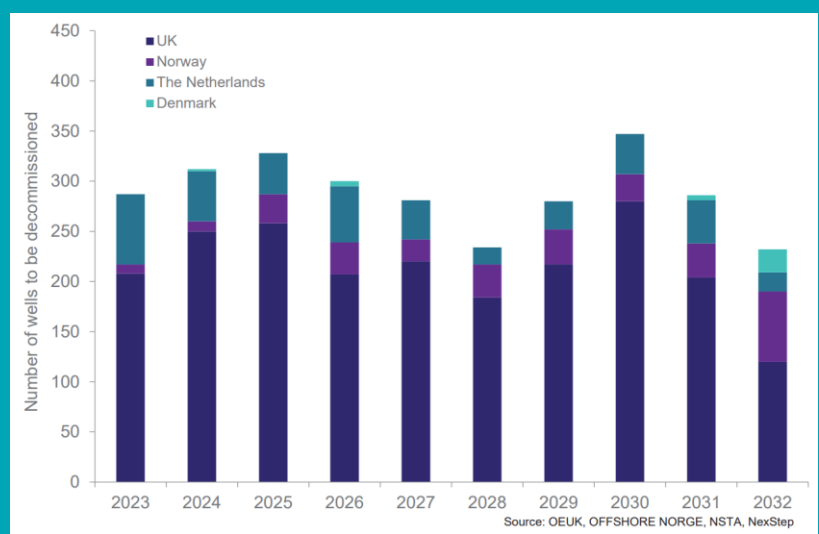


Technology Qualification Framework for Well P&A Technologies

SPE Well Decommissioning
5 June 2024

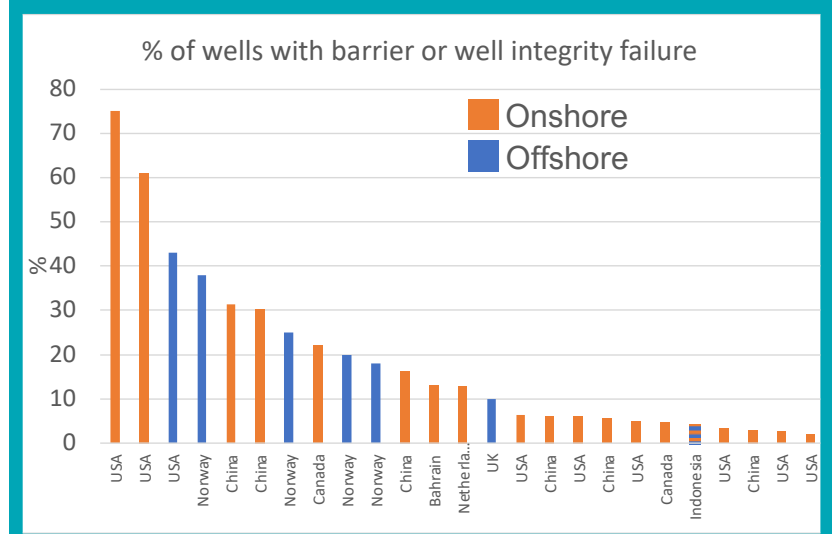


Opportunities



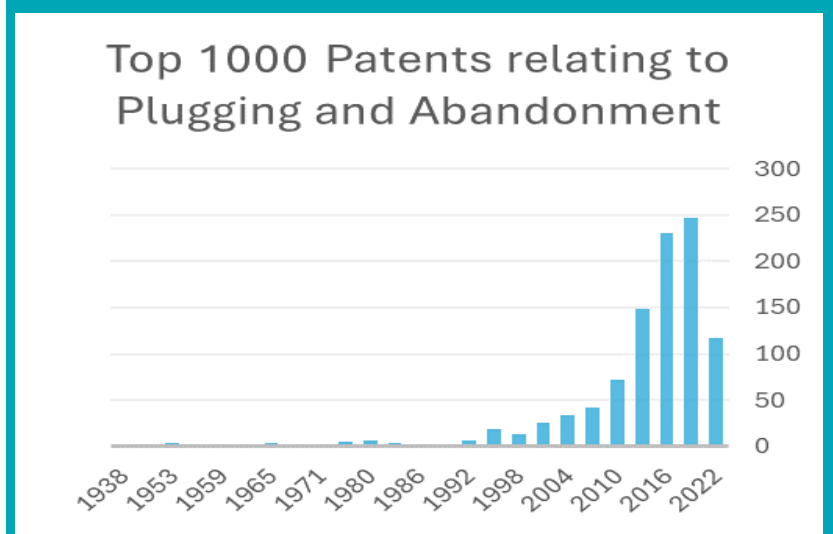
- 1000s of wells requiring decommissioning across NS
- Wells account for 51% of decommissioning expenditure
- Current rising costs per well

Issues



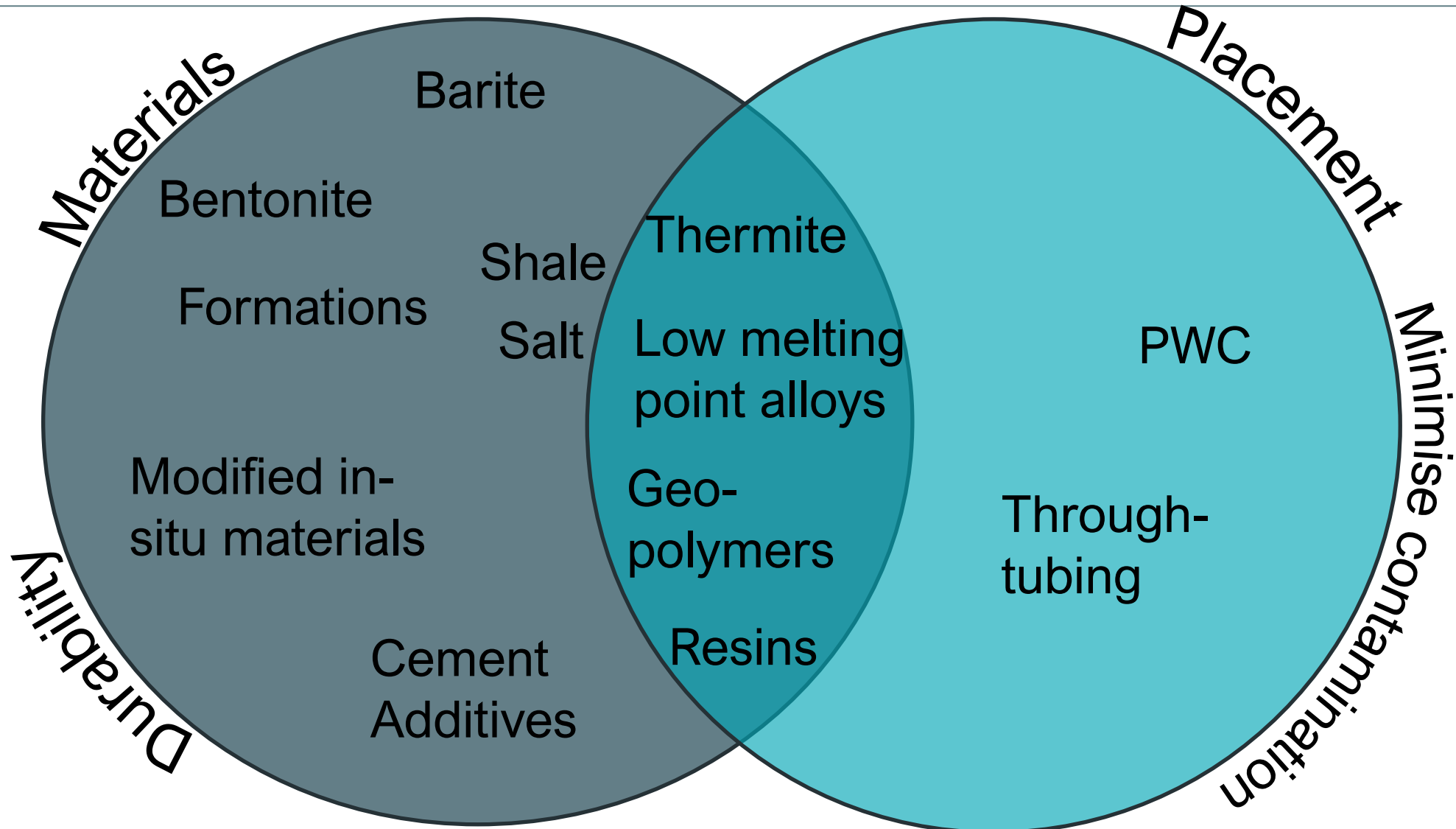
- Known integrity issues with cement
- Wide variance with age and region
- Increased concern with CCS

Solutions



- Hundreds of technologies are being developed
- Low uptake and confidence in new solutions
- Qualification process is too slow

Current and Future P&A



Key challenges with Proving P&A Technologies



Understanding what is required to qualify a technology –
Defining requirements, identifying risks and key activities, checklists.



Agreeing when a technology is qualified –
Communication, evidence and common understanding.



Opportunities to trial and verify well barriers –
Pilots/Field trials, operators' willingness to take risks.

What is required to qualify a P&A technology?



Identification of requirements

Identification of risks and activities

Requirements Proforma

FMECA Template

Requirements Help Sheet

Why requirements are needed

Before an alternative well barrier is designed or manufactured it is essential to understand the requirements both from a well barrier perspective and from a development perspective. Lessons from the past indicate that such effort and attention will be rewarded if it is well done. The identified requirements provide the essential criteria against which design, production and testing activities can be measured and appropriate development decisions made.

Types and examples of requirements

There are many different types of requirements that all other need to be met for a new technology to be introduced to well search. For example, requirements related to certification, required functions, installation, performance, validation performance, and the well barrier specific requirements. The main categories of requirements are:

- What are the barrier technology used to do and how well does it have to do it?
- What is the required barrier operational life based on normal conditions?
- How long before failure of the barrier is acceptable?
- Can the well barrier be repaired? Are there any specific disposal comments?
- Can the barrier be repaired?
- Are there any health and safety risks during barrier production, (physical) storage, and delivery?
- Are there any health and safety risks from the installation, confusion, or failure of the well barrier?
- How readily should the barrier / barrier material be tested and assessed? What tests, temperatures, frequencies should be used?
- Are there any installation constraints or limitations that need to be addressed to successfully install the barrier?
- What environmental might the barrier be exposed to when installed? What is routine and what is extreme?
- Does the barrier design or production process need to conform to an existing code, standard or regulation?
- What testing, validation and commissioning is required? Does it fit any needs to be measured?
- Who is able to provide verification of compliance with specified codes, standards and regulations if required?

How do I find out what the requirements are?

It is important to start by identifying the potential users of the well barrier technology. Early discussions with operators and well barrier users can be very beneficial to understanding their needs. In addition, some expertise for technology qualification requirements from various required entities, codes and authorities. Specific requirements from an ISO and IEC, or industry organizations such as OGE and NORSOK, also have requirements to help find relevant codes, standards, guidelines, and regulations. However, meeting through and understanding these documents can be time consuming and hence it is recommended that a discussion with small specialists in field with technical experts, well operators, independent operators and companies with relevant knowledge of the operations and relevant regulations.

Once the key requirements for the well barrier technology have been identified, these then need to be translated further in the context of specific well barrier contents and profiles, e.g. material or component specifications. For well barrier technologies that interface with other equipment and other activities well barrier activities (e.g. testing) may have to be needed to understand and align with the wider system requirements.

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Alignment with qualification guidance

Well decommissioning guideline requirements

When is a technology qualified?



Technology Maturity Assessment - TRL

High Level Well Barrier TRL Assessment

TRL Assessment Completion Status

Type of Assessment

Date of Assessment

High Level Well Barrier TRL Assessment

TRL 1: Basic Research

TRL 2: Well Barrier Concept Formulation

TRL 3: Well Barrier Concept Development

TRL 4: Well Barrier Concept Demonstration

TRL 5: Well Barrier Prototype Development

TRL 6: Well Barrier Validation

TRL 7: Well Barrier Integration Testing

TRL 8: Well Barrier Installation and Verification

TRL 9: Well Barrier Proven

High Level Well Barrier TRL Assessment Help Sheet

Use of Technology Readiness Levels (TRLs)

The Technology Readiness Level (TRL) concept, first developed by NASA, is now used in many industry sectors and provides an indication of technology maturity. TRLs typically run from 1 to 9 with TRL 1 being the lowest level of technology maturity and TRL 9 corresponding to field or mission proven technology.

Bespoke TRL definitions have been developed for alternative well barrier materials, however, the intent is consistent with most sectors using the same 1 to 9 levels with slight variations in the level descriptions to reflect this specific application. Hence the High Level TRL 1 to 9 definitions provide a common framework for communicating technology maturity, e.g. to investors, funding bodies or end-users, to enable an understanding of the extent and nature of work required to qualify technology to the required level as well as the potential level of technical and commercial risk.

The oil and gas industry also uses a 0 to 7 scale, particularly for subsea applications, see API RP 17Q and ISO 20815. This uses similar definitions for corresponding levels with e.g. API RP 17Q TRL 7 corresponding to NASA TRL 9. It is important to be clear which scale is used (1 to 9 or 0 to 7) when communicating achieved TRL to a third party.

Advancement of a specific TRL may be a requirement for investment or technology application by end-users. TRL milestones are sometimes used as decision stage gates in technology development projects, for example to support continued investment decisions, or adoption into deployment projects.

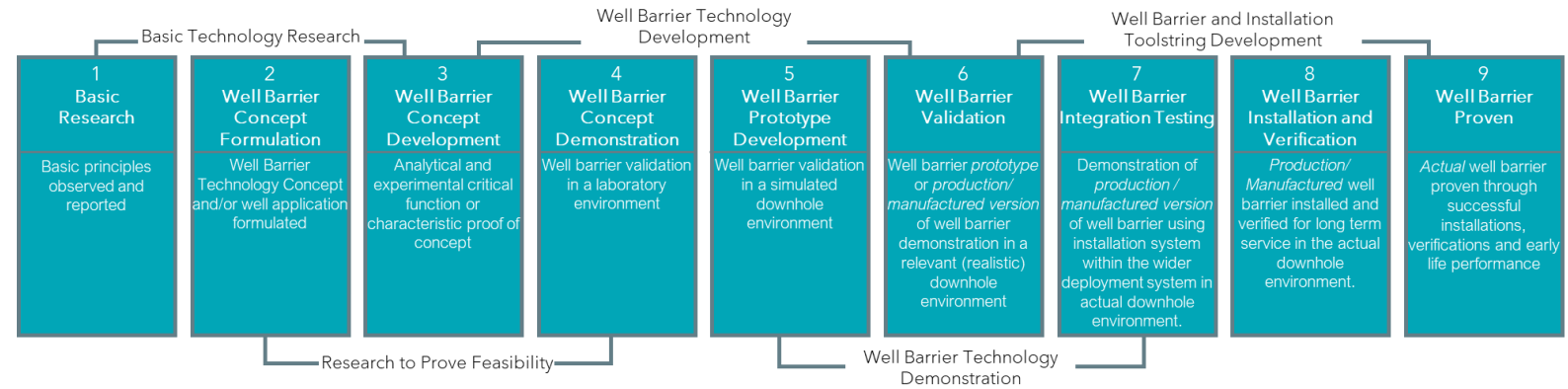
Assessing TRL

Early in a technology qualification project, TRL is often assessed at a high level for the technology system as a whole to enable an initial understanding of the technology maturity to support qualification planning and include in funding applications. The 'High Level TRL Assessment' worksheet has been designed to support this. It offers a bespoke 1 to 9 TRL scale combining guidance from different industry sectors and applied to alternative well barrier materials. For each TRL, five contributing elements are described to indicate the types of activities expected to be completed to achieve that TRL.

As work progresses and more detail about the design becomes available, a more detailed component level assessment can be undertaken. The component assessment can then be used to provide an overall technology system TRL.

The TRL assessment should be based on evidence of undertaking the required qualification activity elements to achieve each TRL. It is recommended that the assessment is undertaken as a group activity involving relevant members of the technology development team. For modified technology being qualified for new applications, it can be useful to get input

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Technology Maturity Assessment

- Provides a consistent approach and evidenced against TRL claims
- 5 high level tasks/activities identified for each TRL
- Colour coded dashboard to indicate completeness
- Reviewed and agreed by Operator consortium members

Opportunities – Pilot of Framework



- Well barrier technologies from an array of developers to understand the different approaches needed to qualify and place an alternative barrier material.
- First Pilot of Framework has commenced
 - Requirements Proforma completed – Lessons learnt incorporated.
 - FMECA in progress – Two workshops held with risks and mitigations identified.
- Development of an Installation Checklist for well barrier technology.
- Guidance for Requirements Proforma & Qualification Gap Assessment.
- Extension of Framework for inspection, verification and enabling technologies.

Objectives and Goals



AN EFFICIENT QUALIFICATION
PROCESS AND GUIDANCE

DE-RISKED FIELD TRIALS
AND PILOTS WITH
GREATER SUCCESS

QUALIFIED PERMANENT
CAPROCK BARRIERS

REGULATOR ENGAGEMENT
AND CONSENT

QUALIFICATION AND
DEPLOYMENT CHECKLIST FOR
ALTERNATIVE BARRIERS

EXTENSION TO INSPECTION &
VERIFICATION TECHNOLOGY;
P&A ENABLING TECHNOLOGIES

A PORTFOLIO OF PROVEN
ALTERNATIVE BARRIERS
READY FOR USE

6

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A problem shared is a problem exported.



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The Power of Collaboration

A problem shared is a problem solved.



Thank you

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