



The use of technology to reduce P&A costs and improve assurance

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OTM estimates that global decommissioning costs are upwards of \$12.4 billion per year

P&A is responsible for

10% to 43%

of total decommissioning costs worldwide

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Key questions

- Are there innovative solutions out there?
- Do they really reduce P&A costs?
- What if they don't fit within the current regulations?



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The industry momentum behind cost-effective wells P&A with robust assurance is growing, and technology has a key part in this

Understand

The industry needs and concerns are well documented, now is the time to:

- Identify existing solutions
- Highlight technology and knowledge gaps
- Learn from others
- Assess suitability of regulations

Decide

Aging assets, low oil and disruptive technologies make for a challenging backdrop requiring:

- Risk identification & mitigation
- Cost analysis/reduction
- Collaboration between operators, technology providers and Centers of Excellence

Develop

Science & technology led innovation using cross industry insights to:

- Improve efficiencies
- Reduce dependence on rig-deployed technology
- Design alternative barrier technologies
- Model leak paths & failure

Deploy

Managing the adoption of new technologies, optimising processes, development planning & independent verification

Moving away from a

“we have always done this”

mentality within the boundaries of regulation

The lack of innovative solutions back in 2009 is now being rectified with some exciting and disruptive technologies entering the market

Examples of innovative technologies

- Bismuth plugs
 - Provide a metal-to-metal seal across casing
- Resins
 - Can provide seals between annulus and formation
- Thermite seals
 - High energy downhole reaction negates requirement to pull tubulars
- Rigless P&A
 - No requirement for costly rigs
- Shale as a barrier
 - In-situ annular seal



OTM's view on "the ones to watch"

There is no “silver bullet”, but a portfolio of options which enable traditional P&A methods to be challenged

The focus is now on the drivers for successful P&A

- Have the correct targets been sealed?
 - Knowledge of the well
 - Placement accuracy
- Is there fluid/gas leakage?
 - Reliability of the cement sheath
 - Seal reliability of plugs
- How good is the barrier?
 - Material
 - Longevity
 - Testing, verification and assurance
- How do we use it?
 - Integration into the overall P&A system

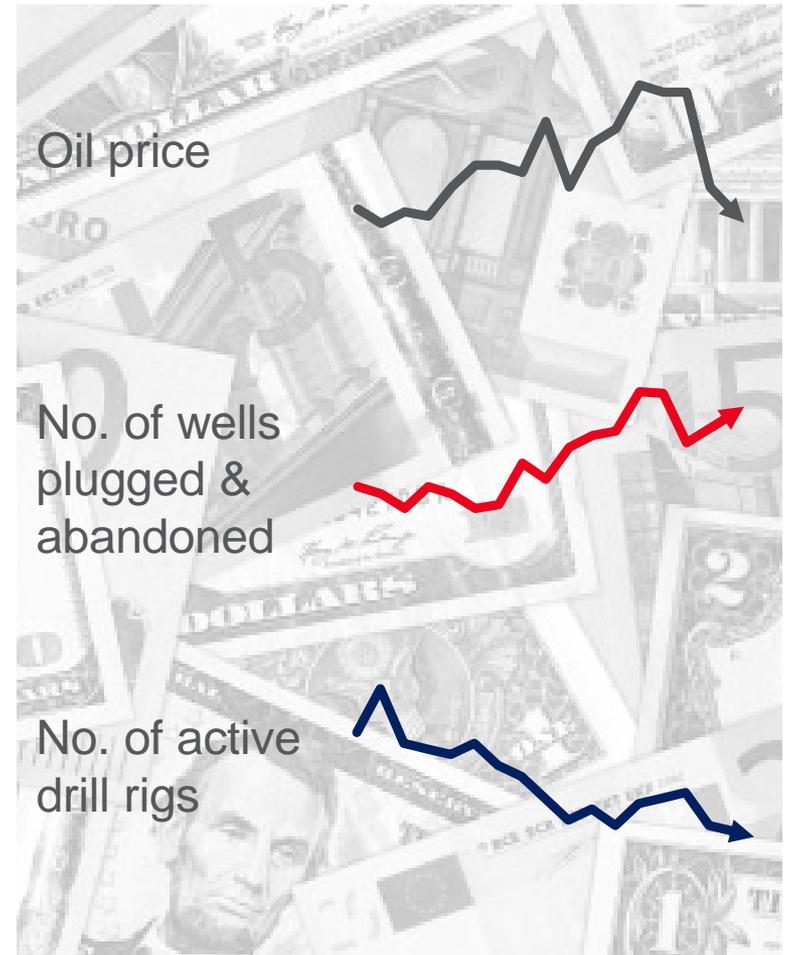
Rather than following the “tried and tested” process



In the current climate, there is reluctance to spend money unnecessarily, this may prove an advantage for P&A

Macro trends effects on P&A costs

- Low oil price is bringing forward decommissioning dates as remaining OIP is not economically recoverable
- Many mature fields have already undergone extensions and are now requiring decommissioning with a peak in the next 5 years
- Reduced drilling activity has resulted in a surplus of rigs, which can result in more favourable day rates



To effectively reduce costs the right technology must be selected for each well, there is no one solution that fits all cases

How to quantify potential cost savings

- Accurately cost your “base case” for traditional P&A
- Identify available technologies
- Understand how these are deployed and support requirements
- Relevance of the technology to your portfolio
- Do they align with your overall abandonment philosophy
- Identify where the potential savings lie and if they can be realised
- Estimate costs and compare to base case

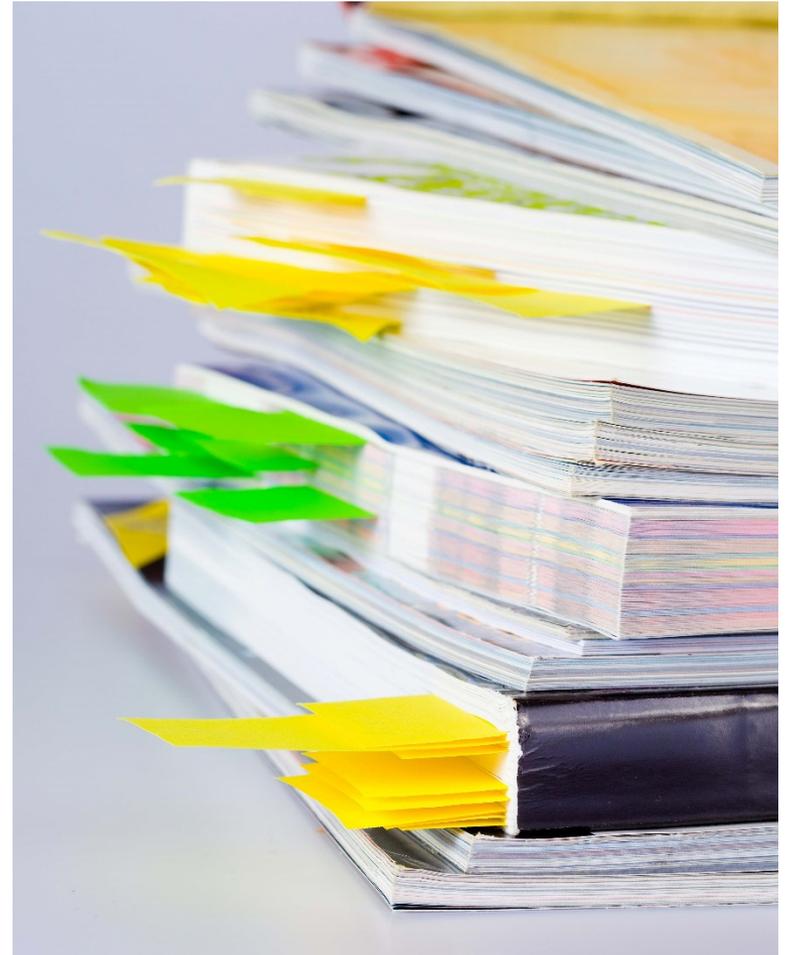
Factors that must be considered when comparing P&A costs

- Rig design and capabilities
- Possibility of using a mobile rig
- Coil tubing/wireline access
- Accommodation and support services
- Crane capacity
- Well design
- Casing design and records
- Cement design and records
- Logging records
- Field history
- Well histories
- Existing well integrity issues

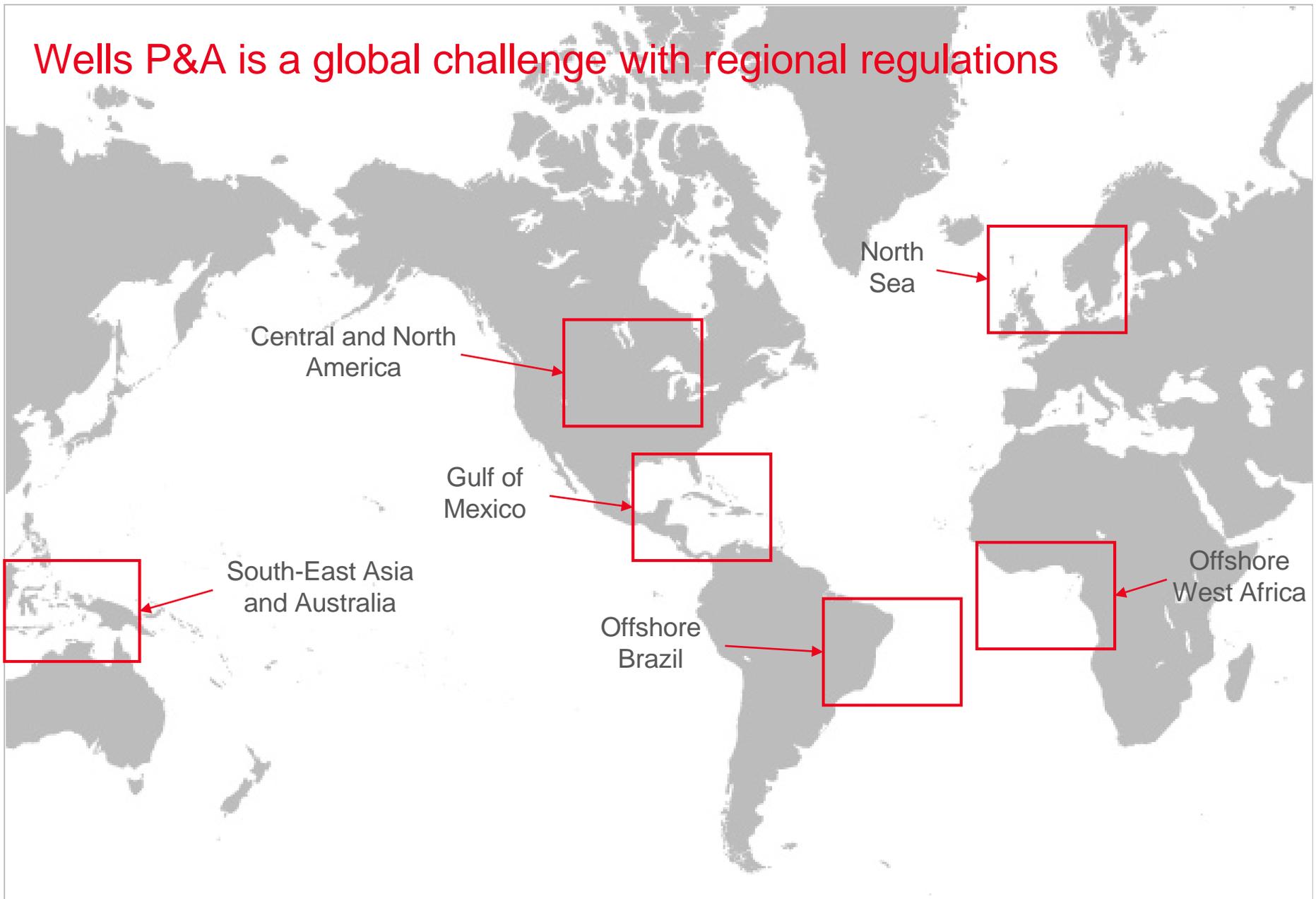
Once begun, the focus is on carrying out the P&A process as safely and cost-effectively as possible – real cost reduction comes earlier

Define your abandonment philosophy early to enable cost-effective deployment

- New technology takes time to commercialise
- Big cost-savings are made in repeatability rather than bespoke services
- Identify who else is doing the same and take advantage of collaboration opportunities
- Make use of all available well information to predict where the challenges will lie
- Preparation is key to ensuring wells P&A costs are predictable and controlled



Wells P&A is a global challenge with regional regulations



What is the theory behind the regulations? Why? Where? What? How?

General plugging requirements

In general, regulations specify where cement plugs should be set, sealing the following main targets:

- Open hole
- Separate pay zones
- Perforations
- Liner tops and channels in cement
- Surface locations (3' or 1m on land to 10 to 15' or 3 to 5m, below ML offshore)
- Damaged sections (wear points, milling, perms, etc.)
- Multi-laterals
- Corrosive zones (highly corrosive salt water?)
- Special cases (clearing sea floor, rigs to reefs, geothermal, etc.)

Is there a smarter way to look at this?

Regional examples

- In Canada, current practice involves well monitoring during its active lifetime, while no monitoring is required after adequate abandonment is reported
- P&A regulations in Norway do not cover processes for qualification of new materials or technologies
- P&A regulations in the UK provide guidelines on how to qualify materials (not all technologies used for P&A) for abandonment
- DNV GL have released a set of new P&A guidelines that are based on the risk-approach methodology

Is there a way we can safely leave tubulars and completions downhole?

When using technology to reduce P&A costs, there needs to be a combination of collaboration and individual operator effort

Collaboration

- Understanding and applicability of regulations
- Global standardisation
- Qualification of new materials and techniques
- Sharing of best practice
- Fundamental technical understanding of technologies
- Permanence of barriers
- Influencing regulators – how good is good enough?



Individual operator effort

- Risk-based approach is unique for each company
- Apply detailed knowledge of individual wells
- Identify cost-saving technologies
- Grow internal experience/knowledge base
- Set abandonment philosophy
- Develop a technology plan 5-10 years out
- Develop a roadmap



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Answers to the key questions

- There are many innovative solutions out there gaining traction in a cost-sensitive environment
- Detailed knowledge of individual wells and common challenges is required to quantify potential cost savings
- A risk based approach is required to identify “how good is good enough”



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