of waste plastic (of the right type and form) into the UCG reactor via the oxygen line. This would need researching but if successful it might provide the following image and cost advantages for UCG:

1. Help solve the issue of waste plastic by recycling it (i.e. conversion to hydrogen, methane and hence methanol) rather than the current solution of incineration at end-of-life with heat recovery, which gives rise to even more greenhouse gas emissions.
2. Higher hydrogen yield, as plastic contains 3 times as much hydrogen as coal.

If hydrogen becomes the intended goal for some UCG operations it might also be possible to reduce the oxygen supply, which is only used to prevent the dilution of syngas by nitrogen. This would improve profitability as well as reducing the carbon footprint of the technology. It is appreciated it is easier to molecularly sieve hydrogen from a concentrated gas rather than a dilute one but where that cost balance lies would need to be researched.

*A hydrogen molecular sieving plant was successfully installed at British Steel Llanwern Cokes Ovens in 1992 and operated successfully for over 12 years, until closure of the coke ovens. The plant molecularly sieved hydrogen from coke oven gas, supplying the Work's bulk hydrogen requirements as well as other off-site users. Installation of the facility resulted in the closure of the local natural gas reformation plant that provided bulk hydrogen.

1. Directive 2010/75/EU of the European Parliament and of the Council
On industrial emissions (integrated pollution prevention and control)
Official Journal of the European Union, Page No. L 334/17 (Dated 24th Nov. 2010)
2. Statutory Instrument 2016/1154
The Environmental Permitting (England and Wales) Regulations 2016
3. Statutory Instrument 2012 No.360

- The Pollution Prevention and Control (Scotland) Regulations 2012 (PPC 2012)
4. Northern Ireland Statutory Rules 2013 N.160
Pollution Prevention and Control (Industrial Emissions) Regulations (Northern Ireland) 2013
 5. Directive 2011/92/EU of the European Parliament and of the Council
On the assessment of the effects of certain public and private projects on the environment
Official Journal of the European Union, Page No. L 26/1 (Dated 13th Dec. 2011)
 6. Directive 2014/52/EU of the European Parliament and of the Council
Amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment
Official Journal of the European Union, Page No. L 124/1 (Dated 16th April 2014)
 7. Statutory Instrument 2017 No.571
The Town and Country Planning (Environmental Impact Assessment) Regulations 2017
 8. Statutory Instrument 2017 No.567 (W.136)
The Town and Country Planning (Environmental Impact Assessment) (Wales) Regulations 2017
 9. Statutory Instrument 2017 No.102
The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017
 10. Northern Ireland Statutory Rules 2017 N.83
The Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2017
 11. Helen Day Permitting & Licensing Assistant Manager Coal Authority, Mansfield NG18 4RG, Private Communication 28th August 2020
 12. <https://www.bgs.ac.uk/data/maps/maps.cfc?method=viewRecord&mapId=12086>
 13. Environmental Impact Assessment of Projects Guidance on Screening (Directive 2011/92/EU as amended by 2014/52/EU)
Published by the European Commission 2017 ISBN 978-92-79-74371-9
 14. Environmental Impact Assessment of Projects Guidance on Scoping (Directive 2011/92/EU as amended by 2014/52/EU)
Published by the European Commission 2017 ISBN 978-79-74375-7
 15. Environmental Impact Assessment of Projects Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU) Published by the European Commission 2017 ISBN 978-92-7974373-3