European Union Network for the Implementation and Enforcement of Environmental Law

Onshore Oil and Gas Well Decommissioning, Closure & Liabilities Funding – Phase IV – 2018

Sharing regulatory best practice and strategy for the safe decommissioning and closure of onshore oil and gas wells, together with a review of Member States approach to funding environmental liabilities at onshore oil and gas sites.

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Introduction to IMPEL

The European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL) is an international non-profit association of the environmental authorities of the EU Member States, acceding and candidate countries of the European Union and EEA countries. The association is registered in Belgium and its legal seat is in Brussels, Belgium.

IMPEL was set up in 1992 as an informal network of European regulators and authorities concerned with the implementation and enforcement of environmental law. IMPEL's objective is to create the necessary impetus in the European Community to make progress on ensuring a more effective application of environmental legislation. The core of the IMPEL activities concerns awareness raising, capacity building and exchange of information and experiences on implementation, enforcement and international enforcement collaboration as well as promoting and supporting the practicability and enforceability of European environmental legislation.

IMPEL has developed into a considerable, widely known organisation, being mentioned in a number of EU legislative and policy documents, e.g. the 7th Environment Action Programme and the Recommendation on Minimum Criteria for Environmental Inspections.

The expertise and experience of the participants within IMPEL make the network uniquely qualified to work on both technical and regulatory aspects of EU environmental legislation.

Information on the IMPEL Network is also available through its website at: www.impel.eu

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Summary of the scope of previous phases

2015: Phase 1 of this IMPEL project brought representatives of a number of countries together to consider best practice for regulating the onshore oil and gas industry as a whole, including, where appropriate, unconventional fossil fuels and high volume hydraulic fracturing.

2016: Phase 2 of this project built upon the work in Phase 1 by reviewing in greater detail participants' regulatory approaches on priority topics and promoting best practice. Specific topic areas for Phase 2 included the regulation of extractive waste and the importance of encouraging public participation and engagement.

2017: Phase 3 addressed the specific monitoring requirements that are necessary to protect the environment and demonstrate compliance in the oil and gas industry. The aim of this phase was to enable the sharing of current and future regulatory requirements for monitoring of emissions to air and water during the lifecycle of onshore oil and gas sites.

Executive Summary – 2018

Phase 4 of the project was set up to review regulatory best practice and strategy for end of life upstream oil and gas installations. All oil and gas infrastructure can generate significant and lasting environmental harm unless it is properly decommissioned at the end of operations, but wells present the biggest challenges due to difficulty of access and the possible migration of hydrocarbons. This project therefore has a strong focus on wells, while not neglecting other infrastructure.

As a well approaches the end of its lifecycle and is likely to produce little or no further income, the operator may be unwilling or unable (for example due to insolvency) to finance decommissioning work. In this situation operations may simply be suspended and the well is said to be in suspension rather than decommissioned.

The role of formal (regulatory) and voluntary (industry best practice) standards within the onshore oil and gas industry is discussed and it is shown that these can work together towards a common goal. For well integrity and decommissioning there are a number of world-class industry best practice guidelines published in Europe that are widely considered to represent Best Available Technique (BAT). Where these are not available international alternatives exist.

All countries contributing to this project require a relevant notification, work program, permit or concession for decommissioning to be undertaken. However, the specific regulatory tools in use across Europe have been addressed in previous IMPEL projects and are not covered here. Instead, this work looks at permitting and compliance in the decommissioning stage and identifies the importance of developing trust between operators and regulators and the benefits of maintaining professional relationships.

Operator behaviour and possible drivers for poor performance in relation to decommissioning end of life oil and gas infrastructure is reviewed with the aim of identifying the scale of any problems and where improvements could best be made. No evidence of widespread poor performance was found,

but it was noted that even a very small number of poor performing operators can lead to significant environmental damage and associated loss of public confidence in the industry and the regulator. Potential solutions, including the role of research and development are discussed.

Techniques for the decommissioning of surface infrastructure are widely understood, so this project focusses on the role of Best Available Technique (BAT) for well decommissioning. Further research is desirable on long term performance of well plugging materials to abandon end of life wells, and on the reasons for short and long term loss of well integrity.

The project examines the effectiveness of current methods of funding for financial provision including guarantees and explores other viable options that could provide an alternative method of managing environmental liabilities. Participating countries completed a questionnaire that was issued to gather data on how they currently manage funding for financial provision and its effectiveness for the oil and gas industry.

None of the countries who responded reported having drawn on financial provision to remediate oil and gas sites and therefore this project can draw no new conclusions. Other models for protecting the public purse, such as a new levy system, are discussed and further work is encouraged to explore options. All of this work is completed in the context of European legislative framework and by drawing on the findings of previous IMPEL work.

Key recommendations from phase 4 (2018) include:

- Regulators should maintain an awareness of technological developments in the onshore oil and gas industry by engaging with academia and EU research programmes (example: Horizon 2020).
- Countries should consider holding a national wells registry to accurately record the location and other important details of all onshore oil and gas wells. For greater consistency a European numbering system for wells could be developed for use by all participating countries.
- A representative national industry organisation should be established in order to develop codes of practice, promote compliance and facilitate communications between operators and regulators.
- Regulators should ensure that their staff have the relevant skills and qualifications that apply to their role in order to communicate regulatory requirements and influence compliance. When supported by an effective engagement strategy this will help build working realtionships and deliver positive results.
- The IMPEL group proposes that scientific research is carried out into the long-term effectiveness and integrity of well decommissioning techniques and materials to protect the environment.
- At a national policy level countries are recommended to investigate the effectiveness and cost/benefits of different financial agreements including an onshore oil and gas levy-system.
- Countries should review their current guidance around financial provision to provide clarity on the substantial legal, financial and regulatory knowledge required to ensure that the financial provision is always secure, sufficient and available when needed; this should ideally extend to guidance or training for onshore oil and gas operators.

Disclaimer

This report is the result of a project within the IMPEL network. The content does not necessarily represent the view of the national administrations or the Commission.

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1. Introduction

1.1. Background

Europe has a long history of oil and gas well development, starting with manually dug wells in Poland and Romania in the 1850s quickly progressing to early cable drilling rigs less than a decade later. The twentieth century saw significant advancements in onshore exploration and drilling, with the invention of the dual-cone and tri-cone rotary drills.

As drilling technologies improved Europe saw a massive expansion in the number of wells drilled both onshore and offshore. Production was so high that some European countries were nearly self-sufficient in oil and gas before production began to decline rapidly in the early 2000s. Oil and gas production across much of Europe is now at an historic low due to increasing maturity of the hydrocarbon plays. However, ongoing exploration and the possibility of shale gas may result in a resurgence of onshore drilling in some countries.

All of these wells have one thing in common, that is the process of drilling has potentially altered the sub-surface environment, at least in the vicinity of the well. How much effect a well has on its environment will depend on how it was designed, built and operated throughout its production life, including the influence of legislation and effective regulation. What impact a well continues to have on its environment in future will depend on all of these factors together with how it is decommissioned.

Although the potential impacts and liabilities will be considered for all oil and gas infrastructure across a site, the very nature of wells presents regulators with more challenges than surface infrastructure. Some additional considerations that are specific to wells include:

1. Lack of direct access: to carry out an inspection or diagnose the cause of a problem it is often necessary to rely on a range of wireline logs, the correct interpretation of which usually require specialist skills.
2. Effective and proportionate environmental monitoring: this can be challenging due to the depth and uncertainty of the geology.
3. Timescales: the risks from old wells are not time limited, so decisions made now must be viewed in terms of their potential impacts on future generations.
4. Engineering standards: many existing wells were developed decades ago when drilling and completion standards were more basic.
5. Materials standards: historically, the long-term performance of materials in some harsh underground environment (e.g. CO_2, H_2S) was not so well appreciated.
6. Complications over ownership of wells, clarity on who is responsible and how competent authorities can track ownership and manage any associated legal issues.

An operator may decide to suspend operations (in other words cease production), in which case the well is likely to be “shut-in”. This involves closing the relevant valves in the headworks to maintain the necessary pressure in the well and prevent it from collapsing under the significant formation pressures. A well in

which operations have been suspended can typically be re-entered at a later date at relatively modest cost. This can have advantages, for example if new technology is subsequently developed that allows more oil and gas to be profitably extracted. This is not the same as permanent well decommissioning.

Well decommissioning can be defined as the activities undertaken to permanently plug and abandon (it is often abbreviated to P&A) a well or a wellbore that will no longer be used or re-entered. Permanent well abandonment means establishing the necessary and verified well barriers of materials with adequate properties and characteristics to assure no leakages over time (time is not defined). These well barriers should permanently isolate all permeable zones with flow potential. A badly decomissioned oil & gas well presents an in-perpetuity risk to the environment; in the most extreme cases it may also give rise to significant safety concerns for human health.

When a new well is being drilled it is in the expectation that it will generate profit. However, at the end of its life this asset becomes a liability and there may be an unwillingness on the part of a small number of operators to invest adequately in decommissioning. There is also the risk that problems are identified in the years post-decommissioning, when the operator may no longer be in existence. In these situations it is easy for liabilities to become orphaned which could potentially result in a burden on the public purse. It was identified that under current procedures the window of opportunity to protect the public purse narrows while decommissioning is delayed and oil and gas infrastructure remains in a redundant state.

While recognising that good well design, together with exemplary standards of drilling and completion are critical to the well lifecycle integrity, this project is focussing on well decommissioning and funding provision for liabilities to protect the environment and reduce the potential burden on the public purse.

The aim of the 2018 IMPEL project was to explore the regulation of the decommissioning phase. The project also investigated whether there are any obvious gaps in funding for financial provision and to explore other viable options for environmental liabilities.

While this report is strictly limited to onshore oil and gas operations, some of the recommendations may also be applicable to other deep drilling activities, such as geothermal energy projects.

1.2. Project Methodology

An outline project plan was prepared, discussed and agreed in the project terms of reference in December 2017. In early 2018, details of the first workshop were discussed with the hosts in Romania.

A questionnaire covering financial guarantees and provision for environmental liabilities was drawn up in April and distributed to the project team in May. Some of the project team had also attended a 1-day conference on financial provision for the extractive industries organized by the European Commission in Brussels on 26th January 2018.

The first workshop of the 2018 IMPEL project was held in Bacau, Romania on 14-15 May 2018. This workshop was attended by seven Member States and covered the topic of "Decommissioning and Closure of Onshore Oil & Gas Wells". During the workshop a site visit was undertaken to see a well operated by Petrom which was in the process of being decommissioned and a further site visit was made to a decommissioned well site.

We would like to thank Pavel Jitaru, Valentin Lordacke and Mihaela Bozonca, representatives of Petrom who generously gave their time to support the Romania workshop and for allowing the IMPEL party to visit a well in the process of being decommissioned.

Following the workshop nine countries returned a questionnaire that provided information on how financial provision for environmental liabilities are managed. The questionnaire was developed with the kind assistance of the IMPEL Liabilities Project and the Alberta Energy Regulator.

A second workshop was held in Brussels, Belgium on 24-25 September 2018. At this workshop a working draft of the Project Report, which included the results and conclusions from the questionnaire, was reviewed by the assembled group. The group also highlighted other ideas for inclusion on the topic of either oil and gas site decommissioning or financial provision. There was no site visit arranged for the Brussels workshop.

There was a good level of support for this 2018 (Phase 4) IMPEL project covering onshore oil and gas well decommissioning, closure and liabilities funding regulation of onshore oil and gas developments.

2. Decommissioning & Closure of Onshore Oil & Gas Wells

2.1. Formal and voluntary standards on well decommissioning

2.1.1. Discussion

The current recognised approach is for well design to consider the whole lifecycle through to and including plugging and abandonment (decommissioning). However, many of the wells that are now coming to the end of their operational life were not necessarily designed with decommissioning as a priority. The same is true for surface infrastructure, particularly with respect to the increased use of geomembranes for tertiary containment. This implies that more recent oil and gas development, along with all future projects, could be expected to be of a higher standard.

The high standards of drilling and well completion that regulators currently expect may not always be achieved unless appropriate controls are put in place. The group discussed that standards are often influenced by expansion and recession in the oil and gas industry. During a boom in industrial development there may not be enough experienced staff or the right drilling rigs to meet demand,

potentially leading to a reduction in standards. In periods of industry recession, companies may seek to reduce overheads by laying off staff some of whom may be their most experienced staff.

Improved standards of drilling and well completions have previously come mostly from a combination of developing domestic legislation and empirical industry experience. In other words successful and innovative solutions gradually gain credibility across the industry. We are now seeing an increase in the amount of research and development being carried out by both the industry and academia, some of which is funded by the European Commission (e.g. International Horizon 2020 projects). There seems little doubt that a lot of this work is being driven by the worldwide desire to exploit shale gas and tight oil formations that until recently were considered impractical or uneconomic. However, it should be noted that the exploitation of onshore hydrocarbons and shale gas in particular is banned in some European Member States.

The workshop did highlight a different approach to site-specific, risk-based methodologies. Some countries offer very little flexibility in the way that operators may undertake decommissioning of sites, while others support a risk-based approach to the work needing to be carried out.

The one common principle that most countries have adopted is that the operator is required to submit a plan of the decommissioning work they wish to undertake for the general approval of the responsible regulator or government body. If the plan is approved, this is confirmed by the issuing of a concession or a permit by one or more regulatory authorities. However, the government department from which the approval is issued varies from country to country, for example: Construction or Environmental Regulations, Department of Energy, Department of Mining, or Health & Safety Executive.

Although all countries who attended the workshop considered decommissioning to include surface infrastructure along with the wells, some countries approached the approval process differently. The surface infrastructure has the potential to impact soils and water, which means the decommissioning has to comply with environmental and planning regulations. The wells on the other hand often have to meet standards set out in environmental, energy, mining, and health & safety regulations.

The relevant European Directives that apply to onshore oil and gas are shown in table 2.1 and will need to be considered during decommissioning. Only some of these may directly control that activity. Please refer to earlier IMPEL Oil & Gas project phases for a more complete description of the regulatory tools for onshore oil and gas and the application of EU Directives. In addition to the European Directives, there is a wide range of domestic legislation within individual countries that directly controls onshore oil and gas activities. A list of these regulations is beyond the scope of this report.

Table 2.1 List of selected European Environmental Directives that may need to be considered during the decommissioning of onshore oil and gas infrastructure.

Name	Reference	Main subject matter or activity covered
Industrial Emissions Directive	2010/75/EU	Protection of air, land and water from specific activities, such as the flaring of gas above 10 tonnes/day and refining activities.
Seveso Directive (COMAH)	2012/18/EU	Storage of crude oil subject to certain limits based on the chemical nature of the crude.
European Mining Waste Directive	2006/21/EC	Management and storage of extractive waste
Waste Framework Directive	2008/98/EC	Management and storage of Framework waste
Water Framework Directive (and Daughter Directive)	2000/60/EC (2006/60/EC)	Protection of surface water and groundwater
Environmental Liabilities Directive	2004/35/CE	Provision for environmental liability
Environmental Impact Assessment	2011/92/EU	Environmental protection (certain criteria apply and not all oil and gas sites require an EIA)
Air Quality Directives	2004/107/EC 2008/50/EC	Protection of air quality

2.1.2. Conclusions

The workshop highlighted a variety of different approaches by Member States to the use of formal regulatory standards and voluntary standards, which are usually published under the heading of Industry Best Practice Guidelines (IBPGs).

From the workshop discussions the role of the formal or voluntary standards is to ensure that the industry can operate while achieving a number of key objectives. These are the factors against which the effectiveness of the standards will be judged:

1. Resource conservation – this is of national importance to ensure the best possible exploration and use of available natural energy resources.
2. Health & safety – necessary for both to the workers on site and the general public who may be within range of any onshore oil and gas activities.
3. Environmental protection – to ensure that operations are carried out in a way that there are no unacceptable environmental impacts to land, water and air.
4. Efficiency – that the formal or voluntary standards are applied in such a way that they do not prevent the effective recovery of oil & gas.

In developing the formal standards several countries sought the opinion of industry; in fact it is hard to imagine how such standards might be developed without consultation. Likewise, when the IBPGs are being written, they must take full account of all current applicable regulations. A good example of an IBPG is the Norwegian ***Well integrity in drilling and well operations Rev. 4 June 2013*** (formerly known as the NORSOK D-010), which defines the minimum functional and performance oriented requirements and guidelines for well design, planning and execution of safe well operations. Therefore, both the content and the final objectives of the formal and voluntary standards are often very similar, if not the same.

The workshop identified that for some countries there is a degree of uncertainty over the location or identification of oil and gas wells once they have been decommissioned, especially where the casing is cut several metres below ground level. Prior to decommissioning when the wells are visible and the operator is present on site this would be a relatively simple problem to resolve using Global Positioning Systems (GPS) to record an accurate location. However, these data could still be "lost" if held solely by the operator and they were to cease to exist post decommissioning.

It is clear that with no single piece of European legislation or guidance (formal or voluntary standards) having been adopted, countries have developed their own approach based on domestic legislation and supported by IBPGs. The European Commission is in the process of developing guidance on hydrocarbon best available techniques that may help in this regard.

International experience has concluded that applying high standards of conservation and reducing any environmental disturbance to a minimum are crucial for reducing the impact that must later be addressed.

2.1.3. Recommendations

1) Regulators should be aware that good well-design, high drilling standards and the use of the most appropriate down-hole equipment are significant factors in achieving effective well integrity over the entire life cycle of the well. The availability and selection of experienced drill crews and well maintained drilling rigs will have a significant impact on the standard of wells drilled, plugged and abandoned. Regulators should identify ways at a national level to ensure that high standards in

design, operation, maintenance and decommissioning are not compromised by changes in demand for oil and gas whether through economic cycles or energy policy.

2) All standards should be regularly reviewed by regulators and policy makers and kept up to date due to the speed of progress, particularly in areas of new and emerging technology.
3) Regulators should engage with academia at a European and/or worldwide level to keep pace with technological developments in methods and especially materials. This will facilitate the necessary approval processes ahead of wide scale deployment.
4) This project recommends that Member States hold a national Well Registry to maintain accurate records of the precise locations and other important data on wells. It was agreed that these data, which would include accurate coordinates of each well location, would benefit from the development of a consistent European well numbering system and be stored in public access database. It is recommended that it accords with the land use and mineral planning process of the country concerned and made available for use by governments, official bodies, general public, farmers, land owners, and any companies looking to develop or manage land use.

2.2. Permitting and compliance

2.2.1. Discussion

All countries reported that decommissioning may only be undertaken with the relevant notification, work program, permit or concession in place. The notification, work program, permit or concession is the document that sets out the conditions with which the operator must comply, including monitoring and reporting requirements.

Relationships between oil and gas operators and regulators was reported as being mostly very good. This certainly seems to be the case where large operators are concerned and the regulator has the necessary experience. Where relationship problems occurred there was usually an identifiable cause, which might include: interpersonal skills, lack of information, failure to meet face to face and not spending time building effective working relationships. Although it was not discussed in detail in the workshop, a representative national industry organisation can play a significant role in helping the operator/regulator relationship to function effectively by promoting compliance with standards and facilitating effective communication.

The risks of non-compliance with environmental permits arising from operators lacking access to funding or approaching insolvency were discussed.

Some countries are now publishing their compliance data for the oil and gas industry. The issues around this approach were not considered during this workshop

2.2.2. Conclusions

Although an operator is responsible for compliance with the relevant permit conditions, including legally required reports, there may be more that can be done to influence operator behaviour and reduce the risk of smaller issues and misunderstandings from escalating. For example, regular meetings between operators and regulators that are carried out in a professional way to build trust, are likely to result in productive working relations.

Some operators may not wish to build effective dialogue with regulators, particularly if there is the perception that communication only takes place when things have gone wrong and conversations are mostly limited to enforcement action. The regulator will need to have an effective plan in place on how to manage these operators to ensure compliance.

2.2.3. Recommendations

1) Regulators and operators are recommended to establish respect and trust with each other, investing time to build working relationships that deliver results.
2) Regulators should have a suitable intervention plan to influence high levels of compliance and ensure robust and consistent enforcement of requirements.
3) A representative national industry organisation should be established and/or encouraged to develop codes of practice, promote high levels of compliance and facilitate communication.

2.3. Operator behaviour on well decommissioning

2.3.1. Discussion

The decommissioning of oil and gas infrastructure can be costly to an operator and coming at the end of the operational (income generating) period there may be a lack of enthusiasm to undertake the necessary work. In this situation there may be a significant number of sites, which instead of being decommissioned, are suspended and the wells “shut in”.

There are other reasons why a well may be shut in and not fully decommissioned, for example a period of very low commodity price, or the prospect of extracting significantly more oil or gas when an emerging technology is subsequently developed. Some of these reasons may be valid, for example the national government will have a responsibility to the public over energy conservation.

In countries where there is a historic backlog of wells that require decommissioning the process may take a number of years, or even decades. Not only are there cost implications to decommissioning a large number of wells, but the rigs and appropriately qualified staff will almost certainly be limited at any given time.

There are a number of factors that are contributing to any perceived delays in operators decommissioning old wells and it is far from clear how long is appropriate to leave a well in suspension before full plugging and abandonment (P&A) is carried out. Countries attending the workshop reported time limits of between 3 – 5 years (assuming a time limit applied), but there was no clear evidence that there would be adverse environmental impacts if a well was left in suspension for longer, for example more than 5 years.

The risk of having no formal time limit for decommissioning, either for an individual well or for the site as a whole, is that an operator could possess an escalating liabilities portfolio as more wells / sites come to the end of their productive life. A high liabilities to assets ratio increases the likelihood that an operator may become insolvent and unable to undertake any necessary environmental remediation.

Following decommissioning most countries said they require the operator to carry out some form of environmental monitoring at their site. No clear pattern emerged on how long afterwards an individual well or a whole site should undergo monitoring, although most countries reported using a risk-based approach. This included "earned recognition", where as a result of demonstrating consistent exemplary performance throughout the lifetime of the well, there would be sufficient information available, so that a less onerous monitoring plan could be imposed through their permit for the post-decommissioning stage.

Suggestions for post-closure monitoring periods ranged from 0 – 10 years. One country reported that if well records showed that there had been no issues during the life of the well, they would not require any monitoring to be carried out post-decommissioning. Another country has different legislation (and therefore very different monitoring requirements) based on how much a well has produced over the course of its life. It was noted that where monitoring is only carried out at operational sites, so long as there is at least one operational well, then the full suite of monitoring is still undertaken at the site. Only when the last well at a site is decommissioned does monitoring stop.

One country reported that under domestic legislation the cost of increased or extended monitoring falls to the state, the financial consequences of which could impact the rate of decommissioning.

2.3.2. Conclusions

The workshop did not highlight any widespread or repeated poor behaviour or attitude towards decommissioning. Rather, there are a number of important factors that may be influencing timescales for decommissioning, many of which could be down to domestic government priorities or international commodity markets.

The larger or majority state-owned operators appear to be achieving a good standard of compliance with relevant legislation and are often doing more in terms of public engagement. However, this is not limited to such operators.

The number of poor-performing and disengaged operators is probably small, but nevertheless the potential damage they can do, both to the environment and to the reputation of the oil and gas industry, should be taken seriously.

There was no conclusion to the question of what is the most appropriate duration to continue monitoring post decommissioning. A risk-based approach, based on location, design, use and earned recognition may be the most fair and pragmatic solution.

International experience concluded that the growth of inactive infrastructure in the onshore oil and gas industry is becoming a global challenge. It is creating a very significant risk to the environment, public safety, and to public finances. Worldwide, many jurisdictions are looking at ways to reinforce that it is unwanted behaviour and are looking at setting hard timelines for how long a well can remain inactive before decommissioning must be completed.

2.3.3. Recommendations

1) Broadly, this IMPEL project supports further research into the long-term viability of well decommissioning (plugging and abandonment) processes and the materials used.
2) More effort is required by regulators to make operators aware of their post-closure monitoring obligations from the outset through effective communication and guidance.
3) A further review is considered desirable of options to set hard timelines by when decommissioning of inactive infrastructure must be completed.

2.4. Existing & emerging technology to inform BAT & emerging techniques

2.4.1. Discussion

Best Available Technique (BAT) is defined in Directive 2010/75/EU as:

"the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole".

For over a century, oil and gas wells have been decommissioned (a process known as plugging and abandonment) using cement plugs, the design of which is dependent on factors such as the geology and the design of the well. Then in 1920, Halliburton developed an "advanced technique" for cementing well casing in the formation by pumping cement down the well and back up the annular space. For the first time oil and gas wells could be effectively sealed to the formation and the environment protected at the end of operations. This revolutionary idea attracted strong initial

resistance, but once adopted it has become normal procedure for the decommissioning of wells worldwide.

Good practice is to carry out pressure testing on the well following decommissioning, to demonstrate that at the time the test is carried out the well is effectively sealed. Following this testing safety regulations rarely require further checks unless a problem is detected. In contrast, environmental regulations may require ongoing monitoring for a temporary period.

If a well passes the post-decommissioning pressure test then the likelihood is that an adequate seal has been achieved and problems in the short- to medium-term would not be expected. Passive risks to the wells integrity exist in the long-term from corrosion of steel well tubulars / joints and eventual chemical breakdown of the cement. Adverse environmental effects from these slow processes may not be seen for many decades or even hundreds of years. Short term mechanical risks include well interactions (e.g. a new well accidentally drilled through a decommissioned well), or from fault re-activation (natural or induced) cutting the wellbore at a critical depth horizon.

Problems have been reported with installing cement plugs in gassing wells; the gas passes through the cement as it is hardening, creating tiny pathways that result in failing a subsequent pressure test. New technologies may be more appropriate for decommissioning such wells and indeed BAT allows for the operator to use an alternative technique so long as it is equally as good, or better, than the industry best practice standard. Field-scale tests have recently been carried out in more than one country on "Thermite", which is one such new technology currently under development. Some countries have published guidelines on the necessary level of testing required for acceptance of new techniques.

Several European funded study programmes under Horizon 2020 have been carrying out research into shale gas, resulting in a number of scientific and technical developments that are likely to improve the environmental performance of the oil and gas industry in future.

2.4.2. Conclusions

Short-term mechanical risks to well integrity, such as from well interactions or fault-reactivation, may increase in areas where wells are drilled very close together, or where fluids are injected into the formation at high pressure. However, these concerns primarily apply to the exploration and production phase and are only relevant to decommissioning where new wells are drilled in close proximity to old infrastructure.

Medium- and long-term risks are more likely due to eventual breakdown of the materials used, such as corrosion of steel tubulars and degradation of cement. There are obvious challenges in understanding the long-term performance of materials used to plug and abandon wells, particularly where there are hostile chemical environments (e.g. H_2S and CO_2), or in high temperature wells.

More time is needed to gain a clear understanding on the long-term performance of some well decommissioning techniques and materials. This lack of evidence for long-term materials performance could present difficulties for regulators, especially when trying to set appropriate post decommissioning monitoring periods.

Some situations, such as gassing wells, can prove challenging for traditional plugging and abandonment techniques (e.g. cement). Industry should be encouraged to explore new and emerging techniques for well decommissioning (subject of course to appropriate testing). Industry support and engagement with the scientific community is important in this regard. Regulators should also recognise work done to improve environmental protection during decommissioning activities.

2.4.3. Recommendations

1) To carry out, or support, a study into the effectiveness of well decommissioning procedures undertaken on historic wells to establish if the process was effective in protecting the environment.
2) Fault reactivation assessments and micro-seismic monitoring should be considered best practice for shale gas wells and included in the EC Hydrocarbons Best Available Techniques guidance.
3) The European Commission continues to support high quality proposals for international research and development through programmes such as Horizon 2020 wherever possible.
4) Regulators continue to engage with academia, such as through respected Horizon 2020 projects to try to gain a better picture of how materials used in well decommissioning perform in the medium- to long-term future. This learning will inform an evidence-led, risk-based approach to regulation of the oil and gas sector.

3. Funding Environmental Liabilities at Onshore Oil & Gas Sites

3.1. Methodology

This section of the project builds on the work undertaken by IMPEL in 2016 (IMPEL project 2016/20) *"Protecting the Environment and the Public Purse"*. The 2016 project had a wide scope, referring to case studies from a range of industry sectors and collecting the views of financial provision practitioners, academics, financial services, industry and regulators. The report sets out the strengths and weaknesses of the different methods of financial provision, concluding that this is a challenging area.

The follow up work in 2017 (IMPEL project 2017/22) *"Financial Provision for Environmental Liabilities – Practical Guide"* is a reference document for regulators, clearly setting out issues to consider when making decisions around financial provision. It also highlights the importance of ongoing maintenance and monitoring of financial provision agreements to ensure a successful outcome should there be a need to draw on funds.

The 2016 and 2017 IMPEL projects referred to above have led to a better understanding of the availability and suitability of financial tools most likely to deliver secure and sufficient cover that will be available to the regulator when needed.

This (2018) IMPEL project is not looking to repeat the work carried out in the previous projects described above and is focussed solely on the onshore oil and gas sector. The objectives of the current project are to look at some of the challenges to implementing effective financial provision (including guarantees), as well as the methods and circumstances under which competent authorities in the different Member States require financial provision to be put in place. This study will focus on how the correct sum is arrived at, what happens when a transfer of liabilities takes place between operators, those issues specific to decommissioning and whether financial provision should continue into the post-closure phase.

It was recognised from the start of the project that there would not be sufficient time in the Bacau workshop to cover both well decommissioning and financial provision. It was also recognised that for many countries the best representative to contribute to discussions on well decommissioning may not be the same as for financial provision. Therefore, it was decided to develop a questionnaire to collect information on the various funding mechanisms available for financial provision (including guarantees), which would allow the project team an extended period of time in which to gather these data and return their forms electronically. A summary of the questionnaire responses was discussed in detail at the Brussels workshop in October 2018.

The questionnaire was developed with the kind assistance of Kim Bradley (SEPA, Scotland) and David Hardie of the Alberta Energy Regulator (AER, Calgary, Alberta).

3.2. Summary of Questionnaire Responses

Completed questionnaires were received from nine countries: Canada; Croatia; Latvia; Poland; Turkey; Scotland, England, France and Hungary.

The following is a summary of the responses received:

Requirements for financial provision to cover onshore oil & gas infrastructure liabilities

Most countries reported that there was a legal requirement for operators to provide financial provision for onshore oil and gas activities. This was typically given as “mining law” or “petroleum law”, but in all cases referred to the extractive industries. Two countries have no legal requirement and leave it up to operators to decide if they want to make financial provision.

Liabilities can be separated into those that are foreseen and those that are unforeseen. An example of a foreseen liability would be the requirement to return a site to its original condition at the end of the period of operation. An example of an unforeseen liability would be environmental remediation of a site following an unexpected accidental spillage of harmful fluids. No countries reported having different financial provision requirements for unforeseen liabilities compared to foreseen liabilities. However, it was noted that the task of calculating the level of financial provision necessary to cover the cost of foreseen liabilities is likely to be more straightforward than estimating the cover required for unforeseen liabilities.

Among those countries who have a legal requirement for financial provision, none reported that this applies to the wellbore in isolation. In all cases the costing for liabilities would take account of all wellsite and associated infrastructure.

Oil and gas plays progress through the various stages of exploration; testing (statistical validation); piloting (variance reduction); development (production phase); and finally to decommissioning and closure. It is recognised that there will be differences in the requirements for financial provision throughout the lifecycle of an oil and gas site and Member States were asked to describe their current approach. Most countries reported no major differences in either the scope or the scale of financial provision between the exploration and production phases and in most cases the value of the provision is simply based on the actual liabilities of the operator. However, this is not always the case and different models were reported. Two examples of where there is a different approach between exploration and production phases are presented:

1. *During the exploration phase, financial capacity is evaluated considering the proposed geoscience project and the drillings. During the exploitation phase, financial capacity is evaluated considering the development plan to produce the field and the costs of abandonment (closure) of wells.*
2. *The requirement for financial provisions is not tied to the lifecycle status of the infrastructure. In Alberta, it is generally a result of a company having been determined to having less assets than liabilities according to a calculation stated in our liability programs. In this case, the company is*

required to provide financial provisions to make up the shortfall and have the assets as calculated and financial provision equal the liabilities.

Suspended wells are wells that are inactive or dormant. They will always be "shut in" and may be plugged (for example in the lower part of the well immediately above the producing formation), but they will not yet have been decommissioned. Suspended wells can usually be re-entered, for example if new technology or an increase in the commodity price makes it viable to restart production. No countries reported that the requirement for financial provision ceased when a well is suspended. Most countries work on the basis that so long as liabilities exist and permits or concessions are active, then financial provision will continue to be a requirement.

Several countries noted that as an oil and gas site progresses from the later stages of production through decommissioning to the closure and after-closure period, there is a reduction in environmental regulatory requirements and tools that apply, impacting the opportunity to fund environmental liabilities.

The opportunity to fund environmental liabilities associated with late-life wells may also be reduced due to changes in operator circumstances. For example, down-selling (where liabilities are sold to smaller operators towards the end of production life). The result of this could be that some operators may not having sufficient funds to meet their level of liabilities and in the most extreme case a company could be liquidated before wells are fully decommissioned.

Responses were mixed with respect to financial provision during the post-decommissioning phase. It was not clear from several replies whether effective and robust financial provision does continue after a well has been decommissioned. One country reported that the financial provision is liquidated once a well is decommissioned provided their mayor gives approval. However, another country responded that provision is maintained for a period of five years following decommissioning.

A major question around oil and gas infrastructure liabilities, regardless of the financial provision in place, is who will oversee (that is to manage and supervise contracts) the remediation works if the operator is no longer in existence. In several cases it seems likely that the state (i.e. one or more state organisations) would have to manage the remediation. In some cases this depends on whether the government is party to the financial provision, or if the activity took place on public owned lands.

Of the countries in which financial provision is a requirement, most reported that the law does not differentiate between private and publicly owned liabilities. In these cases financial provision is required regardless of ownership. However, two countries reported that publicly owned operators did not need to put in place financial provision.

Types of financial provision in use

The choice of which method of financial provision to use is important to determine whether the funding is secure, sufficient and available to pay for remediation when required. A variety of mechanisms were reported from European countries that include:

- Cash deposit
- Performance bond (debenture note)
- Civil liability insurance
- Bank guarantee
- Bills of exchange (promissory note)
- Pledges on securities issued by state treasury

Outside of Europe there is likely to be a similar wide range of financial products available, but based on previous experience the Alberta Energy Regulator will only accept a cash deposit or letter of credit due to the fact that other options have proven unreliable.

Prior to the 2018 IMPEL project, the subject of financial provision was the focus of a European Commission workshop held in Brussels on 26 January 2018. The workshop was attended by industry and specialists from the financial services sector in addition to technical representatives from the Member States.

None of the European countries reported having used financial provision to pay for environmental remediation at oil and gas sites. This could be due to the fact that no liabilities have failed, or it has not been necessary to call on funds. One country transfers ongoing liabilities to the state within a few months of successful decommissioning, but only if the site had a good track-record and the post decommissioning tests demonstrate that wells are adequately sealed.

No European countries reported having drawn on funding provision to pay for the environmental impacts of onshore oil and gas activities, so it is not possible to present examples of what worked well and what fell short of the basic requirements. We would have to look to other studies within Europe that have explored a wider range of industry sectors and also outside Europe to draw useful conclusions on the performance of different mechanisms of financial provision.

The Alberta Energy Regulator (AER) reported that in almost every case, the amount of financial provision collected was insufficient to cover the costs of closure. The reasons given for this included: the difficulty with accurately calculating the level of financial provision required; maintaining an understanding of the value of liabilities presented by a wide range of infrastructure at oil and gas sites; and collecting financial provisions at a less than optimal time.

Assessment of the level of financial provision

No clear pattern emerged on who is responsible for calculating the amount of financial provision required. Four countries reported that the operator is themselves responsible for calculating the correct value of their liabilities, with the regulator then evaluating the operator's proposal. This is effectively true also for

the two countries where financial provision is voluntary (i.e. it is up to the operator to decide if and how they make provision for liabilities). In other countries the value of provision is calculated by a government body or regulator, based on liabilities information provided by the operator. A clear outcome is that the process of correctly calculating and/or reviewing an operator's liabilities must be collaborative between the operator and the regulator/government department.

None of the countries who responded to the questionnaire reported that they consult with others (for example landowners, communities or other regulatory bodies) when they assess oil and gas liabilities. Consulting with other 3rd party groups and landowners in particular could have the benefit of identifying any additional liabilities that should be taken into account when financial provision is established.

There are many different ways in which operators can provide for their current liabilities, some of which rely on the financial security of an institution such as a bank or an insurance company. It is recognised that this opens up another risk in terms of potential failure of that organisation. So even if financial provision is correctly calculated to cover an operator's current liabilities, there is potential for insolvency or complete failure or a 3rd party organisation to undermine the process.

In some cases the scale of an operator's liabilities can be considerable, to the extent that the ability of the financial body to provide the cover (e.g. a bank that is holding a bond, or an insurance company that has underwritten an insurance policy) could be uncertain. Some countries do require an assessment to be made of the financial resilience of the financial institution involved in providing for liabilities, but two countries reported that they didn't. One country requires such an assessment to be undertaken only where the oil and gas extraction activity is conducted on state-owned properties, but not on private properties. The geographical region in which a financial institution is established may also be of consideration if there are local laws or regulations that could affect how or when the financial provision is paid. One country also reported that the regulator would seek further reassurance if the financial provider was a credit institution.

Oil and gas installations progress throughout their lifecycle from exploration to decommissioning and eventual site closure. Commonly, operators will have many sites in different stages of their lifecycle, meaning that the actual liabilities are constantly changing. Therefore, financial provision can only be accurate if it is reviewed on a frequent and regular basis.

One country reported that re-calculation is required whenever a new technical operation plan is requested (around 5 yearly intervals), or if the working budget changes.

Another factor that could undermine the successful application of financial provision is underfunding. We have already noted the difficulty of correctly calculating the cost of liabilities and that recalculation should be undertaken on a regular basis. It was reported that in Alberta, in nearly every case the total amount of provision collected was insufficient to cover the costs of closure. This suggests that a contingency factor or reserve might be considered in order to provide mitigation against underfunding.

Most countries reported that there is no contingency factor added to the calculated amount. However, two countries do include an error margin (no value or percentage given) and another adds a contingency factor in the minority of situations where site-specific liability is calculated.

In order to guarantee consistency and fairness across the oil and gas industry, operators might request guidance from regulators or governments on the way that the cost of liabilities and therefore the total amount of financial provision is to be calculated. There is guidance on assessing the amount of financial provision to meet specific requirements in environmental law. AER also provided links to guidance covering the types of provision that are acceptable, how to prepare liability assessments, the cost parameters involved, and how to calculate the amount of provision necessary.

The IMPEL project feels that more guidance around financial provision is required, but that more debate is needed to determine whether the guidance should be produced by the European Commission or national governments.

It is clearly important that the amount of financial provision put in place and the legal status of that provision is secure. All countries with a requirement for financial provision reported that these checks are carried out. In all cases it is the relevant ministry or other competent authority (e.g. mining or licensing authority) who performs the checks.

Managing the transfer of liabilities and infrastructure

A transfer of liabilities will occur when a site or an asset changes ownership. At this time financial provision will effectively have to start again with the new operator. There was general agreement among those who replied that the transfer of a concession is only permitted if the appropriate regulatory authority approve such a transfer.

There was also general agreement that as part of the approval process for a change of ownership to proceed, the new operator must demonstrate they have sufficient financial capacity (including the necessary financial provision) to take on the additional liabilities. In most cases this will go hand-in-hand with establishing their technical capacity to correctly manage those assets.

Where the financial capacity of the new operator is in doubt, or the necessary amount of provision is not in place, most countries' regulatory authorities have the power to prevent a transfer of ownership taking place.

The point at which oil and gas infrastructure is sold or transferred is an opportunity to assess the potential risks and liabilities. Most countries reported that their regulatory authorities carry out checks to ensure the infrastructure being transferred is fully compliant with the relevant requirements at the time of transfer.

Although most countries reported carrying out compliance checks at the time of a transfer, there was no consensus that a proposed transfer would be stopped until full compliance was re-established. Around half of the countries that responded clearly stated that a transfer would be stopped.

3.3. Discussion and Conclusions

IMPEL projects in 2016 and 2017 found that financial provision is both highly complex to get right and currently remains an emerging technique in environmental protection. The multi-disciplinary nature (involving legal, financial, and technical expertise), and the fact that legal action is often necessary to access funds in the event of default by the operator, means that strict legal wording of the financial provision is fundamental to its success.

Other potential risks identified by the previous IMPEL projects include the low-ranking of the environment under insolvency proceedings; the interaction between relevant domestic corporate insolvency law and financial provision; and significant under-estimation by regulators of the level of time and technical expertise to properly monitor and manage the financial provision.

There were also some positive findings from this previous IMPEL project work:

- A good range of options for financial provision products are available in Europe;
- Some excellent case studies have been collected of situations in which funds have been called on, demonstrating the benefit of good financial provision;
- A successful outcome was found to be greatest where there was strong collaboration between all parties.

In the EU there is good high-level guidance on the criteria for financial provision; the bibliography of the 2016 IMPEL report lists these. However, some industry sectors currently have little or no guidance on the highly technical process of calculating the cost of operator liabilities. This is a matter that clearly needs addressing given the importance of carrying out regular reviews of the value of an operator's liabilities and the implications for the public purse if liabilities are underestimated. Some countries concluded that there would be a place for further European guidance, but the majority view was that this could be handled at a national level.

The questionnaire responses strongly suggests that insufficient engagement takes place with third-party interest groups and landowners (including farmers). This could lead to under-provision if the views of these groups are not adequately addressed during the scoping exercise.

Although several countries do ensure that oil and gas sites undergoing transfer of ownership must be fully compliant with relevant legislation (as well as their permit conditions) at the time of transfer, there are

others who do not. A transfer of ownership is a good opportunity to ensure that everything is in order at a site prior to a new operator taking over

It has been shown that financial provision for environmental liabilities has the potential to be an effective tool with which to protect the public purse, but only where it meets the three tests of **secure, sufficient and available when needed**. For Member States to be confident that financial provision meets these tests, their competent authorities will need to invest significant time and resources in developing the appropriate technical, legal, and financial expertise. To ensure that financial provision is set-up and reviewed effectively on a regular basis will represent a significant cost burden to regulators. If the cost of administering financial provision is not recovered through the fees charged to operators, but falls to the taxpayer instead, then it goes against the well-established polluter pays principle.

Experience from many other countries has demonstrated that even where financial provision appears to be in place, remediation of the environment is not prioritised over other creditors, especially where insolvency courts are involved. The consequences could be long delays in the commencement of remediation, which could often make environmental problems worse and significantly increase the total cost of repair. That could mean that even if the full funds are eventually released, which is not guaranteed, total remediation costs could then exceed the amount of funding available.

If remediation becomes necessary after the financial provision has lapsed, or the operator has ceased trading, a landowner or the public purse (depending on the domestic legislation of the country concerned) may have to cover the cost. For this reason regulators may insist that provision is maintained post decommissioning. However, long-term costs that remain on the balance sheet for many years after an asset has ceased to generate income are unwelcome to operators. Operators also need to commit to the appropriate level of ongoing monitoring and enforcement throughout the whole lifecycle of each regulated liability.

In the Brussels workshop the subject of a government levy (set at a national level as a percentage of the oil and gas produced) was discussed. Such a levy would be ring-fenced to specifically cover environmental liabilities from the upstream oil and gas sector, especially long-term liabilities arising in the post-closure phase when environmental permits have been surrendered. For the majority of operators the cost of this approach would be fair and proportionate. Smaller operators, who often take on the responsibility for wells in the final stages of production before decommissioning, can be disadvantaged when purchasing financial provision by high 'liability to asset ratios'. A centralised fund based on a percentage of revenue from production would spread the cost of financial provision across the life of a well regardless of the size of the operator involved.

Under a levy system the funds would be safe from interference by third-party legal action and insolvency courts that earlier IMPEL projects have identified as perhaps the greatest risk to financial provision. The funds could also be released promptly, allowing remediation work to commence before further damage to the environment occurred. There would be a benefit to operators too in that they would no longer have to

fund financial provision, or reimburse regulators for the considerable expense of administering financial provision agreements through permit fees or additional time & materials charges. Such incentives may tip the balance in favour of national governments introducing an oil and gas levy in place of financial provision agreements.

3.4. Recommendations

At a national level countries are recommended to research and investigate the effectiveness and cost/benefits of different financial agreements. This study should include in scope an oil and gas levy to provide a fund that is secure, sufficient and available when needed to cover environmental liabilities and which is protected from the legally vulnerability of some other financial agreements.

The IMPEL project recommends that regulators make it a requirement that all oil and gas sites undergoing transfer of ownership are fully compliant with all relevant legislation (as well as their permit conditions) at the time of transfer. Some countries already adopt such an approach, but it is recommended that this becomes standard practice across all Member States.

The IMPEL project would encourage regulators to engage in more discussion with 3rd party groups including landowners to ensure that the scope of any financial provision is adequately addressed.

At a national level countries should review their current guidance around financial provision to provide clarity on the substantial legal, financial and regulatory knowledge required to ensure provision is secure, sufficient and available when needed. This should ideally extend to guidance, or training for operators.

A collaborative approach between the operator and the regulator/government department should be adopted to help improve the calculation / review of an operator's liabilities.

4. Overall key recommendations from the 2018 IMPEL project

Scientific studies should be undertaken at an international level to better understand the controls on long-term well integrity following plugging and abandonment (decommissioning) processes. Focussing on the stability of cement plugs over very long timescales and the rate of corrosion of steel well tubulars. Operators need to be aware of their post closure monitoring obligations from the outset, aided by good regulatory advice. Options should be considered for setting hard timelines to complete the decommissioning of inactive infrastructure.

Regulators should maintain an awareness of new and emerging technologies in the onshore oil and gas industry by engaging with academia and EU research programmes, such as Horizon 2020. The European

Commission should continue to support high-quality research proposals, for example through Horizon 2020, whever possible.

Countries should consider holding a national wells registry to accurately record the location and other relevant details of all oil and gas wells. To achieve a greater consistency, a European numbering system for wells could be developed for use in all participating countries.

Regulators should ensure that their staff have the relevant skills and qualifications in order to confidently carry out their role and gain respect from operators. When supported by an effective engagement strategy this will help build effective working realtionships and deliver positive results.

Regulators and operators should aim to establish effective working relationships that are built on trust and respect, but to have a suitable intervention plan for when this approach fails to deliver desired outcomes.

A representative national industry organisation should be established and/or encouraged in order to develop codes of practice, promote compliance and facilitate communications between operators and regulators.

Regulators should have more discussion with 3rd party groups, such as landowners in particular, to ensure that the interests of those parties and therefore the scope of financial provision is adequately addressed.

Regulators should make it a consistent requirement that all oil and gas installations are compliant with all relevant regulations at the time those assets are transferred to another operator. Some countries already adopt this approach, but it is recommended that this becomes standard practice across all Member States.

At a national level countries are recommended to investigate the effectiveness and cost/benefits of different financial agreements. This study should include in scope an oil and gas levy to provide a fund that is secure, sufficient and available when needed to cover environmental liabilities and which is protected from the legally vulnerability of some other financial agreements.

Countries should review their current guidance around financial provision to provide clarity on the substantial legal, financial and regulatory knowledge required to ensure provision is always secure, sufficient and available when needed; this should ideally extend to guidance or training for operators.