

SPE Review London

The official e-magazine of the Society of Petroleum Engineers' London branch

Enabling a risk-based approach to well plugging and abandonment

PLUS+

- * Cloud technology – will it replace local high-performance computing?
- * Letters from the Chair and the Editor
- * Conference: SPE Upstream Finance and Investments
- * SPE YPs active in Portsmouth chapter
- * Communicating complex ideas to a non-techie audience



BEHIND THE SCENES

MEET THE BOARD

EVENTS

SPE Review London

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Behind the Scenes: SPE Review Editorial Board



Jonathan Ovens

After graduating from Cambridge University with a Ph.D in Physics, Jonathan joined Shell in 1986. Reservoir Engineer – hydraulic fracturing, pressure transient analysis and reservoir simulation.

1997 - 2012: independent consultant: North Sea, North Africa and the Middle East.

Experience: Exploration and Development planning to Reserves Evaluation.

2013: Senior Reservoir Engineer at JX Nippon E&P (UK) Ltd.

2009 and 2015 served with SPE Europec Technical Committee.

Member of the SPE London Board.

Josh Beinke

Graduated from University of Adelaide in 2008 with a Petroleum Engineering degree.

Worked various roles with Chevron, Origin Energy and Santos, including as a

Production Engineer on the Gorgon Field during First Gas. Following move to Europe

in 2016, consulted on European and African assets (specialising in data room and field

development advisory) before current position working in Amsterdam as a

Production/Exploitation Engineer with Vermilion Energy.



Ffion Llwyd-Jones

Editor and business writer, with 15+ years experience in North America/ UK.

Editor for several trade and consumer magazines (print and/online).

Provides industry-related case studies, and detailed, research-driven B2B Designer reports and technical white papers.

Accomplished photographer, and videographer.

Educated in Canada, and in the UK, with BA (Hons) from The Open University.

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Letter from the SPE London Chair



Welcome to the November/December issue of SPE Review London! I hope you are all already in the festive mode in spite of the nights drawing in!

In the first few months of the current SPE year, London section organised several highly successful events. We conducted a first Young Professionals (YPs)-Senior Professionals workshop, covering best practices in modelling, business deals, M&A asset valuation and other topics. Our events included an outstanding SPE Upstream Finance and Investments Conference, and the annual full-day seminar: Introduction to Oil and Gas, Exploration and Production. We continue into 2020 with other exciting events our programme team is developing, including jointly hosted initiatives with affiliated organisations to cover issues connected to a future energy transition.

In the last ten years, the demographics have shifted such that students and YPs comprise the largest segment of the membership, which has many implications. All students sections have updated their committee rosters and run their multiple activities. Our YPs team welcomes new graduates into the SPE professional family by organising a North Sea oil and gas decommissioning event, and collaborating with Portsmouth University for SPE Week.

SPE London has also made a commitment to partner with the Arkwright Engineering Scholarship Scheme. The aim is to support 'A'-level students who are showing a strong interest in pursuing an engineering career. The programme is up and running with our first scholar signed up. We are committed to a two-year financial sponsorship, and we will also need to facilitate work experience days and industry familiarisation. We have developed a multi-year plan that aims to support additional students on an annual basis.

Our society is membership-driven and our programmes are designed to serve the needs of our diverse membership. To ensure our society remains relevant for years to come, we need to anticipate the needs of our future members so they are prepared to drive the next wave of innovations for the energy industry. We will be strengthening the tools and methods we use to disseminate knowledge to members by creating initiatives to provide quality content in a variety of formats, such as print, video, and audio, so it is more engaging and consumable for all our members.

We are always looking for volunteers to join our ambitious team, please write to us at SPELondon@spemail.org.

At the same time, we appreciate your choice to be a member of SPE – it is time to renew your membership!

In closing, there was another definition of an engineer: someone who solves a problem you didn't know you had in a way you don't understand. In fact, petroleum engineers ensure that energy will continue to be a key component to societal functioning and people's everyday lives. We solve important challenges that contribute to energy security and national prosperity.

Best season's greetings!

Maxim Kotenev, SPE London Chair



Letter from the Editor



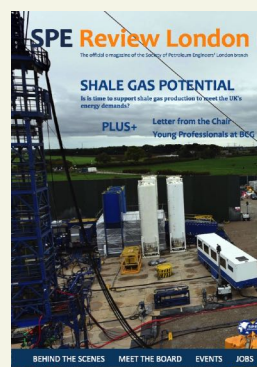
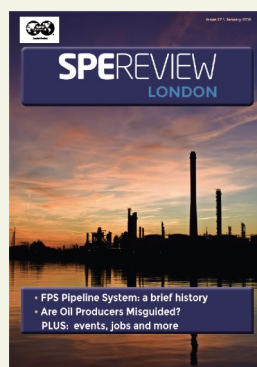
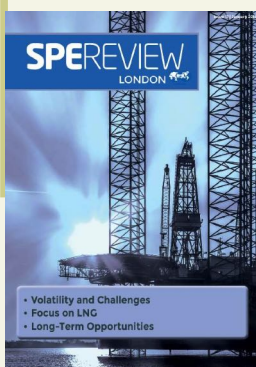
I have been Editor of the SPE Review for the past three years. During that time I have had the pleasure of producing some 30 editions of the Review. When I started in 2016 the Industry was still in shock over the 2014 oil price collapse and the London Section was witnessing a reduction in the number of companies based around London. However, Richa had established a well practiced team with Ffion and during three years the team has grown to include Josh and Justin and is now a very polished unit!

My initial idea was to introduce more technical articles into the Review and to base these on the Monthly Program run by Tim Lines. Keeping the format to 1000 words and a few figures meant the load on authors was lighter and did not impinge on the SPE Paper format. However, I soon discovered that the SPE London section is incredibly diverse with several sections acting almost independently of each other: the YP Section, Student Section, Women in Energy and the new Business events. In addition, Tim supplies a regular list of SPE Distinguished Lecturers who sometime supply excellent articles. Hence the Review seemed to be the natural place where some integration and cross fertilisation could be achieved and I am pleased to say that we now attract regular contributions from all sections.

Looking back on the Reviews published in the last three years, we have seen a wide range of articles, from Quantum Computing, through Women in Energy, to Fraccing and Field Abandonment. This reflects the diversity of experience we have in the SPE and the way London continues to be a diverse place to work and, at the same time, reflects the nature of the UK Oil and Gas sector. I recommend people to look back over our little library as inspiration for further reading.

However, I have decided that it is time to step down from the Review and let another person take over. I would like to thank Ffion, Josh and Justin for their excellent work and look forward to reading many excellent future editions of the Review.

Jonathan Owens



SPE YP London: Active Portsmouth Chapter

SPE University of Portsmouth Student chapter organises SPE WEEK at their University every year during the Consolidation Week. This year, the Student chapter organised interesting events and programs for the Petroleum Engineering students on Reservoir Engineering, Petrophysics, and Data Science topics.



Members of SPE Portsmouth student chapter attending the technical talk organised by SPE London YPs

SPE Portsmouth student chapter is quite an active student chapter in the London section, engaging with the Industrial Professionals and Student bodies to enhance better experience as a learning outcome. During the SPE WEEK on the 30 October, SPE London YP engaged in supporting the Student chapter by presenting a technical talk on Efficient Field Management Optimization and Reservoir Simulation by Mohamed Ahmed Alfeel. This was an interesting topic and can be applicable to students in their projects and assessments.



Mohammed Ahmed spoke on evaluating development scenarios and supporting decision making, highlighting challenges involved in building simulation models integrating different data applications and applying new technologies to control and optimise the challenges. He also introduced local optimisation and how that can influence the optimise repeatable and high-frequency field controls.

Mohamed also spoke about job opportunities in the industry, and how the industry is transforming every year towards digitalisation and sustainability. Many

students spoke about student graduate opportunities in companies and projects.

This was a great initiative by the Student chapter and the Young Professional committee interacting with students and Young Professionals in exchanging technical knowledge concerning the Reservoir Engineering and Field Optimisation.

SPE University of Portsmouth Student chapter would like to thank SPE London Section and YP Committee in supporting student chapter in organising events and programs.

Enabling a risk-based approach to well plugging and abandonment



Brian Willis is an R&D Engineer at Astrimar Ltd. In this article, he discusses how moving away from a prescribed approach for well P&A design to a risk-based one can significantly contribute to further reductions.

Well plugging and abandonment (P&A) accounts for at least 44% of the total decommissioning costs on the United Kingdom Continental Shelf (UKCS), which currently stand at an estimated £49bn in total. Decommissioning encompasses all activities required to restore the seafloor to its original state before the wells were drilled and includes the removal of topside and subsea assets. According to the latest Oil & Gas UK Decommissioning Insight report, the industry has already achieved an impressive 17% reduction in estimated total costs, close to half of the regulator (OGA) driven initiative to achieve a 35% reduction.

Moving away from a prescribed approach for well P&A design to a risk-based one can significantly contribute to further reductions by designing solutions appropriate for the identified risks that enable new technologies, such as alternatives to cement as a barrier material and rig-less abandonment methods, together with the means for plug and barrier verification to be more easily incorporated in future designs. This has necessitated the development of a well system modelling tool called STEM-flow. The models in STEM-flow are built to represent the critical components of a decommissioned well, addressing all uncertainties in the system and capturing the failure mechanisms of barriers, while still being efficient across large spatial and time domains, as required by these kinds of assessments.

STEM-flow was originally developed to support the qualification of alternative barrier materials. It has been applied extensively to bismuth alloys but it is equally applicable to all barrier materials including cement. During two recently completed projects, it became clear that simply performing the material properties tests, as suggested in O&G UK Qualification Guidelines of Materials for Abandonment of Wells, does not directly demonstrate that the performance of the barriers meet all specified requirements and there has to be additional relevant function and performance testing of a plug, including a means to use the results from the qualification tests, to predict future long term performance and comparability with traditional cements.

STEM-flow employs a novel approach to barrier system modelling using flow block diagrams similar to those used in reliability engineering, coupled with fluid flow models to represent leakage through a complex decommissioned well system. For example, consider the simple scenario, shown in Figure 1, of a single cement plug set in a casing. The well barrier consists of the following elements: the cement plug; the casing (assumed to remain intact); the annulus cement behind the casing; and the near wellbore formation. Each of

these have different ways in which they can fail and multiple leak pathways that may cause those failures, some of which may not be independent.

The rectangular elements represent the isolated zones which typically include the depleted reservoir and the fluid containing zones between the well barriers. The circular elements represent the barriers which prevent or restrict the migration of fluids through each leak pathways. These pathways include bulk and microannulus routes to the isolated zones. These flow block diagram models can be extended to address multiple barriers and flow zones for a complete well system. Typically, a complete well system will

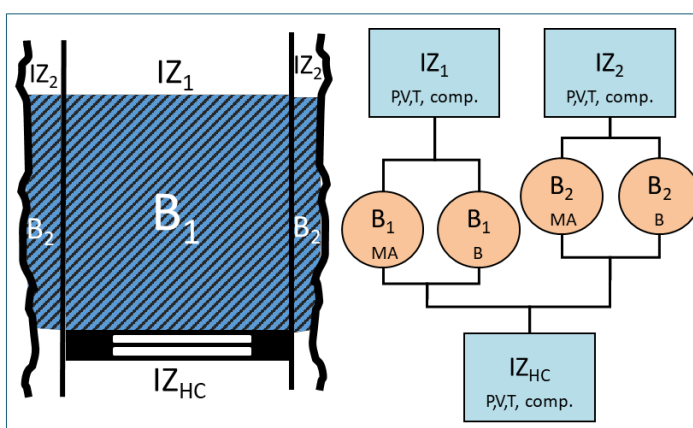


Figure 1: Simple system model of a casing plug with microannulus (MA) and bulk (B) leak pathways.



Enabling a risk-based approach... continued

comprise a minimum of three well barriers (primary, secondary and surface). For a well leak to occur there must be a driving force. Typically, this is assumed to be pressure difference across the barrier resulting from reservoir recharging, but it can also be caused by buoyancy forces. The state of each isolated zone and the condition of each well barrier can change with time and is dependent on the composition of the fluids present and their interactions with barrier materials. If any well barriers degrade or fail, they will be unable to completely seal the well. To capture these effects, all STEM-flow models including barrier degradation models, are time-dependent allowing for dynamics changes to the state of each barrier and isolated zone with time.

Importantly, this modelling approach has overcome the challenge of scale, capturing the effects of a microannulus of less than 100 µm on a 30m plug, in a well which is potentially thousands of meters deep, over time scales ranging from hours to days for the placement and setting of a plug that must last thousands of years; 3,000 years is the suggested life according to the OGUK qualification guidelines.

A core capability of STEM-flow, enabling the risk-based approach, is the ability to perform Monte Carlo Simulations (MCS). To put it simply, the simulations are repeated thousands of times, each time with slightly different inputs drawn from an uncertainty distribution for design, material property and degradation parameters. Instead of providing a single answer for critical performance measures, like the time for first hydrocarbon breakthrough, predicted leak rates and volumes and leak pathway analysis, MCS makes it possible to demonstrate the confidence in the results based on the statistical distribution of the model inputs.

Figure 2 shown below, provides results from an example simulation comparing a cement casing plug to an annulus plug set in a section milled window of a 5-½” casing. Removal of the annulus cement by section milling has improved the overall reliability, evident by the delay in the onset of leakage compared to the casing plug. Critical system component can be identified, if they have a significant effect on the overall system

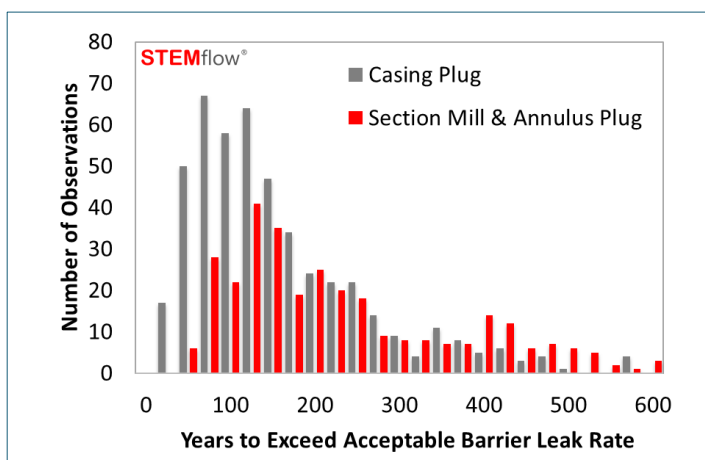


Figure 2: Comparative leak rate assessment of a cement casing and annulus plug placed in a section milled window.

performance, thus potentially indicating where additional effort needs to be made to reduce the uncertainty from that input, perhaps through further testing or suggesting additional well barriers or remediation and intervention may be required.

A risk-based approach to well P&A design enables Operators to move away from a prescribed approach to one of quantitatively demonstrating, to the regulator and wider community, that a proposed design is ALARP (As Low As Reasonably Possible) and where, and under what conditions, a dispensation may be justifiable. This can free up resources for more challenging P&A jobs, which often require significant intervention, rig-time

and ingenuity to complete. For technology developers, it can complement their development plan, as the plugs and associated failure mechanisms are simulated using qualification test data. The confidence in these results will reflect the effort and thoroughness of their technology qualification programme. It also enables comparative assessment of the predicted field performance compared to cement and other plugging materials, thereby providing greater confidence when moving towards field trials with an Operator.

Following a risk-based approach to well P&A should provide significant benefits to Operators and technology developers, by providing quantitative and comparative assessments and enabling Operators to include new plugging technologies and simpler well P&A designs with the highest integrity and lowest cost and risk.

For further details, refer to the paper: Willis, B. M., Strutt, J. E., & Eden, R. D. (2019, April). Long Term Well Plug Integrity Assurance—A Probabilistic Approach. In Offshore Technology Conference. Offshore Technology Conference. <https://doi.org/10.4043/29259-MS>

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RISC-sponsored conference: SPE Upstream Finance and Investments



On 29 October 2019 the SPE Upstream Finance and Investments Conference was held in London. The event attracted an international audience from across the upstream industry and saw well respected speakers share insights on the issues within the oil and gas, finance and investments industries. 21 countries were represented by the ticket holders.

The successful event brought together like-minded industry experts, who addressed key topics regarding the changing financial landscape within upstream oil and gas. The number of attendees was higher than the previous two years, and there was energetic debate and discussion in the room.

Conference highlights



Alistair Stobie, CFO, Hurricane Energy

The day commenced with **Hurricane Energy** showing the changes in markets and sentiments in the industry, and how we may take advantage of transitions. This talk also described the current ‘gloom’ seen in some financial markets.

The same themes were picked up in the M&A&D session, but these sentiments were contrasted by the speakers. Speakers from **Tailwind Energy** and **Siccar Point Energy** have taken advantage of the market timing, low competition for high quality assets, and getting the right forms of capital to finance their strategies. 40% of the UK’s production is in the hands of private equity, an increase from only 5% a decade earlier. **Citigroup** reminded us that investors have always expected reliable returns on their capital, but now the pressures of increased ESG (Environmental, Social and governance) demands are reducing the number of attractive upstream investments.



Jonathan Roger, CEO, Siccar Point Energy

Critical Resources showed that companies failing to maintain ESG standards have an increased risk of divestment, lower share price, or higher hurdles for new funding. In the European markets, ESG is not just a ‘nice-to-have’, but now a standard part of investment decisions, with over \$30 trillion of assets invested using ESG criteria in 2018. Resource companies are under pressures to integrate ESG issues into their businesses. **Io Consulting** reported that emissions from oil and gas production represent a quarter of full lifecycle emissions. And **BP** introduced the Oil & Gas Climate Initiative which aims to



RISC-sponsored conference ... continued

use Carbon Capture, Usage & Storage (CCUS) to reduce CO2 emissions and meet the Net Zero aims of the UK by 2050.

Kerogen Capital stated that Private Equity funds have renewed interest in the North Sea E&P as for first time, the improved fiscal regime in the UK is better than the US Gulf of Mexico. This was confirmed by **Blue Water Energy** who showed this region has more PE deals than anywhere else (outside the US) in recent years. Private Equity is investing heavily in developments, not just production. **TerraOil Swiss** said that although private investors seek very high returns, their long investment timeframe is less influenced by short-term cycles or events. **Mercuria** stressed the importance of integration and alignment between the funders and management teams, especially the views on risks, timing, using creative solutions, and exit strategies.

Petrofac gave a case study of a doubling in worker productivity delivered by using a digital twin model, combined with a digitisation of offshore work. **PA Consulting** reminded us to avoid the hype around disruptive digital technologies, to start small, and to focus on the problems being solved. **EnQuest** presented a case study where new technologies, improved workplace culture, and integrated planning all combined to extend the life of the mature Magnus field by 10 years. These factors also delivered increases in production and reductions in OPEX. **OGUK** introduced the Efficiency Task Force, to encourage and support a culture of collaboration across the industry.

Conference Chairs	Adam Borushek , RISC Advisory Basak Kurtoglu , Quantum Energy Partners
Keynote Speaker	Alistair Stobie , Chief Financial Officer, Hurricane Energy
M&A&D Trends - The Current and Changing Investment Climate	Speakers: Jonathan Roger , CEO, Siccar Point Energy, Shreyas Bordia , Managing Director, Citigroup, and Stephen Edwards , CEO, Tailwind Energy Session Chairpersons: Manoj Devashish , Citigroup, and Oguz Gurbuz , Scotiabank
Sustainability and Investments in Energy Development	Speakers: Richard Dyson , CEO, ig consulting, Chris Hindle , Head of Energy, Critical Resource, and Ian Hunter , Commercial Manager, OCCI Clean Gas Project, BP Session Chairpersons: Adam Borushek , RISC Advisory, and Alison Isherwood , AJ Isherwood Consulting
The New Vanguard of Privately Financed E&P Companies	Speaker: David Gallagher , Global Head of Structuring & Origination, Mercuria, Roy Kelly , Partner, Kerogen Capital, Khash Mohajerani , Director, Blue Water Energy, and Peter Krempin , CEO, TerraOil Swiss Session Chairpersons: Jim Bradley , RPS Energy, and Steve Griffiths , ERCE
Name of the Game: Capital Efficiency and Technology	Speakers: Jonathan Carpenter , Head of Strategy, Petrofac, Glenn Corr , Director Growth Assets, EnQuest, Justin Lowe , Digital and Cyber Security Expert, PA Consulting, and Emily Taylor , Continuous Improvement Manager, Oil & Gas UK Session Chairpersons: Willem Bloem , Bloem Consultants, Ramin Lakani , Muse Stancil & Co, and Darcy Spady , Independent Director



Shreyas Bordia, Managing Director, Citigroup



Roy Kelly, Partner, Kerogen Capital



Adam Borushek, Principal Consultant, RISC Advisory

Communicating complex ideas to a non-technical audience: Introduction to E&P

In November, SPE London organised its 15th annual Introduction to Exploration and Production Seminar. It provides an introduction to the full life cycle of oil and gas fields, in addition to covering the basics in exploration, geoscience, drilling, operations, reservoir management and commercial terms.



Nine industry professionals, with decades of experience across the industry spectrum, presented an introduction to their discipline, showcasing the complexity of the Exploration and Production business. Attendees (gathered at The Geological Society) formed a diverse audience in terms of professional background and experience.

The day started off with dispelling a wide range of trivial misconceptions around the industry followed by a broad introduction to the Global Context of the operations of an Oil and Gas company. After setting the scene in which E&P projects take place, the presentations were linked up following the life-cycle of projects, starting with undoubtedly the most crucial, Geology and Geophysics.

After the first networking coffee break, the discussion continued on the technical aspects of the business, introducing the audience to the next phase of activities once a potential reservoir in a petroleum system is located, Drilling, Petrophysics and Reservoir Engineering. After the light introduction in the morning, these sessions had the chance to showcase some of the state-of-the-art equipment and technologies the industry is using on a daily basis to get assets ready for the development stage, and started to familiarise the audience with the immense scale at which E&P operations take place and rounded off the Exploration related activities of the industry.

The afternoon sessions placed the focus on the operational elements, following on the asset life cycle theme from the morning.

The next session presented insights into Facilities & Production Engineering, displaying the wide range of projects executed to produce hydrocarbon assets around the world, whether onshore US or in the depths of

the ocean offshore west of Shetland. Now that all were familiar with the technical components of an asset, it was time to move towards the Economic and Commercial aspects of the industry.

The audience was introduced to the most widely used economic decision criteria, which enables companies to evaluate assets from a commercial point of view and make important strategic decisions around which assets

TOPIC	SPEAKER
Introduction by Seminar Chair	Adam Borushek, RISC Advisory
Geology & Geophysics	Ahmed Selem, AMS Consultancy
Drilling & Petrophysics	Stewart McGregor, Merlin ERDC
Reservoir Engineering and Petroleum Reserves	Adam Borushek, RISC Advisory
Facilities & Production Engineering	Roberto Cirilo, Imperial College London
Economics & Commercial	Lamé Verre, Halliburton
Upstream Deals	Rebecca Jones, Hurricane Energy
Managing E&P projects	Tim Bass, First Alpha Energy Capital
Safety & Environment	Geof Boyd, Esanda Engineering
Global Context	Miles Cudmore, Cudmore Oil & Gas Consulting



Communicating complex ideas ... continued

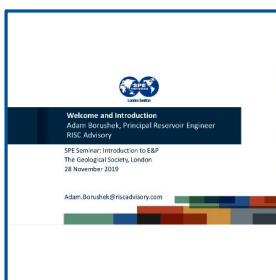
to prioritise.

This brought the asset life-cycle circle to a close, and beyond learning the basics of each stage, the emphasis on communication and co-operation between each business unit was highlighted.

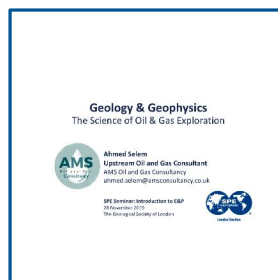
Just before everyone was ready for a tea, we were introduced to the different methods a company can use to monetise its assets, out of which M&A activities were discussed in detail. After a short break, the last stint introduced the audience first to the high standard of Health and Safety action in the industry and showing the remarkable results in reducing incidents during operations. In addition, the inevitable and increasingly relevant Environment factor was discussed, and attendees learnt about the initiatives industry participants are engaged in to offset the significant carbon emissions created by E&P operations.

The day ended with attendees learning about project management techniques applied in the E&P space, yet applicable to any high-scale project.

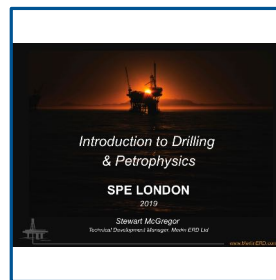
Full presentations available [on the SPE London website](#) or by clicking on individual images below.



Introduction by Seminar Chair



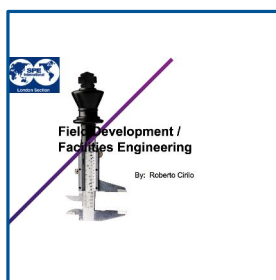
Geology & Geophysics



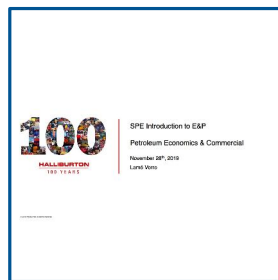
Drilling & Petrophysics



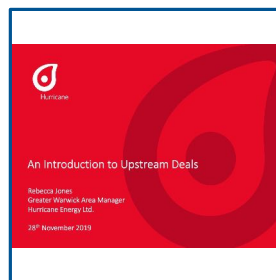
Reservoir Engineering and Petroleum Reserves



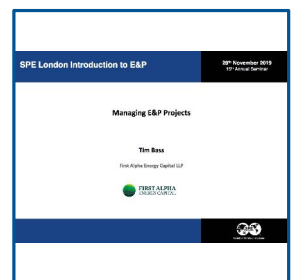
Facilities & Production Engineering



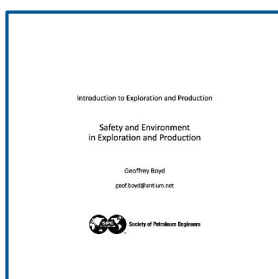
Economics & Commercial



Upstream Deals



Managing E&P Projects



Safety & Environment



Global Context

Will cloud technology replace local HPC installations for reservoir stimulations?



Paolo Orsini, founder and MD of OpenGoSim (OGS), examines insights by early adopters of the technology, on the pros and cons of a fast-evolving field. OGS develops and supports PFLOTRAN reservoir engineering modules.



Introduction

High Performance Computing (HPC) is now widely available on the web, through companies such as Amazon Web Services (AWS), Microsoft Azure and Google Compute Engine. Large scale computing resources can allow reservoir simulations to be performed at high resolution and using multiple realizations, for hydrocarbon recovery and carbon dioxide storage modelling. Cloud computing can offer a flexible alternative to in-house clusters, and a means for smaller groups to access large-scale computing resources.

When OpenGoSim (OGS) started, in 2015, we wanted to tackle large-scale studies, but we had no resources to purchase and maintain a big cluster, so cloud computing was the only way to go. This article discusses our experience with this technology, mainly on the AWS platform.

Benefits

The main attraction of using cloud computing is the ability to access large-scale compute clusters consisting of many CPU nodes and GPU accelerators, at short notice, without having the financial burden of owning, maintaining and upgrading such a system.

The scale of cloud computing vendors means that a cluster of hundreds of cores can be obtained at reasonably short notice, avoiding the delays that can occur when sharing an in-house cluster.

A cloud solution has the advantage of facilitating cooperation. Once a model is in the cloud, reservoir engineers with access to the data can directly suggest input modifications to each other and share results.

Negative aspects are the time and bother involved in the upload and download of data and results, and concerns about security and confidentiality.

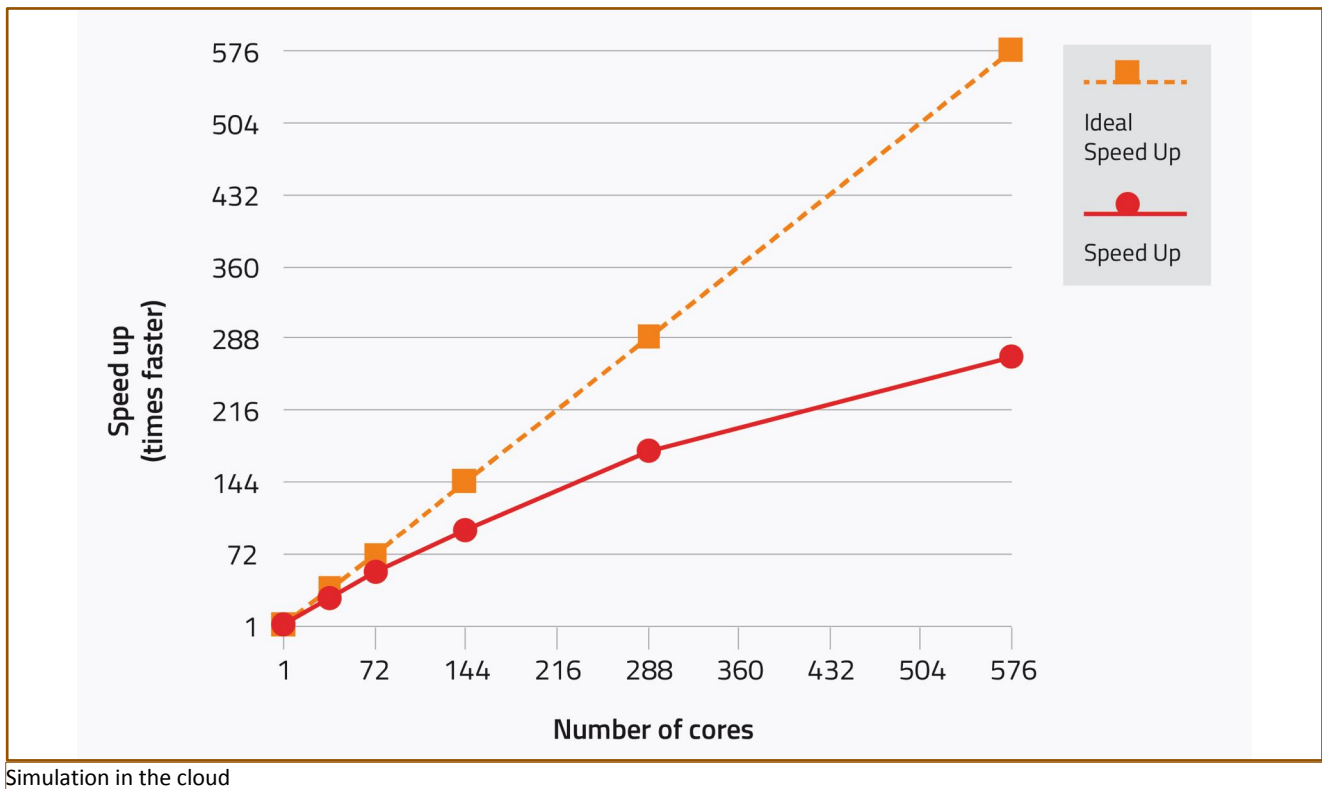
Performance

Cloud providers make available top-end CPUs connected



Cloud technology ... continued

by a fast network with a bandwidth of 100 Gbps [1], currently in the process of being upgraded to 200 Gbps [2]. We tested PFLOTRAN-OGS-1.3, a reservoir simulator parallelised by the means of MPI [3], on an AWS virtual cluster that makes available up to 576 cores. Each cluster node is powered by a 3.0 GHz Intel Xeon Platinum processor with 36 cores. A publicly available model of a potential UK CO2 storage site, named Bunter Closure 36 [4], was used for this test, refining its original grid to obtain a study with about 9.7 Million active cells.



As shown in the scalability plot, a speed up of 270 is observed when using 576 cores, with each core processing about 16,760 cells. The 576-core simulation starts about 5-10 minutes after being submitted using the OGS Web Application that functions as a cloud computing launcher [5].

Data upload and download times can be an issue, especially during model setup and initial testing. For the problem employed in the scaling tests above, for example, the size of the input and output datasets are 270 MB and 1.7 GB respectively after compression has been taken into account. With a relatively fast asymmetrical internet connection of 150 Mbps in download and 25 Mbps in upload, the input upload takes 80 seconds, while the output download requires 90 seconds.

When comparing these times with simulation times of hours, it is clear that the data transfer time is generally still small compared to the runtime. However, this task does still hold up the workflow somewhat. It is also worth mentioning that the largest part of the input file, such as the grid and its properties can be uploaded only once for multiple runs, and tools exist to perform the compression/decompression automatically when selecting a file for data transfer from/to the cloud.

Pricing

AWS offers a price of 0.12 USD per core-hour on a top-end CPU node connected via a 100 Gbps network. A cheaper rate is commonly available on a spot basis, but then the user is vulnerable to being out-bid at any time. Commercial resellers of software that makes available an easy-to-use virtual cluster may charge between 0.15-0.25 USD, depending on contract, usage, etc.



Cloud technology ... continued

These costs may be compared with the in-house option. The raw cost of a core-hour, including equipment and electricity, varies between 0.03 to 0.05 USD, depending on regional power and installation costs. On top of this, one must account for the cost of hosting the server, and staff to maintain the system and network. These two costs add another 0.05 USD per core-hour [6].

This brings the total costs of a core-hour to about 0.1 USD, assuming a typical 80-85% usage. Not surprisingly, an in-house cluster can still be cheaper if well-used. The cloud solution may still offer advantages in terms of capacity and flexibility.

Security

Security is a concern for many reservoir engineers who fear sensitive data can be exposed when stored on an online server. Cloud platforms use sophisticated technologies similar to those employed by online banking to prevent data leakages and hacker attacks. Data is encrypted both when in transit and at rest, login systems are made resistant to attacks via multi-factor authentication strategies, and penetration tests are carried out on regular basis to identify and fix any potential fault and vulnerability. While a certain small risk remains, security policies deployed by cloud providers and their resellers do minimise the possibility of security accidents.

Other aspects of cloud computing

Currently, results are generally downloaded for post-processing. Streaming technologies offer the possibility of also doing post-processing of large reservoir models in the cloud. This would have the advantage of reducing download delays.

Conclusion

Cloud computing is a technology that has not yet fully penetrated the reservoir engineering simulation market. Current technology seems mature enough to carry out computations previously feasible only on a large local cluster. The firepower available to do high-resolution modelling and multiple realizations is a big attraction. For groups unable to maintain a large in-house computing resource, cloud computing offers a way forward. For larger groups with their own computing departments, the cost argument and possibly security concerns may favour of staying in-house. However, even then, cloud computing can still provide a top-up additional resources and access to state-of-the-art computing capability when required. The ideal solution may be a mix: ideally, the engineer having a simple and non-intrusive way of selecting local or cloud platforms.

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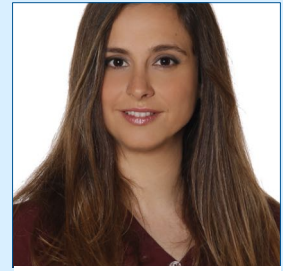
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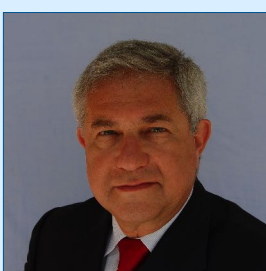
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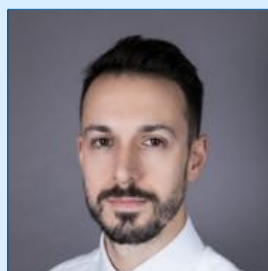
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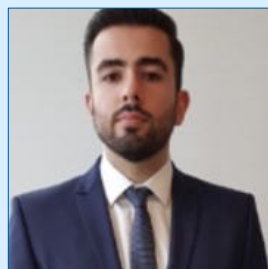
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This workshop is an exclusive platform for industry practitioners to share their latest experiences in Managed Pressure Drilling (MPD) and to learn from each other on improving all aspects of MPD; from initial contracting, equipment standards, supply issues, technology developments, and operational and staffing challenges in a recovering oil market. The workshop aims not only to address the common issues affecting operators, drilling contractors, and service providers, but also to identify and discuss the differing challenges each group may be currently facing.

13-15 January **International Petroleum Technology Conference** Dhahran, Saudi Arabia

The 12th edition of the International Petroleum Technology Conference (IPTC) will be held 13–15 January 2020 at the Dhahran EXPO in Dhahran, Kingdom of Saudi Arabia, with Saudi Aramco serving as the Exclusive Host Organisation. IPTC is a collaborative effort among the American Association of Petroleum Geologists (AAPG), the European Association of Geoscientists and Engineers (EAGE), the Society of Exploration Geophysicists (SEG), and the Society of Petroleum

28-19 January **SPE Workshop: Multiphase and Wet Gas Flow Measurements in Conventional and Unconventional Data Driven Environment** Galveston, Texas, USA

In the new world of maximizing recovery while continuing to lower operational costs, operators need reliable digital technology. Flow rate measurements are the backbone to reservoir management and to maximize recovery. Multiphase and wet gas flow metering technologies are critical tools to meet the new market-driven demands. While these technologies have been commercially available for a couple of decades, the changing operational environments and evolving digital paradigms necessitate a fresh look and renewed discussion on its applications.

4-6 February **SPE Hydraulic Fracturing Technology Conference and Exhibition** Texas, USA

The SPE Hydraulic Fracturing Technology Conference showcases existing and new hydraulic fracturing technologies, using experiences from fracture-stimulated wells, and the application of global learnings. Attend to learn about the latest developments and practices in hydraulic fracturing. The event features a robust technical program, an exhibition of innovative products and services, and multiple networking opportunities.

19-20 February **SPE Symposium: ESP Journey to the Future** Muscat, Oman

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Includes a Live Event on 01/21/2020 at 2:30 PM (GMT) Online webinar

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