



North Sea
Transition
Authority

Technology Insights 2022

Technology Managers' Network webinar

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- Technology plans from 70 UKCS Operators received annually
- Very thankful to companies for their significant efforts

- This afternoon, we present the summary of last year's plans
- Discuss technology trends and examples in a few priority areas

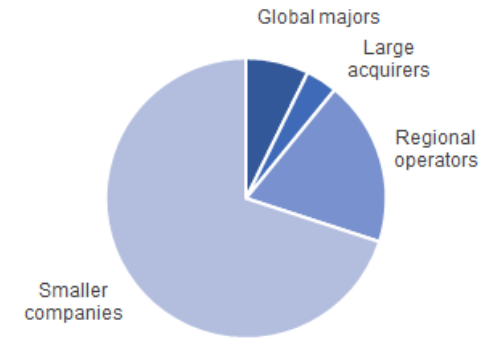
- Detailed findings available on line [NSTA Technology Insights](#)

- Additional information on suppliers technologies at
 - [UKETP \(energytechnologyplatform.com\)](#)
 - [Net Zero Technology Centre \(netzerotc.com\)](#)

- ~70 operators have submitted [Technology Plans](#) annually
- 2017 to 2022
- In this period, significant industry changes, incl.
 - Oil / gas prices
 - Exploration and production decline
 - Asset ownership change
 - Emerging net zero opportunities
- **Operators' direct investment in technology dropped significantly since mid-2010's**
 - Global majors reduced their R&D
 - New entrant acquirers have smaller technology spend
 - Direct spend largely on subsurface and development

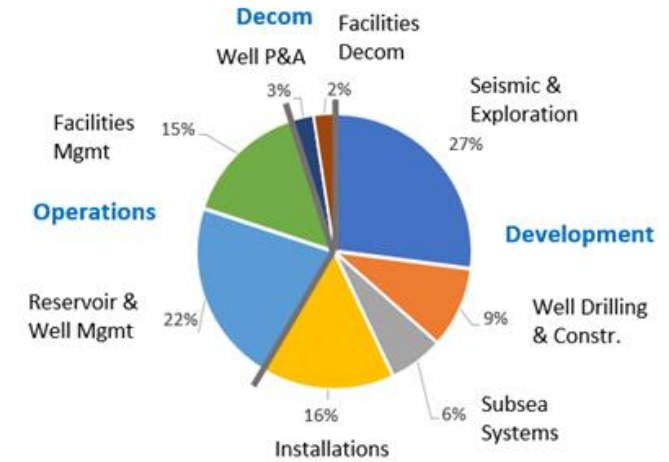
Technology plan submissions

Total = 70



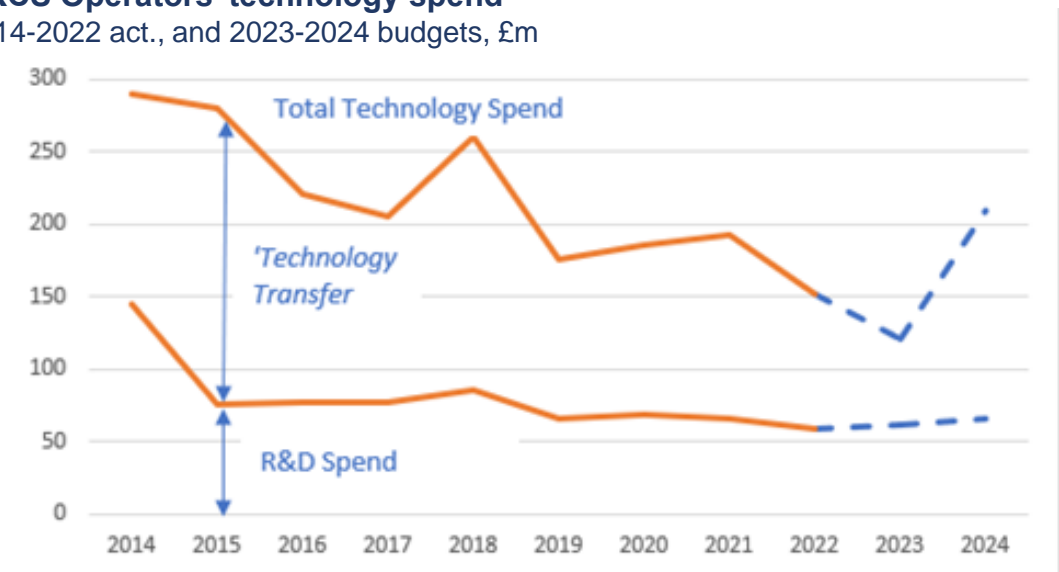
Operators technology spend by category 2022

2022



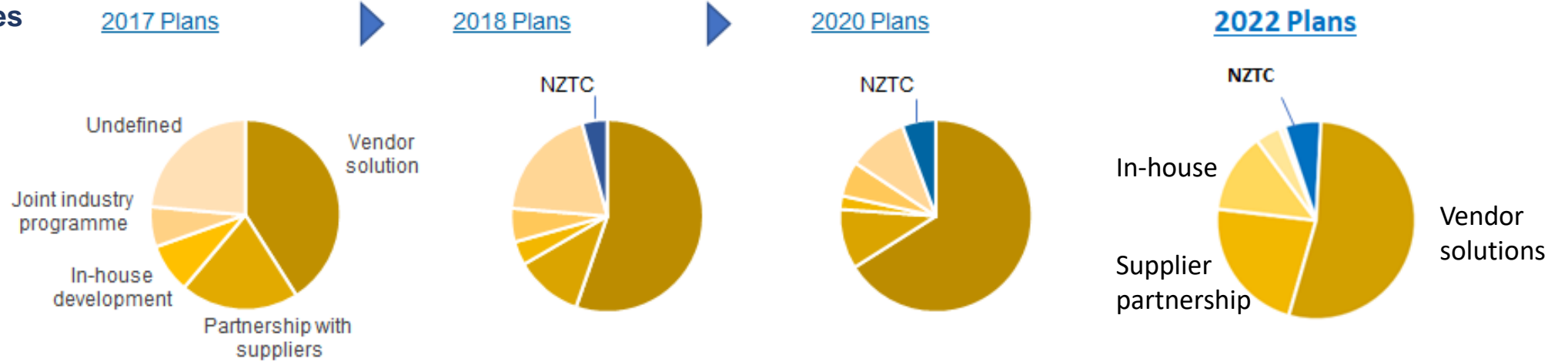
UKCS Operators' technology spend

2014-2022 act., and 2023-2024 budgets, £m



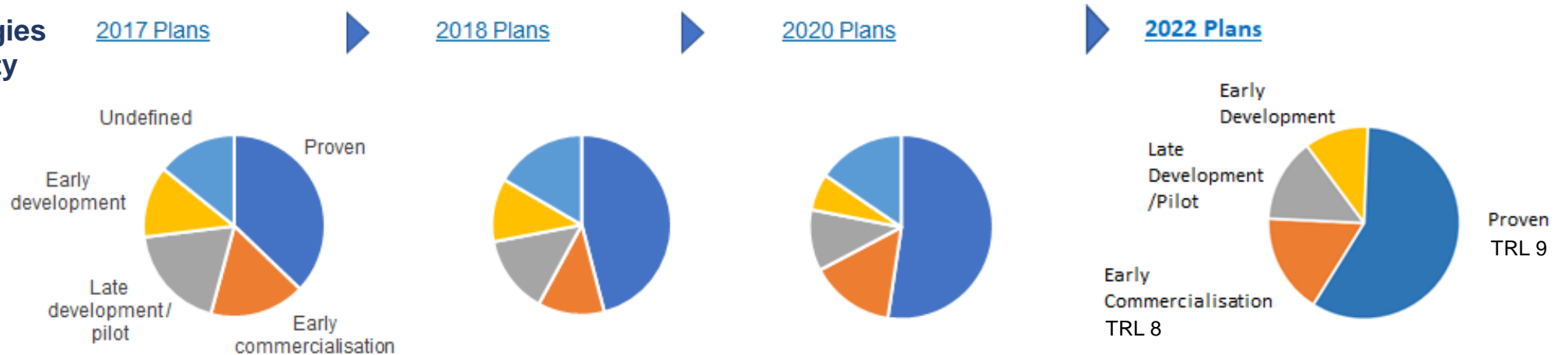
Greater access to Suppliers' technologies compensate for lower Operators' spend

Technologies by source



Predominant focus on deployable technologies - TRL 8 and 9

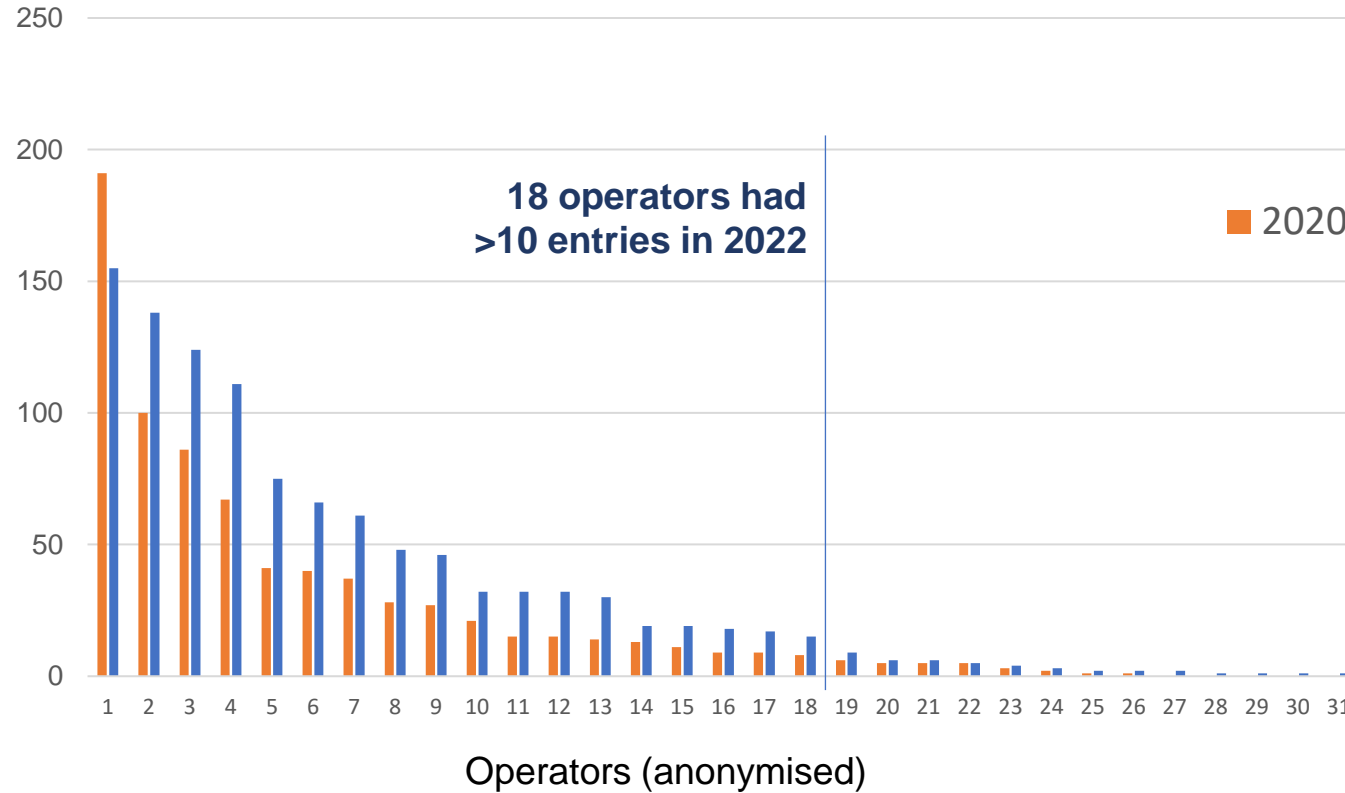
Technologies by maturity



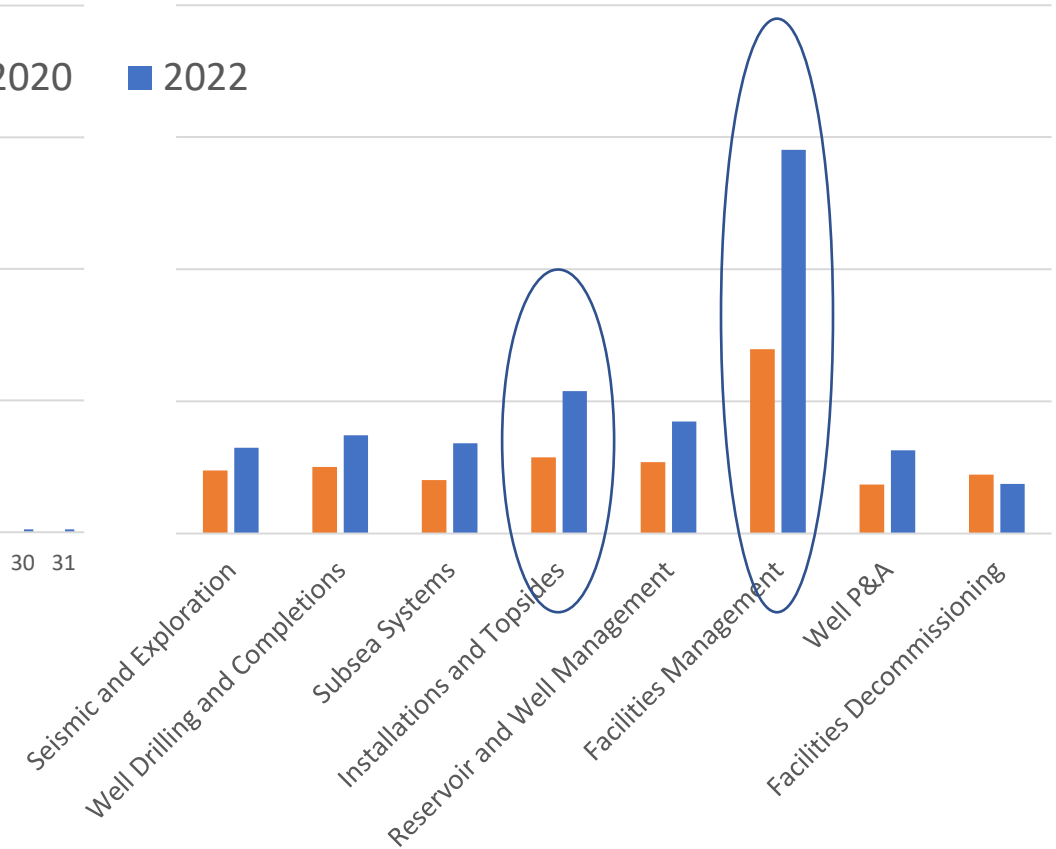
Operators' plans have richer technology content

With larger number of **deployments** being reported

Number of technologies reported

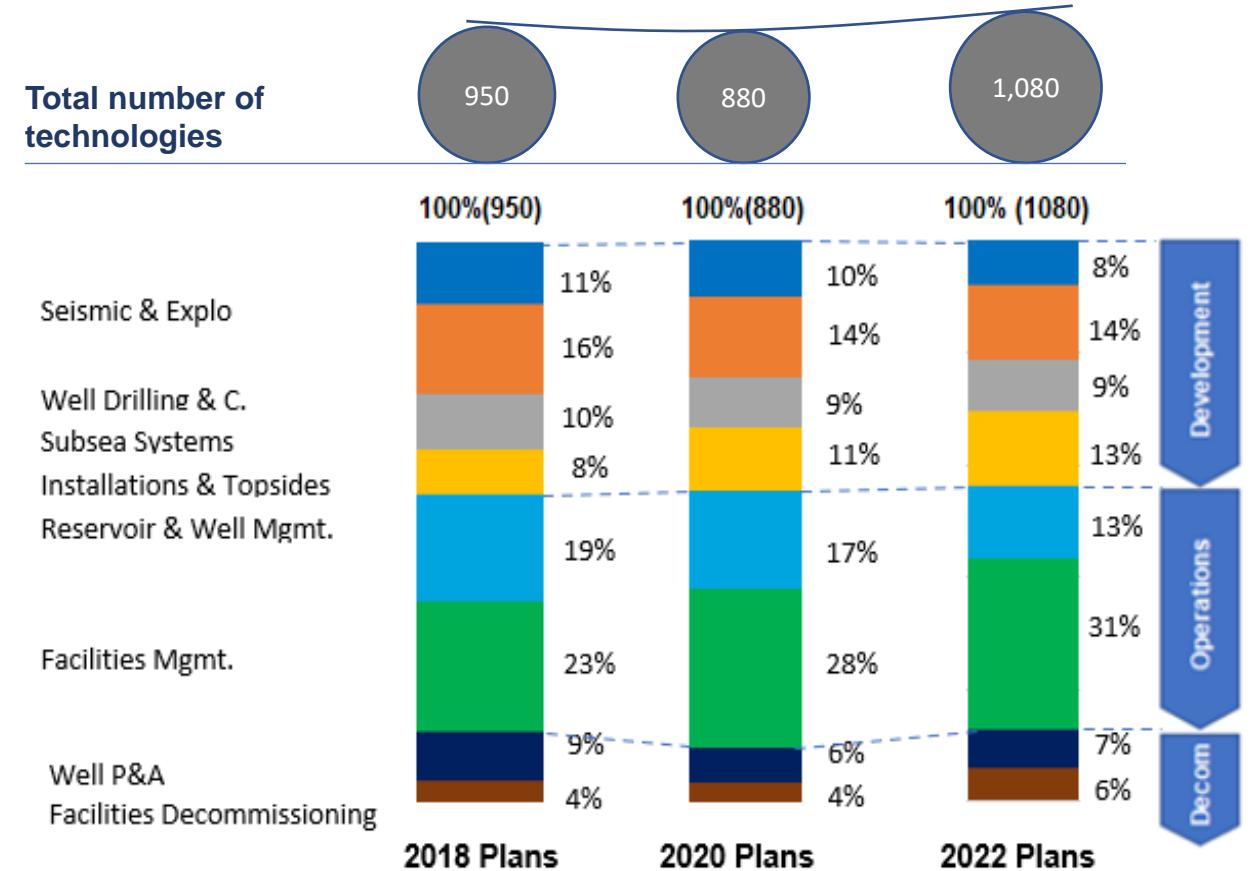


Number of deployments



- Despite declining spend, technology interest by Operators keeps increasing
- Technologies are sought to address challenges in:
 - Exploration and development
 - Asset management
 - Decommissioning
- With the fastest growing areas being
 - Asset management
 - Digital & Data
 - Net Zero

Number of technologies reported



Key trends and highlights

Technology Category	Trend	Highlights
1. Seismic & Exploration	Decline in tech numbers	Acquisition (high resolution 3D broadband, streamers, OBNs, NFVs, autonomous OBNs), processing (Full waveform inversion, AVO), modeling (visualization, machine learning, cycle time efficiencies)
2. Well Construction	Flat	Effective planning of the wells, greater scope of drilling automation, MWD, geosteering to difficult targets and intelligent completions, increasing cost efficiency and productivity
3. Subsea Systems	Growth	Improving pipeline and component designs, integrating old and new controls, factory approach to installation, subsea processing facilities
4. Installations, Topsides	Strong growth	Reducing facilities cost and emissions, emissions monitoring, low carbon power, electrification enabling technologies, low-cost unmanned wellhead platforms
5. Res. & Well Mgmt.	Decline	Addressing ageing well stock requiring remediation to maintain production - reducing workover costs with low-cost rigs and retrofit solutions, well integrity repairs, stimulation and other production enhancement
6. Facility Management	Strong growth	Non-intrusive inspections, automation, connecting onshore and offshore workers, digital twins, remote operations
7. Well P&A	Growth	New materials and deployment techniques – improving understanding of well integrity status, and advancing towards more rigless abandonment
8. Facility Decom.	Growth	Facility decommissioning – a broad spectrum of technologies for the clean up, conditioning and removal, and growing focus on cost-effective subsea decom
9. Digital & Data	Strong growth	Connecting onshore and offshore workers, surveys, digital twins, remote operations, advances in modelling and analysis using AI/ML, productivity enhancements, remote monitoring and data visualization
10. Net Zero	Strong growth	Emission reduction and monitoring, more efficient use of energy and sharing of sources, low carbon power, enabling technologies for CCUS and hydrogen production, transport and storage

Findings by category – *Life cycle*

Eight *asset life-cycle* categories

1. Seismic & Exploration

2. Well drilling & construction

3. Subsea systems

4. Installations & Topsides

5. Reservoir & Well management

6. Facility management

7. Well P&A

8. Facility decommissioning

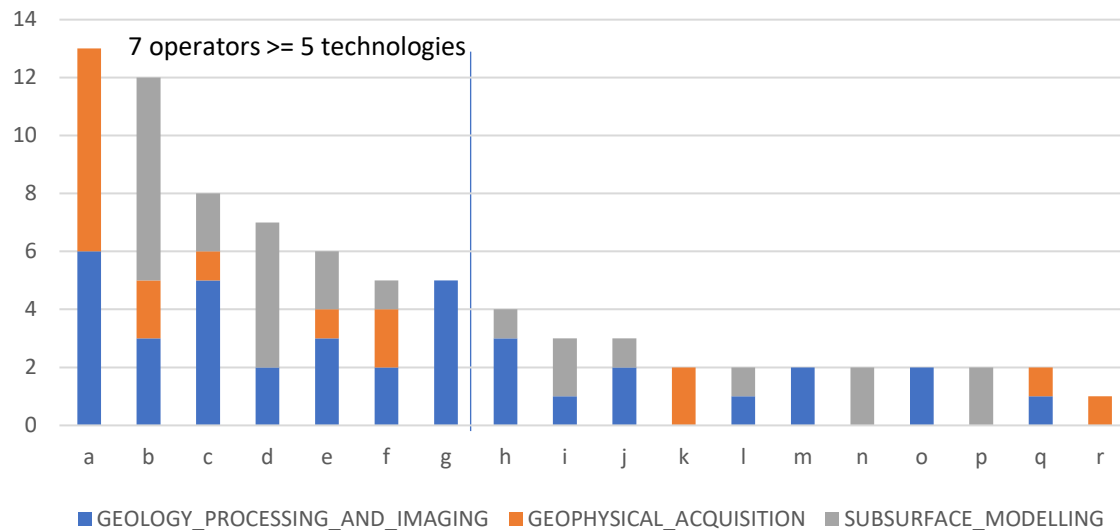
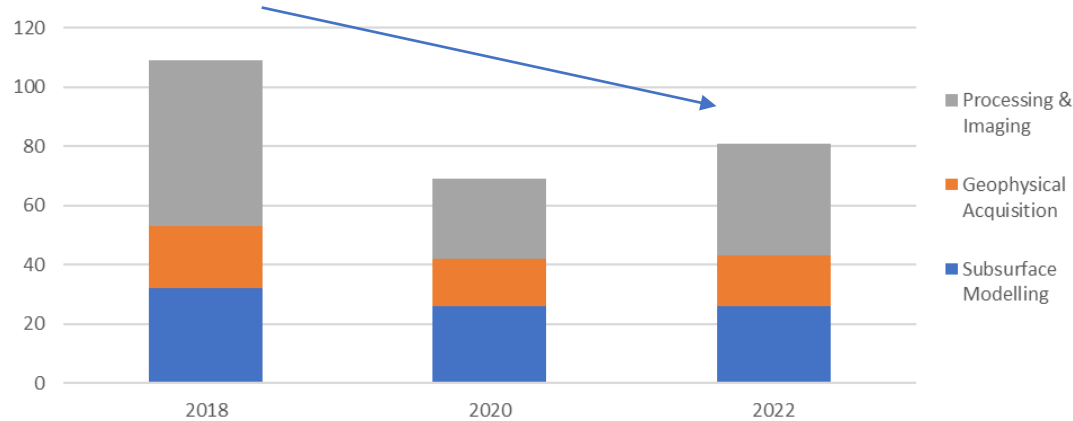
Two *cross-cutting* themes

9. Digital & Data

10. Net Zero

1. Seismic & exploration

Number of technologies reported



Operators (anonymised)

Geophysical acquisition is being channelled to improve illumination of complex or challenging subsurface targets and reducing cost of acquisition.

- High resolution broadband, and wide- and multi-azimuth surface acquisition
- Ocean bottom seismic (Nodes, High-density nodes, Nodes on a rope)
- Autonomous deployable/retrievable nodes for reduced cost and footprint (eg allowing colocation with windfarms)
- Vertical seismic profiles, DAS fibre, also applied to 4D
- Passive seismic
- Ocean bottom sources (reduced impact on marine life)

Processing and imaging by novel modelling and analytical techniques, enhancements to OBN methods and emerging technologies to improve reservoir mapping.

- FWI and dynamic matching FWI
- Rock physics
- Reprocessing, survey mergers and seismic uplift

Subsurface modeling using AI and Machine learning to improve knowledge of reservoir geology and previously hidden volumes, helping to de-risk complex development targets.

- Application of ML/AI to reduce exploration cycle time
- Fault analysis
- Optimal well placement analysis

1. Examples

Seismic acquisition

Broadband seismic surveys

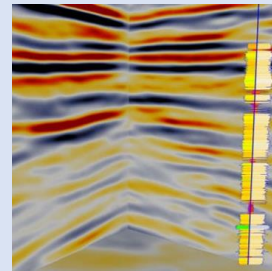
Applied in novel way to leverage wide source and streamer tow acquisition. New WAZ consolidated with existing survey, deliver rich azimuth M-WAZ for High Quality Subsurface Definition for accurate well positioning.

EnQuest (Bressay and Kraken)

Vertical seismic profiles

Optical Distributed Fibre Optics (DFO) along the borehole serves as a seismic receiver array (VSP DAS).

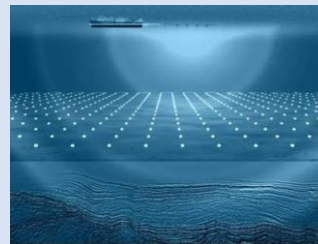
BP (Clair), TotalEnergies (Culzean, Elgin)



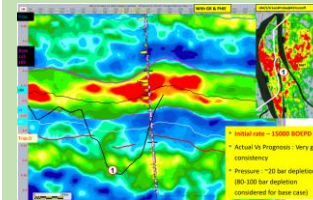
Ocean bottom nodes (OBN)

Use of OBNs for improved seismic acquisition and processing.

Shell (Arran, Fram, Merganser & Shearwater)
TotalEnergies (Alwyn)
BP (Clair & Schiehallion)



Ocean bottom seismic



OBN for velocity and seismic uplift

Improved imaging (input to inversion) with better velocity model & enhanced denoise (higher signal/noise ratio) and broader bandwidth.

TotalEnergies (Alwyn, Alwyn East)

High density ocean bottom seismic

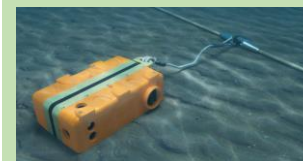
Densely sampled seismic data to improve reservoir imaging, reduce volume uncertainty and inform depletion plan.

BP (Clair Ridge)

Marine Vibrator

Pilot of ocean bottom seismic source technology (TRL 8) which reduces acoustic impact on marine life and acquisition footprint.

TotalEnergies (Elgin)



Advanced and Autonomous OBNs

Autonomous OBNs (deployment and retrieval), nodes on a rope, permanent nodes with AUV communication.

Time lapse seismic (4D)

Vertical seismic profiles DAS VSP surveys

Field trial for borehole Distributed Fibre Optics for seismic surveillance on Clair Ridge (first in the UKCS).

DAS VSP technology augments future 4D seismic programmes through low cost, localised and on demand seismic surveillance. Potential to acquire “mini-4D” surveys increasing frequency and reducing need for full monitor surveys.

TotalEnergies (Culzean, Elgin)
BP (Clair Ridge)

On-Demand Ocean Bottom Nodes (OD OBN)

Semi-permanent seabed system is used for the acquisition of high resolution seismic and seafloor subsidence data. Battery powered nodes are placed permanently on the seabed, with remote activation, verification of event alarms, calibration of internal clocks and harvesting of seismic data performed using an AUV with optical broadband communication devices, and acoustic sensing for node status, activation, telemetry and positioning.



Trials offshore Brazil – partnership including Shell, Petrobras, SENAI CIMATEC, Saipem and Sonardyne

Subsurface store characterisation & MMV

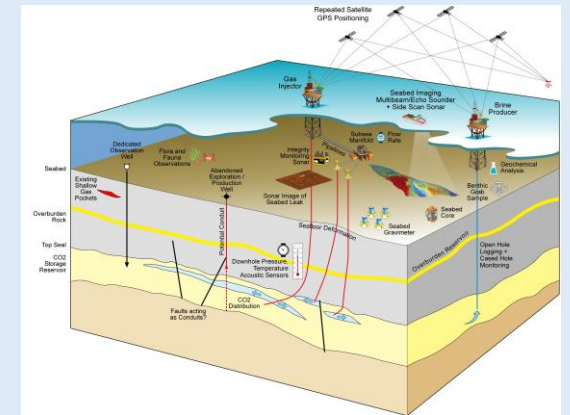
Seismic surveys

Essential for mapping the geometry and extent of storage sites and complexes which underpins dynamic fluid prediction models. A high-quality baseline survey will be necessary / expected for all CO₂ Storage Sites. Reprocessing older surveys may partly address the need, supplemented with new streamer acquisitions and sparse node for velocity surveys.

Monitoring measurement and verification (MMV)

A number of seismic technologies (surface and seabed acquisition and vertical seismic profiles), to be supplemented by other technologies incl. passive seismic, seabed deformation and geochemical monitoring.

Significant role of remote sensing and autonomous systems, for solutions with limited footprint to permit collocation with wind power.



[Link: NSTA study Aug 2022](#)

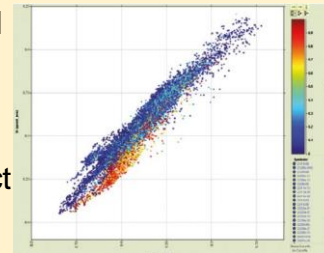
Processing

3D diffraction imaging / diffraction imaging

Seismic processing technique to better image sand injectites not observed by conventional processing. TAQA Diffraction Imaging for Fault and Sand Injectite Imaging at the Harding Fields.

TotalEnergies (Maclure & Tullich), Taqa (Harding)

IKON JiFi inversion - Proprietary IKON JiFi inversion using Proprietary 2018 reprocessed 3D seismic data to better delineate the reservoir facies distribution across the Cook Field and improve prospect evaluation.



Ithaca (Cook, Cook West)

Qeye inversion

Wide ranging seismic inversion project to improve the seismic characterisation of the Palaeocene and Upper Chalk interval. A direct probabilistic inversion to integrate statistical rock physics with a prior model driven by available well data to generate probability density functions describing the facies present across the entire data volume.

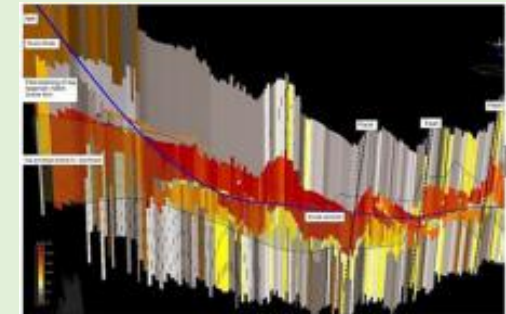
Ithaca (Abigail)

Subsurface modelling

Baker Visitrak

Improved resolution and interpretation of existing and new data to improve modelling accuracy and reduce risk, geospatial reservoir navigation and analysis service.

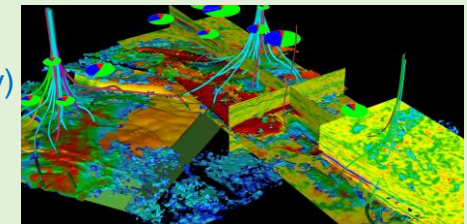
Harbour Energy (Jade, Jasmine, Judy & Joanne)



CoViz for 4D

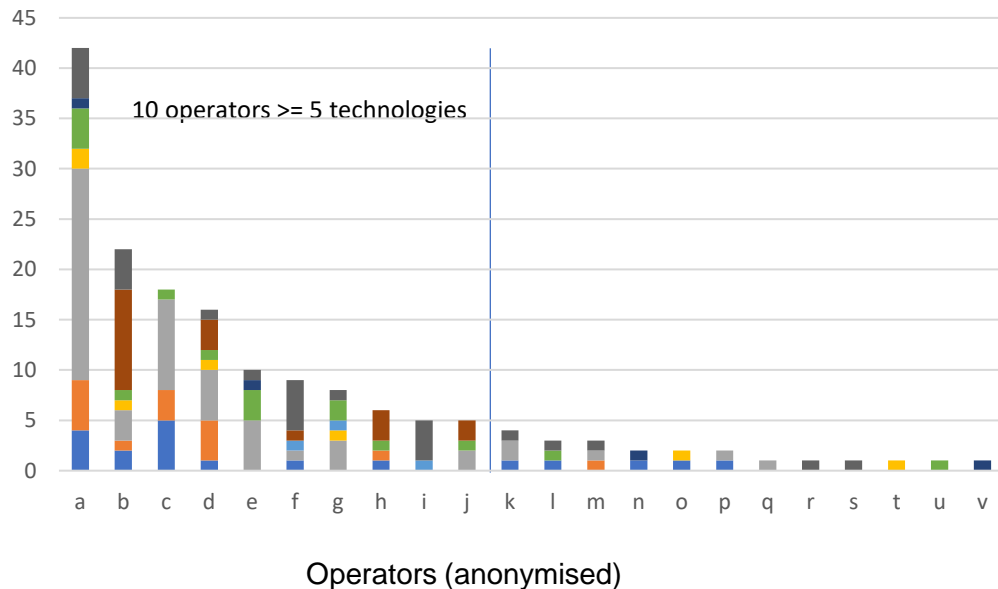
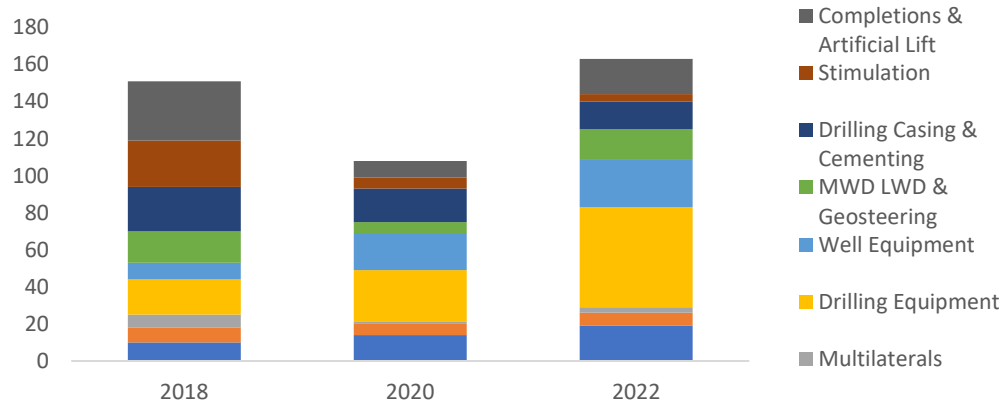
Integration and visualisation of 2D, 3D and 4D data. Dynamic visual analytics for reservoir surveillance and management.

Harbour Energy (Britannia, Lomond, Jade, Jasmine, Judy)



2. Well Drilling & Construction

Number of technologies reported



Well Design & Planning

- Digital well planning using AI

High-angle & ERD

- Big bore wells and slim hole well designs
- Digital solutions for drilling controls, and high accuracy surveying while drilling

MWD, LWD & Geosteering

- Machine learning applied to LWD response against offset wells/models for real-time decision making

Multilaterals

- Advanced-geometry multilaterals to enhance recovery, overcome slot restrictions
- Cost-efficient re-entry ML systems

Drilling Equipment / Well Equipment

- Managed pressure drilling, High Frequency Torsional Oscillation dampening
- Low cost platform modular drilling rig systems

Drilling, casing and cementing

- Swellable sleeves to reduce risk of sustained casing pressure
- New casing centralisers to improve primary cement quality

Stimulation

- Wireline deployed high pulse for scale removal and production stimulation
- Cake removal, hydraulic fracturing

Completions & Artificial Lift

- Multi function wireline tool-strings
- Intelligent completions / autonomous inflow control devices

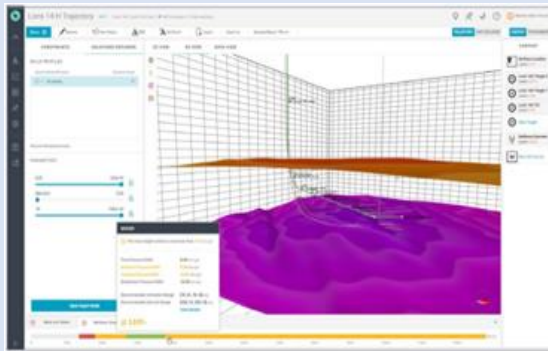
2. Examples

Well Design

Digital well planning using AI

Example: SLB's DrillPlan well construction planning: access to all the data and science in a single, common system.

Equinor (Mariner)
Harbour Energy (Britannia)

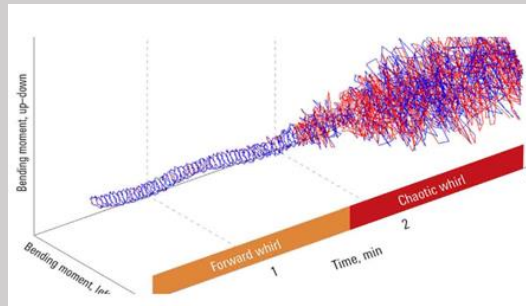


High Angle & ERD

SLB DD Tools

High accuracy surveying to reduce error ellipses in ERD wells. Dual inclination and other survey tool combinations.

Harbour Energy (Britannia)



Drilling

Managed pressure drilling

Active MPD with statically balanced and statically under balanced drilling fluids in HPHT environment.

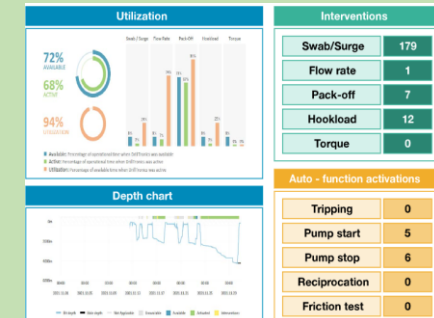
Neptune (Seagull)
Wintershall (Sillimanite)
Harbour Energy (Tolmount)
TotalEnergies (Elgin, Franklin)



Drilling automation in areas such as hole cleaning and fingerprinting de-risks complex wells. Used extensively by majors through global drilling control rooms / CoEs.

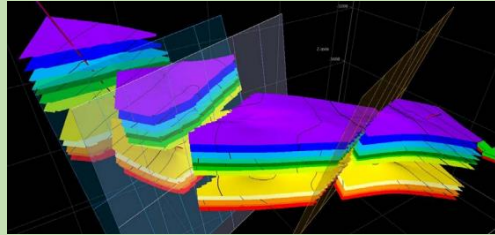
BP
Equinor (Mariner)

Tools like **Seakal's DrillTronics®** supports drillers by safeguarding operations, finding the optimal ROP and automating repetitive mechanical functions in real time.



2. Examples

MWD, LWD & Geosteering



SLB Geosphere

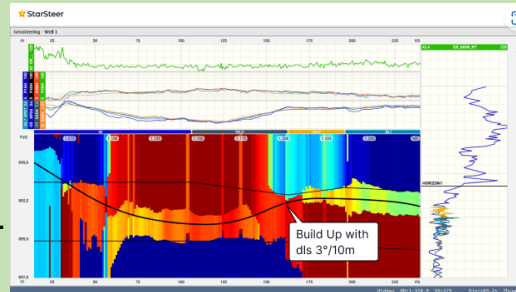
Geosteering in thin reservoir intervals using LWD resistivity imaging technology to look ahead of the bit through inversion.

Harbour Energy (J-Block)
CNR (Columba B/D)
Neptune (Cygnus)

StarSteer

Geosteering software that assists real-time geosteering decisions during drilling by matching LWD log response against offset wells or models.

Shell (Arran)



Well Equipment & Completions



APTARA Christmas Tree

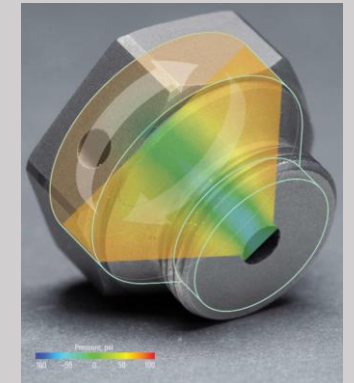
Lightweight compact tree that removes complexity. Modular design to reduce tree cost and lead times.

Siccar Point Energy (Cambo)

Intelligent well completions Autonomous inflow control devices

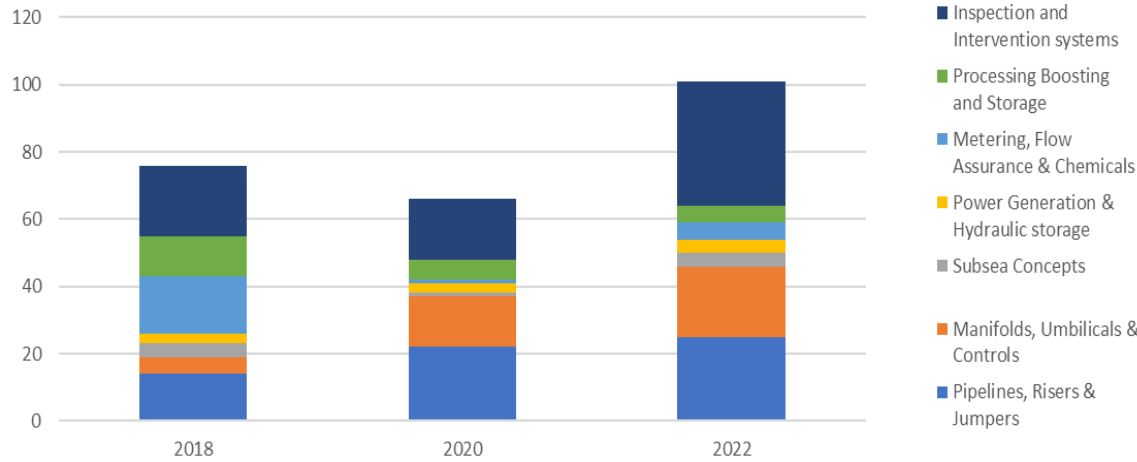
Interval control valves, fibre optic pressure and temperature sensing to level out inflow performance across reservoir sections reducing water production and maximising oil recovery.

CNOOC (Golden Eagle)
KNOC/Dana (Barra)



3. Subsea systems

Number of technologies reported



Pipelines, Risers & Jumpers

- Cost efficient pipelines, incl. composite materials
- Corrosion resistant linings to carbon steel pipe
- Heat insulation and heating systems

Manifolds, Umbilicals & Controls

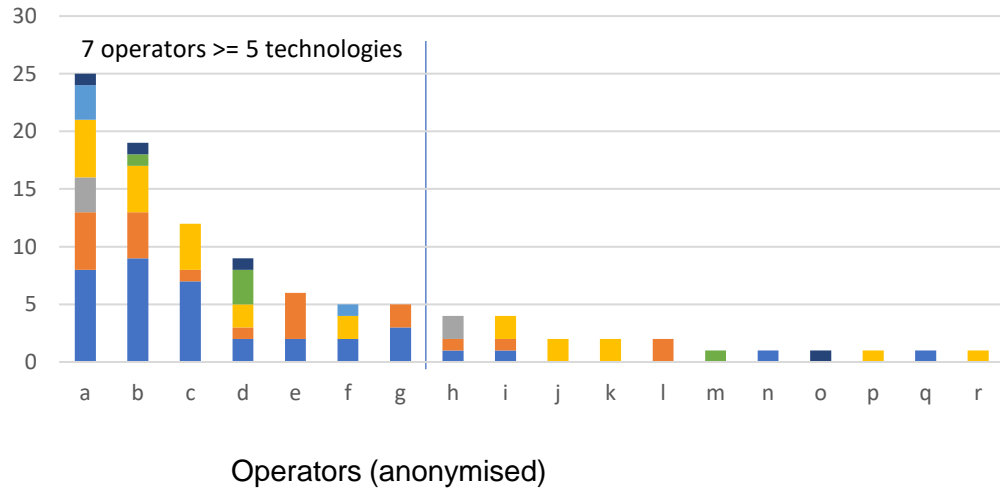
- Non-metallic protection structures for manifolds and trees
- New generation controls and integration with old systems
- New methods of umbilical diagnostics

Inspection & Intervention Systems

- Retrofittable condition monitoring detectors
- Diverless methods of scanning pipelines & risers
- Autonomous vessel design, both subsea and surface enabling unmanned survey and subsea inspections

Processing, Boosting & Storage

- Expanding subsea process and facilities to minimise host deck space use and brownfield scope
- Gas compression and multiphase pumping to enhance tieback distance and maximise recovery
- Water treatment and wellhead seawater injection



3. Examples

Pipelines

Mechanically Lined Pipes

MLP is made of a liner inserted into a carbon steel offshore grade pipe. The liner is typically CRA material around 3mm thick. The liner is not bonded to the host pipe which simplifies the fabrication but adds challenges on integrity in service. The liner is welded to the backing pipe at the ends.

Shell (Jackdaw)

Composite Pipelines

Composite pipeline to replace corroded pipeline sections to provide long term protection and avoid re-occurrence of galvanic corrosion.

Perenco (Bell)

LinerBridge

Polymer barrier technology to minimise internal corrosion of pipelines and risers, minimise corrosion risk, reduce asset lifetime cost, maximise asset uptime and facilitate enhanced oil recovery to maximise reservoir value.



Ithaca (Cook)

Combined Flowline and Umbilical

Development / assessment of combined flowline and umbilical technology, potentially including heated systems to enable marginal discoveries through reduced costs.

Enquest (Comrie)

Remote/Local Jumper Heating

Development / assessment of system to provide local heating of subsea jumpers to overcome high viscosity encountered during start up.

Apache (Corona)

Manifolds Umbilicals & Controls



C-Kore subsea measurement tools find faults and prove the health of umbilicals, jumpers, control modules, down-hole sensors (or anything else) without using downlines. The tools save days of vessel time reducing emissions and allowing more to be achieved in every offshore campaign.

KNOC/Dana (Hudson)

Subsea Control Modules Upgrade option to address known obsolescence issues associated with existing units installed subsea.

Shell (Pierce)

3. Examples

Inspection & Intervention

Retrofit sand detection

The Roxar™ SAM Acoustic Sand Monitor provides real-time production sand information. Utilising acoustics and algorithms, it enables sand separator efficiency monitoring and production optimisation.



Shell (Pierce)

Riser Integrity Fibre-Optics

Use of fibre optics built into riser flexibles for continuous integrity monitoring.

TotalEnergies (Culzean)

ROV Deployed Flexible Scanner

ROV deployed subsea flexible scanner to identify extent of corrosion to armour wires within flexible pipelines.

Apache (Beryl)

Surface and ROV Inspection

Autonomous Surface Vessel acts as a mothership and carries a 450m depth rated full spec ROV which can be controlled from distant onshore operations centres, reducing both manning and emissions.



Fugro Blue Essence USV

Subsea Processing, Boosting & Storage

Wellhead seawater injection

Seawater pump at wellhead to eliminate need for injection water supply system to subsea wells.

Apache (Corona)

Multiphase subsea pumping

Reduce subsea costs and increase reserves through centralised subsea pumping.

Apache (Corona)

Worley's Pseudo Dry Gas Technology

Potential pathway to boost production and recovery, reducing energy consumption for remote offshore gas fields.



Worley, NZTC

Subsea Gas Compression systems

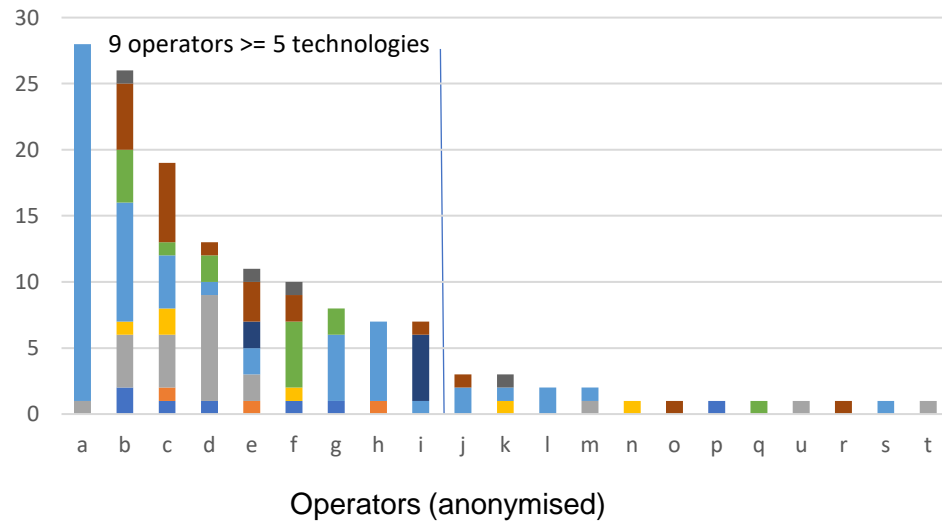
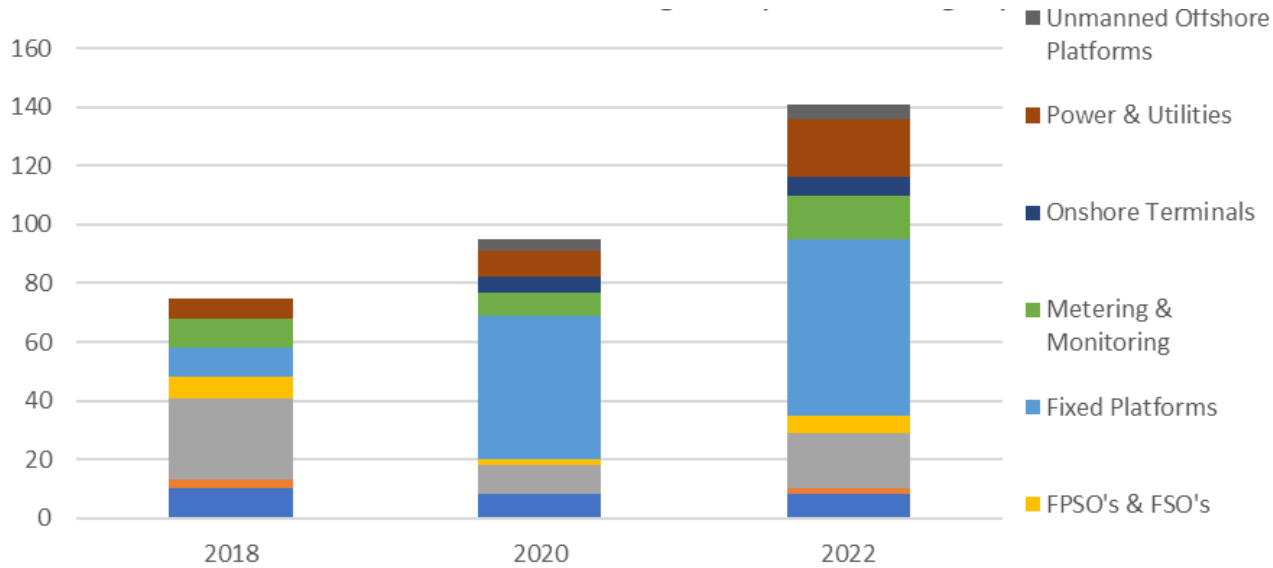
Potential use of Aker OSS proven compression facilities in a subsea environment.



TotalEnergies (Edradour)

4. Installations and topsides

Number of technologies reported



Control systems and automation

- Operators are focussing on Intelligent Plant Analysis, Retrofit Gas Turbine Controls, Machine learning for analytics and event detection, DSC and Automated Control Systems

Metering and monitoring

- Improvement in emission measurement and monitoring
- Remote monitoring applications for remote operations

Separation, treatment and compression

- Flare gas and flash gas recovery technologies
- Membrane and compact separation systems
- Chemicals for heavy/light oil mixtures (integrating a new heavy oil tieback to existing light oil facilities)

Fluid injection / reinjection

- Chemical dosage testing
- Produced water and CO₂ re-injection technologies

Fixed platforms

- NII technologies and electrification enablers

FPSOs and FSUs

- Cost-efficient FPSOs, removing the need for a rotating turret and the subsequent complications of swivel mechanisms when adopting future electrification upgrades

Unmanned installations

- Continuing focus on low-cost wellhead platforms with remote operations, and walk to work access for maintenance

Power and utilities

- Low carbon power technologies, waste heat recovery

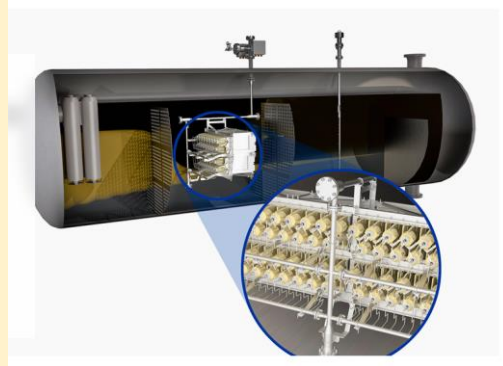
4. Examples

Fluid Separation, Treatment & Compression

VIEC Enhanced Oil/Water separation

Sulzer's electrostatic coalescer internals for vessels. VIEC™ is installed inside an oil/water separator.

Shell (Penguins East & West)



Low Shear Valves

Control valve that minimises mixing energy. Inline and angle type valve leaves droplets intact to improve performance of subsequent separation / treatment.

Shell (Fram, Merganser, Shearwater, Starling)

Ceramic based static / passive membrane filtration system

A ceramic based static / passive membrane system, developed by Rena Quality Group, which will allow offline oil removal from produced water.

KNOC/Dana (Bittern, Guillemot, Clapham, Pict & Saxon)

Metering & Monitoring

ABB's PEMS

Predictive Emission Monitoring System, provides streamlined reporting to improve accuracy of emission reporting from combustion plant and flares. Inferential Modelling Platform uses advanced ML algorithms.



MCR Valve Watch

An automated, online valve monitoring system for critical valves & actuators. Users can remotely monitor valve or actuator performance and correct degradation before it affects safe and reliable operation and potentially contributes to increased flaring.

Score Group's Midas Meter

Non-invasive valve leak detection, quantification and trending. Portable acoustic emission leak detector which finds and quantifies through valve leakages.



4. Examples

Facilities Emission Reduction

Eductor Vapour Recovery

Reduce the CO₂ footprint from flaring of process flash gas. Use of the latest Eductor Vapour Recovery Compression technology to capture flash gas to reduce flaring.

Harbour Energy (Fleming)

Stemless Valves

Axial flow stemless valves could reduce fugitive emissions and reliability and integrity issues associated with conventional valves. Could also reduce flow-induced instability in some services. Potential application in minimising leaks for future hydrogen service.

Harbour Energy
(Calder, Dalton, Everest, Fleming, Jade, Judy, Jasmine)

Power & Utilities (Emission Reduction)

Battery storage

On-site battery system to provide additional power resilience. Potential benefits include, reduced maintenance cost, fuel gas saving, additional back-up power supply and GHG emission reduction.

Woodside, Shell



Hybrid power system

Hybrid solar panel power system providing low maintenance solution for power to the platform whilst charging batteries.

Shell (UKCS)



Sevan 400 Cylindrical FPSO

Removes the need for a turret and avoids associated slip ring / turret issues. Potential to make future electrification easier / lower cost.

Shell (Penguins), Siccar Point (Cambo)

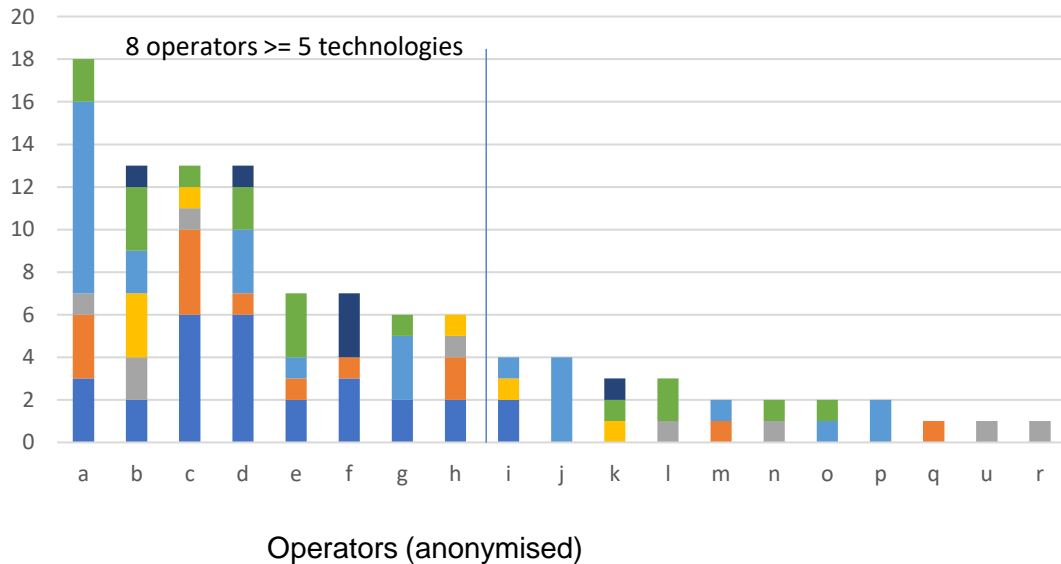
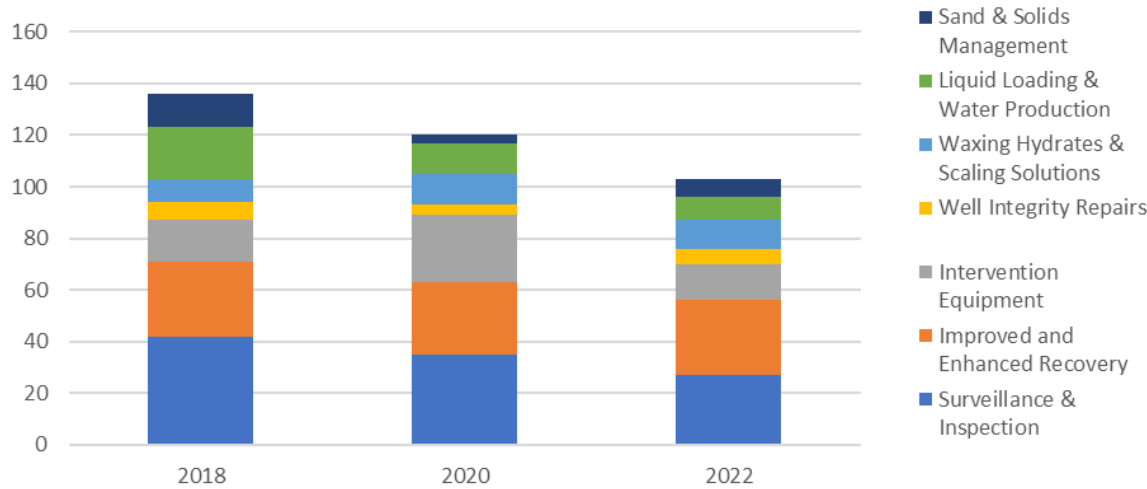
Pilotless Gas Turbine Burners

Potential to avoid coking blockages in burner pilots which can impact power generation reliability and maintenance costs for burner change-outs when running on liquid fuel. Also can drive the need to have additional generation online with associated higher emissions.

Harbour Energy (Lomond, North Everest)

5. Reservoir & well management

Number of technologies reported



Surveillance and Inspection

- Wireless downhole surveillance technologies
- Disposable fibre-lines

Improved and Enhanced Recovery

- Alternative deployment of retrofit ESPs and enabling post installation maintenance and replacement without need for workovers

Intervention Equipment / Well Equipment

- Low cost platform modular drilling rig systems
- Rigless well access systems

Well integrity repairs

- Solutions for wellhead leakages, tracking well leak paths and tubing retrievable / retrofit SSSVs

Liquid loading & Water Production

- Technologies to improve injectivity and breakthrough zone identification, and innovative ways of well water shut off.

Waxing Hydrates & Scaling Solutions

- Deployable technologies using Mechanical, Radio Frequency signals & Electro Hydraulic Pulsing technologies
- Chemicals such as Kinetic Hydrate Inhibitors

Sands & Solids Management

- Retrofittable downhole sand screens, porous foam, oil-based gravel packing
- Sand control completions (EHS screens)

5. Examples

Intervention equipment

Low Cost Workover Rigs

The DWELLOP Lynx WireLine Mast is designed to improve wireline mast operations on fixed offshore installations. It improves access, rigging time and safety for personnel enabling safe and efficient wireline operations.

Shell (Shearwater/Starling)



Well integrity repairs

Expro's annulus intervention

Regain shut-in and low production wells. Octopoda™ allows direct access to annuli reducing intervention time and cost.

Chevron (Thailand)



Wireless Downhole Safety Valve

Retrievable and retrofittable wireless subsurface safety valve systems by several suppliers help restore wells and resume production after SSSV workover.

TotalEnergies (Alwyn North)

Annular isolation sleeve by Isol8

Designed to be run on casing/liner like a centraliser. Left in situ and then melted at well decom stage for annular isolation or when well shows annular integrity issues during production.

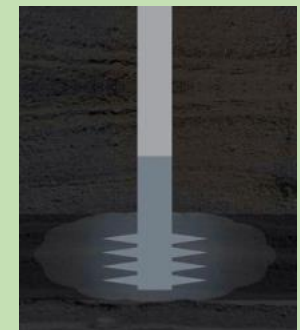
Repsol Sinopec Resources (Fulmar)



Resolute Expanding Polymer Grain

Pumped into the reservoir to make it expand and fully block permeability, it provides a barrier to barrier, self healing seal surrounding the wellbore. It blocks perforations, screens & bore space providing a self healing pre-barrier to plugs and cement

Chevron (Australia 5 wells & USA 2 wells)



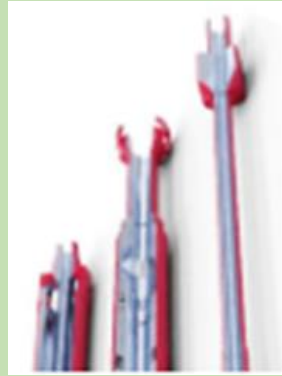
5. Examples

Production enhancement

IGLS Inverse Gas lift System

Enables gas lift installation in wells that have not been configured for conventional gas lift.

TotalEnergies (Alwyn North & Dunbar)



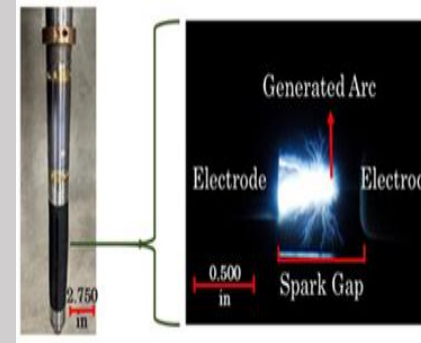
Alternate Conveyed ESPs

Remedial Electrical Submersible Pumps and systems deployed by coil/cable.

Apache (Forties), Repsol Sinopec (Auk), Spirit energy (Statfjord)



Waxing, hydrates, scaling solutions



BlueSpark WASP

Wireline deployed high pulse tool for scale removal and production stimulation using Electro-Hydraulic Pulsing principles.

CNOOC (Buzzard)

SPIN tool Technology

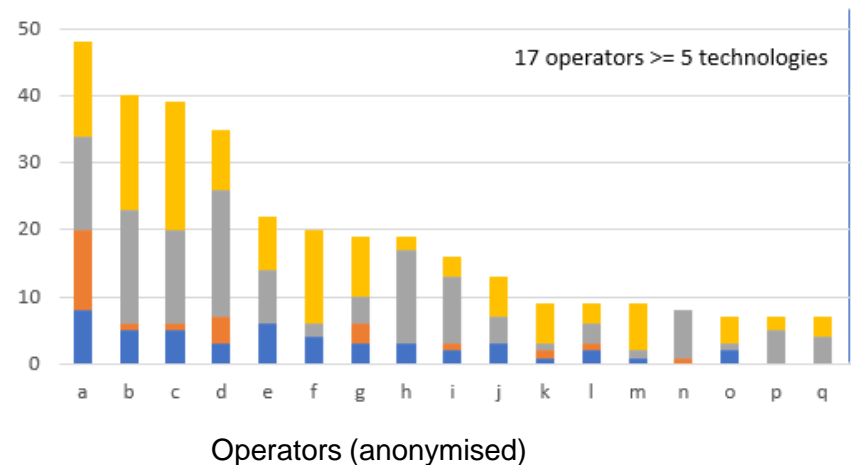
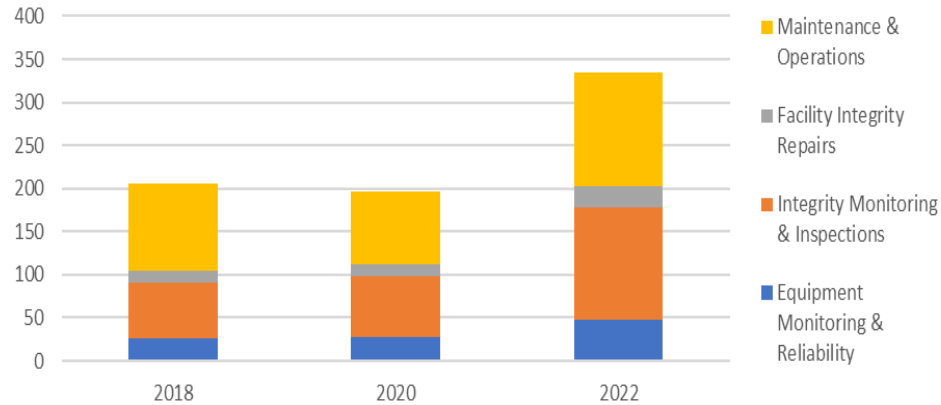
Mechanical scale prevention tool developed by Scale Protection. It prevents scale from growing across the safety valve by changing the flow pattern of the reservoir fluids through the valve. It causes wellbore fluids to swirl reducing the amount of scale that is formed at the flow tube area.



Ithaca (Erskine)

6. Facility management

Number of technologies reported



Equipment Monitoring & Reliability

- Remote monitoring, wireless sensors, cameras
- Robotic deployment
- Data analytics, incl. AI for predictive maintenance

Integrity Inspection & Monitoring

- Vessel inspection
 - *Ultra-sonic, induction/pulsed current, X-rays*
- Corrosion under insulation
 - *Moisture detection, wall thickness, pitting detection*
- Hard to reach areas
 - *crawlers, drones, underwater vehicles*

Integrity repairs

- Laser scanning, tablet tools for part identification, 3D printing for rapid part manufacture
- Laser rust removal, dry-ice blasting, pipeline composite repairs

Maintenance and Operations

- Connected digital worker
- Maintenance and integrity data management
- Virtual assets, augmented reality, digital twins

Enhanced detection and monitoring capabilities

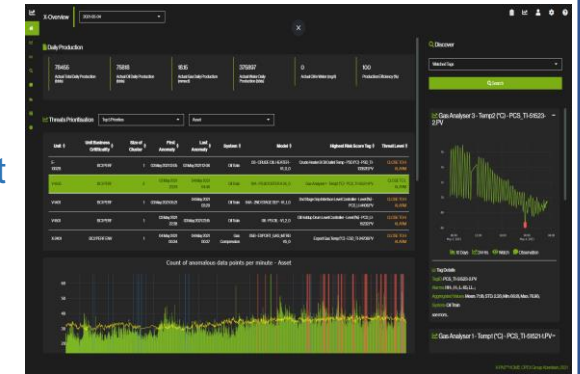
- Vibration sensors (standard technology for critical equipment)
Generally applied on most offshore assets, not reported in technology plans, business as usual for most / all operators
- Wireless sensors (enhances reach)
Easy to add monitoring points, particularly used in retrofit applications (Apache, CNR)
- Camera image amplification (further extends reach to additional rotating equipment and pipework)
Easy to add monitoring points, particularly used in retrofit applications (Shell)
- Online condition monitoring (critical equipment continuous monitoring – predictive/responsive)
 - Ultrasonic Testing (UT) for live integrity monitoring (wall thickness, internal corrosion and erosion)
RSRUK on Piper
 - Bolt integrity, continuous load monitoring
Anasuria Hibiscus

Data analytics and decision support

- Wireless / portable analytics
Hand-held analysers e.g. Baker Hughes SCOUT
- Visualisation via PI and control systems/room
Several operators incl. Apache
- Offline predictive analytics Machine Learning and AI
Example: Opex Group XPAS used by several operators (RSRUK, CNOOC, Harbour)

Data Analytics - AI for Reliability OPEX Group

- Asset surveillance & monitoring
- Pre-configured digital modules – rapid deployment
- System wide model to identify best practice deviations/anomalies
- Prioritised threats & actions



6. Vessel inspection

External

- Conventional ultrasonic (UT) and Phased array ultrasonic (PAUT)
Readily available UT, significant progress with PAUT to resolve complex geometries and limitation of access. Wide deployment offshore, incl. RSRUK
- Eddy Current probes, Eddy Current Array (ECA), Pulsed eddy current (PEC) and arrays (PECA)
Ability to measure steel thickness also in presence of cladding and air gaps.
Offshore deployment, incl. Harbour Energy
- CT scan (X-ray)
Provides convincing evidence when receiver can be located on the other side of equipment, e.g. cladded
- NII applications on online pressurised vessels
Significant advantage, proven by operators like RSRUK & Harbour Energy. Potential interest by ~6 additional operators

Confined space entry

- Caged drone inspection of vessels
Several operators, incl. Shell, KNOC/Dana, Harbour Energy, TotalEnergies
- Digital imaging, digital twins of internals
Shell & TotalEnergies



- Robotic arms, crawlers, magnetic crawlers

TotalEnergies



TotalEnergies – Robotics tank inspection Hydromea

- Collects visual inspection data, validating system performance
- Wireless navigation & communications
- Tetherless operation in complex spaces



6. Hard to reach areas

Inspection at height

- Controllable cameras and lights on extendable poles

Widespread use by multiple operators. business as usual (BAU) for operators incl. TAQA, Harbour Energy and Ithaca

- Drones for visual and thermal inspections

Established technology, good market availability and economies of deployment. BAU for most operators.

- More payload and capabilities (Visual and IR, Chemical sensors, Ultrasonic probes)



Used for tank and pipework inspections at many chemical plants

- Extended reach beyond visual flights

Promising technology for emission and environmental monitoring, with reduced crew logistics (BP, Shell, Harbour Energy)

Splash zone

- Long range ultrasonic

Applications to risers in caissons (Apache)

- Internal and external inspections of platform legs

Using crawlers (RSRUK)

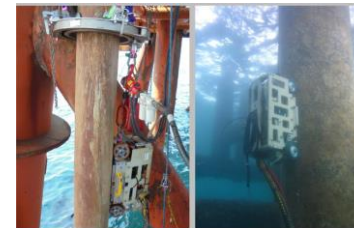
- External caisson cleaning and corrosion mapping

RSRUK (Clyde), TotalEnergies (Alwyn)

Crawlers for caissons, risers and conductors

Innospection

- Magnetic crawler
- Minimal surface preparation
- Various detectors incl. UT, PECT, camera and laser



ToolTec caisson inspection

- External inspection of caissons to determine wall thickness integrity.



6. Corrosion under insulation (CUI)

High TRL

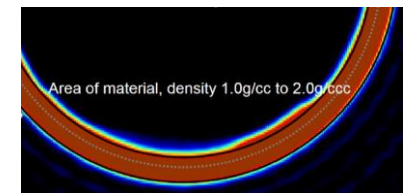
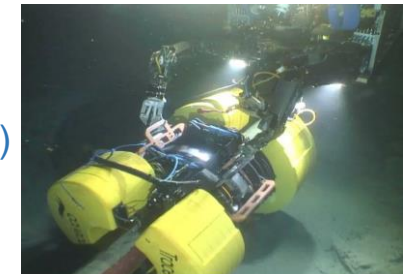
- Phased-array Ultrasonic (PAUT) of structures without removing claddings and coatings
Probes and software commercially available e.g. FlexoFORM and Tracerco
Harbour Energy applying on 10 assets, RSRUK 3 assets
- Pulsed Eddy Current (PEC) for CUI detection
RSRUK 1 asset
- Pipeline CT scan – quality images if detector can be located opposite the source
CNR, RSRUK applying Tracerco's Trace technology
- *Corrosion RadarTM* – combination of EM Guided Wave Radar and moisture detection
Harbour Energy on 10 assets
TotalEnergies on Elgin/Franklin

Mid TRL

- Moisture detection
BP, Neutron backscatter (CNR) and wireless inductance monitoring (3-Sci)
- Pulsed Eddy Current – modified shape and reach of PEC probes (wands, large diameter pipes)
Harbour Energy programme
- Subsea PEC inspection methods
Shell programme

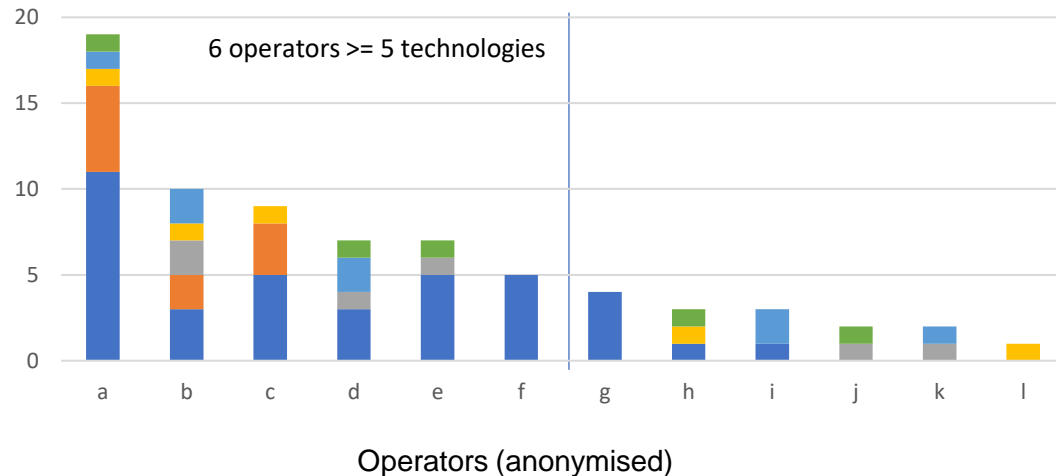
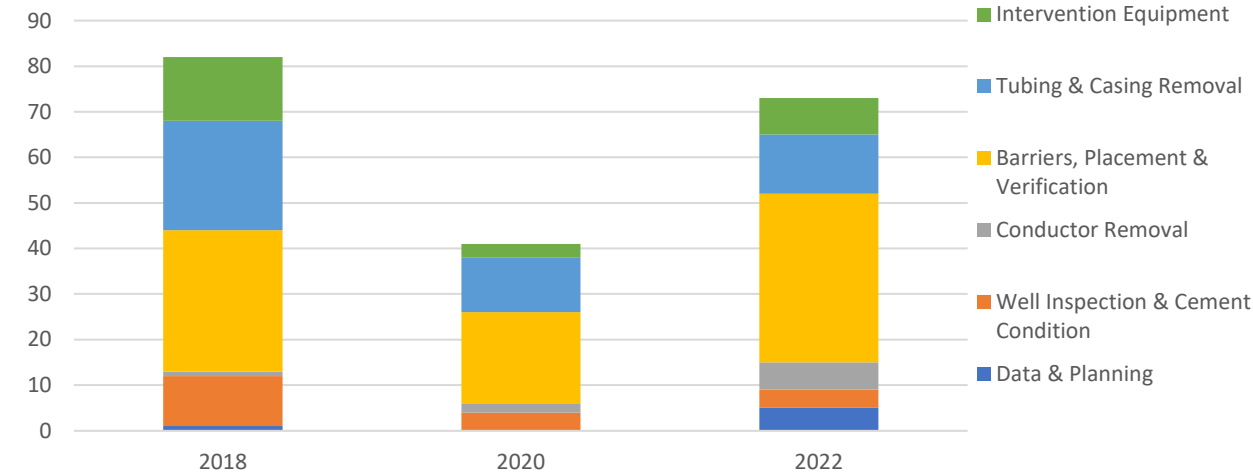
Inspection on non-piggable subsea pipelines RSRUK various assets (2018+)

- Commercial technology (Tracerco)
- Requires vessel & ROV support (cost)
- However significant saving vs alternative of installing pigging
- Able to resolve wall thickness and internal corrosion and other deposits
- Applicable under cladding and insulation and even pipe-in-pipe



7. Well plugging & abandonment

Number of technologies reported



Data & Planning

- Operator focus is on low cost intervention, efficient well P&A operations, collaboration for well P&A campaigns, data logging for well planning

Well Inspection & Cement Condition

- thru tubing logging, down hole wireless sensing, FLI inspections and novel well head sealing techniques

Tubing & Casing Removal

- Use of Light Well Intervention Vessels for subsea open-water abandonments, 2 emerging technologies for breaking the cement bond on casing string, and novel cutting using explosive and propellant fuel

Barriers, Placement & Verification

- Thru Tubing Abandonment, PWC (Perf Wash & Cement), Shale barriers and Fusion Based Alloy, currently in pilot phase

Conductor Removal

- Hydraulic severance equipment to adopt a factory approach to conductor and casing string removal, and emerging technologies for novel cutting techniques – subsea laser cutting and novel application of diamond wire cutting in a dedicated wellhead cutting tool

Intervention Equipment

- Equipment to improve well access for interventions - low cost platform workover rigs/modular drilling rig systems

Well inspection & Cement conditions

- **Expro CATS Pressure Gauge** Pressure monitoring of abandoned wells. Planned to be used on a tertiary exploration well in 2020 to assess depletion of the reservoir sands during an extended production test on an adjacent well.
[Apache \(Beryl\)](#)
- **Wellhead Integrity management** Novel wellhead sealing for production wells due to integrity issues.
[EnQuest \(Magnus\)](#)
- **Probe** Assess cement through multiple strings by Thru-Tubing Logging
[Total Energies \(Culzean, Alwyn North\)](#)
- **Well Sense Tool** Tool to review condition of the well bore. FLI tool deployed on Fibreline to review well bore.
[DNO \(Ketch\)](#)
- **Schlumberger CETT logging tool** Tool for through tubing logging to assess cement quality behind the production casing.
[Harbour Energy \(Bell\)](#)

Conductor removal

- **Hydraulic severance** of conductor and casing strings - Successfully completed by other operators using Control Cutter.
[CNR International \(Banff\)](#), [DNO \(Ketch\)](#), [Harbour Energy \(Bell\)](#), [Perenco \(Amethyst\)](#)
- **Subsea Laser Cutting** Fewer mechanical parts required as part of laser system and as such lower project risk
[EnQuest \(Crathes\) TRL 8 Early Commercialisation](#)
- **Wellhead Cutting Tool** – a WHCT with control of all cutting parameters, including verification of a completed cut, based on a diamond wire technique removing the need for compressed air and combined with a smaller spread.
[CNR International \(Banff\)](#)

Technology Example:

Well Sense FLI tools - length of fibre unspooled from a FLI probe to 7,715m. Active-FLI probes, fitted with electronic sensors and optical telemetry. FLI is primarily designed to be a distributed sensing system, observing the wellbore simultaneously along the entire length of the unspooled fibre.

[Link: TI 22 - 48. Technology Example - Well-Sense FLI System.docx](#)



Tubing & Casing Removal

- **LWIV subsea well abandonment** Open hole 300' tubing cut, recovery and layout on seabed for subsequent uplift by CSV allows Light Well Intervention Vessel only subsea well abandonment
[CNR International \(Banff\)](#)
- **Subsea Open Water P&A** Through-Tubing P&A with an LWIV. Including recovery of tubing hanger and surface tubing to allow setting of environmental plug.
[Shell \(Pierce\)](#)
- **Control Cutter** Bespoke shearing device for surface multi string cutting during phase 3 abandonment operations.
[Shell \(Brent\)](#)
- **Deep casing Tools "Casing Cement Breaker"** Mechanical device to manipulate a casing string in order to break the cement bond between casing and cement or barite and facilitate deep casing recovery.
[TotalEnergies \(Ballindalloch\)](#)
- **SPEX Lattice Cutter** explosive charge which is used as an alternative to milling and **Prometheus** a propellant fuelled tool similar to a Lattice Cutter.
[TotalEnergies \(Alwyn North, Ballindalloch\)](#)
- **AxterReach** locates and retrieves a line (control line, tube encased cable, wireline cable and similar) from a wellbore. For P&A as well as fishing.



Barrier materials and placement

- **Hydrawell PWC** Utilise PWC - Jetting Nozzle Type as a viable abandonment technique, taking advantage of in-house CFD analysis to remove the requirement for drill-out verification
[Harbour Energy \(Bell\)](#)
- **Shale Barriers** Collapsing shales in Balder/Hordaland Formation on MacCulloch - transferrable to other CNS wells.
[Harbour Energy \(All Assets\)](#)
- **LWIV subsea well P&A** Viscous gel plug as base for setting tubing and annular cement barrier in subsea well allowing LWIV only abandonment.
[CNR International \(All Assets\)](#)
- **Resolute Expanding Polymer Grain** pumped into the reservoir to make it expand / pack off and fully block permeability.
- **Isol8 and Novo Ferrum – BiSN** Development of a liquid thermite system pumped downhole and then ignited with a wireline deployed tool.
- **Interwell Thermite Plug** Thermite Plug Utilisation for P&A cost reduction via rig-less thru tubing abandonment.
- **Fusion Based Alloy Thru Tubing Abandonment** “Low cost field trials” collaborating with other operators.
[Spirit Energy, TotalEnergies, Harbour Energy, NZTC](#)



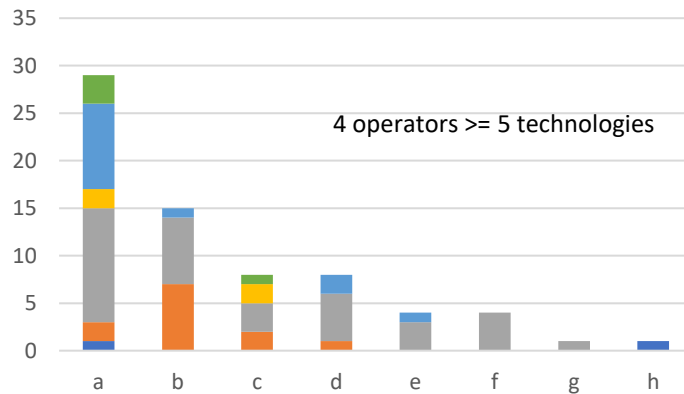
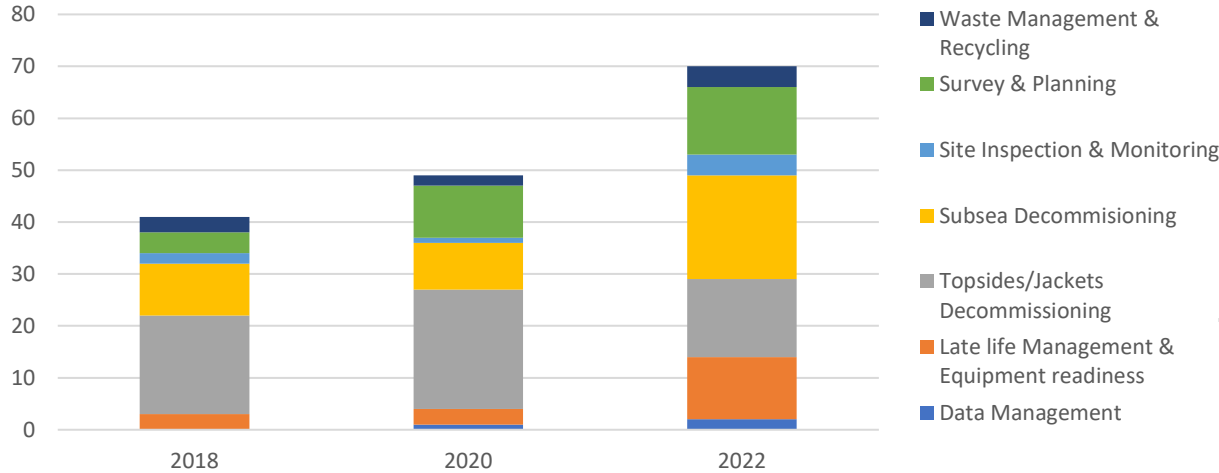
Technology Example:

Spirit Energy are the lead sponsor of a NZTC programme to deliver bulk field trials of alternative barriers enabling rigless abandonment.

[Case Study: Cutting the cost of well P&A with alternative well barriers \(netzerotc.com\)](https://www.netzerotc.com)

8. Facilities decommissioning

Number of technologies reported



Operators (anonymised)

Survey & Planning

- Deployable technologies - Digital Technologies such as Predictive Decommissioning modelling, Scheduling & Optimisation, with Emerging Technologies looking into Marine Ecology and development of a Haptic Hand user interface to control large robotic systems in decommissioning

Late Life Management & Equipment Readiness

- Alternative power generation technologies and Peak load management to reduce emissions during late life and decommissioning phases
- Access systems such as walk to work

Topsides/Jackets Decommissioning

- External flotation systems to float off and tow jackets and topsides to shore for disposal, and re-usable modular grillages, modular access platforms and cutting technologies

Subsea Equipment Decommissioning

- Crane deployed utility ROV with specific decommissioning tooling skids, diverless riser/pipeline separation by ROV tooling

Site Inspection & Monitoring

- Conventional thinking by looking at the impact on the environment of removal activities compared with benefits/risks of “leave in place”
- Energy efficient solutions to guard installations without Guard Vessels, and low carbon solutions with power generation, monitoring and comms

Waste Management & Recycling

- Explosive collapse of structures to reduce height for improved access by remote machinery, digital waste management and tracking, marine ecology studies for subsea structures, mattress recycling

Late-life asset management

- **Walk to work** SMST modular gangway technology delivered ~ 90% uptime of fully connected gangway from CSV to platform when separating Ninian Northern topsides and jacket. Believed to be most northerly application of walk to work.
[CNR International \(Ninian\)](#)
- **Peak load management - Emissions Reduction** Utilising load bank and battery technology to manage peak load and reduce need for higher diesel generation requirements.
[EnQuest \(Broom\)](#)
- **Modular Deck Extensions** Expansion of topside deck space to better perform well P&A and decom activities (avoiding requirement for a TSV).
[TotalEnergies \(Dunbar\)](#)
- **On/Offshore Collaboration Room** Facility to draw together on and offshore teams in a shared virtual working space.
[EnQuest \(Crathes\)](#)
- **Alternative power generation** Specialised vendor to use alternative methods for power generation (e.g. renewables) during and after platform habitation.
[EnQuest \(Broom, Deveron, Heather\)](#)

Subsea decommissioning

- **Utility ROV (UTROV)** During decommissioning all traces of oil and gas material needs to be removed from the seabed in the platform 500m zones. Traditionally carried out by Work Class ROV and Divers. Novel Crane deployed ROV with a "swiss army knife" skid adapted for subsea decommissioning. Utilised primarily for mattress, export line and debris recovery.
[Harbour Energy \(All Assets\) Neptune Energy \(Juliet & Minke\) Repsol Sinopec Resources \(Buchan\)](#)
- **Subsea diverless flexible riser / pipeline separation** Subsea ROV deployed tool to cut through flange bolts enabling pipeline / riser to be separated and pipeline capped for future use with ROV deployed expanding plug.
[CNR International \(Banff, Kyle Ninian, Thelma, Tiffany, Toni\)](#)
- **Anchor handling vessel used for flowline recovery** Bundle cutting and towhead recovery. Flowline recovery.
[TotalEnergies \(Ballindalloch, James\)](#)
- **Adopting a factory approach** New/alternative contracting strategies to carry out removal of subsea infrastructure in a factory approach rather than piecemeal.
[TotalEnergies \(Tulich\)](#)
- **Accelerated Corrosion (NZTC)** Aim of this technique is to avoid subsea infrastructure removal and onshore disposal, but leaving a seabed clear of subsea infrastructure by dissolving steel.
[Repsol Sinopec \(Beatrice\)](#)

Findings by category – *Cross cutting*

Eight *asset life-cycle* categories

1. Seismic & Exploration

2. Well drilling & construction

3. Subsea systems

4. Installations & Topsides

5. Reservoir & Well management

6. Facility management

7. Well P&A

8. Facility decommissioning

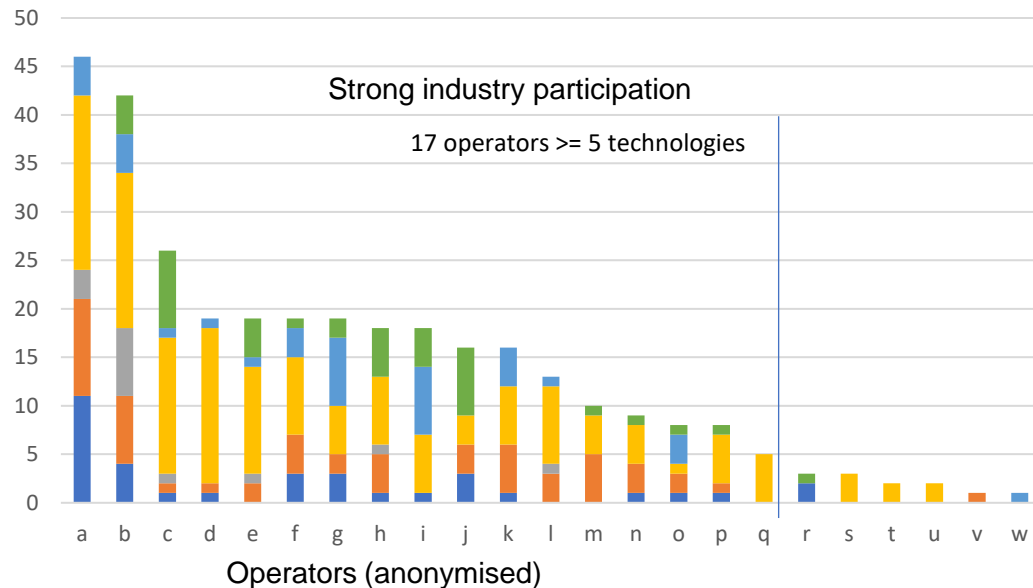
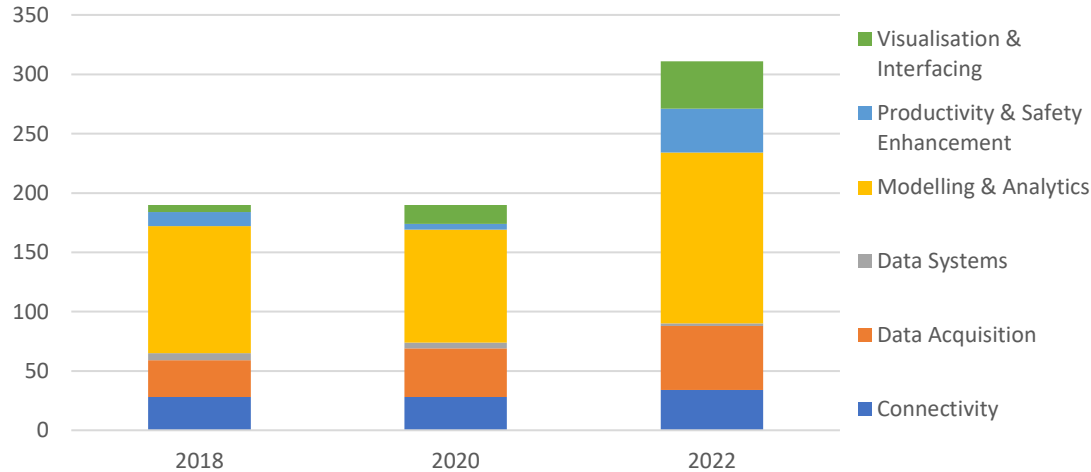
Two *cross-cutting* themes

9. Digital & Data

10. Net Zero

9. Digital & Data

Number of technologies reported



Connectivity

- Increasing deployment of “connected worker” technologies to enable on-site workers to communicate receive and record data in the field via mobile networks using ATEX rated Tablets and head-up displays
- Onshore and Offshore control rooms connected to allow remote operations and reduce offshore manning

Data Acquisition

- Improved methods of Seismic Data Acquisition to increase resolution and improve reservoir sweep
- Laser Scanning of assets creating 3D point cloud data with high accuracy
- Software extracting data directly from documents ensuring revision history is maintained, notable applications to wells

Data systems

- Growth in Digital and Database Management systems for wells and subsea, software for operations management improvement, and Asset integrity management databases

Modelling & Analytics

- Modelling & Analytics has seen a big growth in 2022 with focus on advanced Timelapse 4D seismic data processing techniques and subsurface modelling to better exploit existing reserves and locate missed pay opportunities, using AI/Machine learning

Productivity & Safety Enhancements

- Software for production optimisation, decommissioning scheduling and plan optimisation, production loss analysis, and smart rooms linked to digital twins of offshore assets

Visualisation & Interfacing

- Remotely monitor or inspect offshore assets, improve the assessment and tracking of anomalies, augmented reality for ROVs subsea for wellhead tubing & tree alignment, automated online valve and actuator monitoring

Connectivity

- **Connected Worker** Digitalisation of inspection and anomaly management. Use of remote connected technology linked to maintenance management system and previous surveys to reduce workload of offshore inspectors and maintenance teams.
[BP \(Clair\)](#), [Apache \(Beryl\)](#) [Neo Energy \(Donan\)](#), [Equinor \(Mariner\)](#), [TotalEnergies \(Edradour\)](#)
- **Onshore/Offshore Control Room linkage (Onshore Smart Rooms)** Set up onshore Operations Rooms where key onshore asset support staff can provide direct and timely support to offshore operations.
[CNR International \(Ninian\)](#) [TotalEnergies \(Alwyn, Jura\)](#)
- **Remote Technology Centre** Use of Fugro remote working centre for performing integrity assessments during platform based ROV works. Results in bed and seat savings (but with no commercial savings).
[Repsol Sinopec Resources \(Auk\)](#)
- **4G installation** - Creating a network offshore to enable mobile working and more telemetry to be streamed onshore, 4G LTE to be implemented.
[BP \(Andrew\)](#), [Harbour Energy \(All Assets\)](#), [Neptune \(Cygnus\)](#), [Serica Energy \(Bruce\)](#), [TotalEnergies \(All Assets\)](#)

Data Acquisition

A steady trend of larger dataset acquisition to improve from reservoir understanding and to operational and asset monitoring and planning

- **4D seismic acquisition** Address the potential for imperfect reservoir sweep in complexly-connected reservoirs. 4D acquisition and processing in thin injectite sand bodies subject to water sweep.
[Harbour Energy \(Brodgar, Catcher\)](#), [Taqa \(Harding\)](#), [TotalEnergies \(Jura\)](#)
- **Ultra high density ocean bottom seismic (UHDOBN)** The acquisition of densely sampled seismic data to improve reservoir imaging.
[BP \(Clair\)](#)
- **Laser Scanning** Accurate construction data provided by laser imaging scanner to create 3D point cloud with greater than one mm accuracy.
[KNOC/Dana \(Barra\)](#)
- **GDI Vision** Automating remote visual inspection. Reduced offshore POB, reduced time to complete visual inspection, increased data quality and reduced human exposure. NZTC stage 2 GDI Remote Visual Inspection Project to fully automate inspection by utilising point cloud data.
[Anasuria Operating Company \(Guillemot\)](#)

Productivity & Safety enhancement

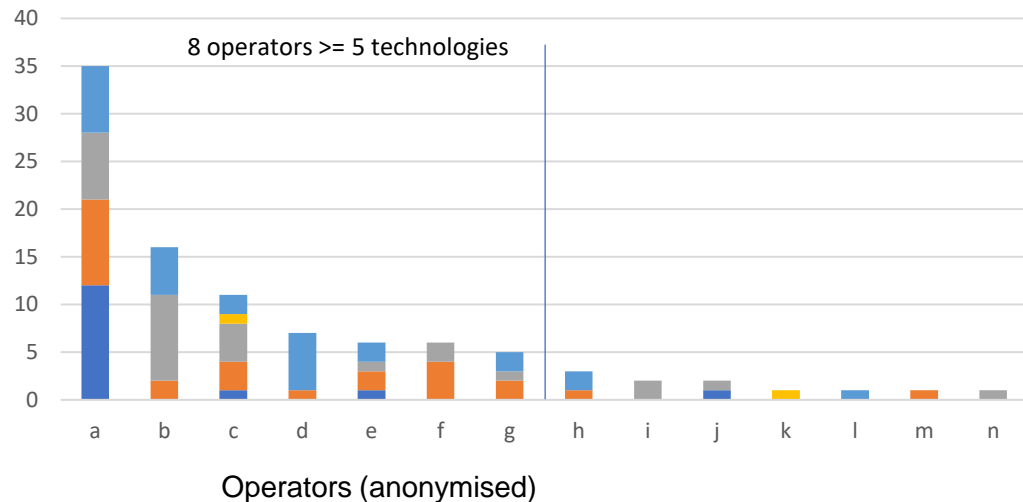
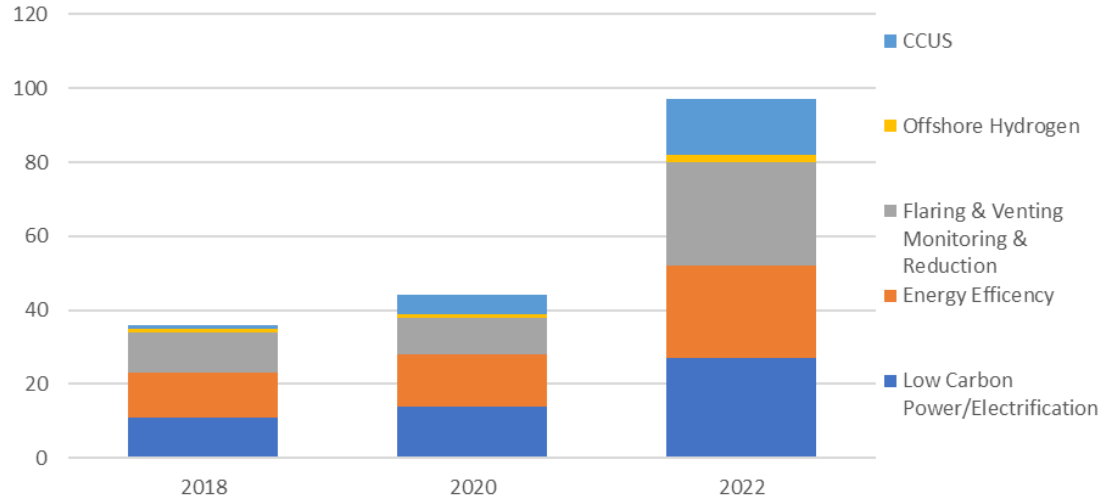
- **Production loss data to Power BI** Production loss data all in one place, therefore reducing time taken to pull data from a variety of sources.
[Spirit](#)
- **Improved Production Optimisation** through use of Petroleum Experts (PETEX) Integrated Production Modelling software (IPM) composed of GAP, PROSPER, MBAL and PVTP
[KNOC/Dana \(Triton Area\)](#)
- **Digital Oil Field System** An integrated production system optimisation model to monitor well and field performance real-time and optimise production output using Petroleum Experts.
[CNOOC \(Buzzard\)](#)
- **Fully integrated 3D model based Asset Management system** A fully integrated 3D model based asset management system/platform that enables efficient and effective visualisation of equipment characteristics using a digital twin philosophy.
[CNR International \(Ninian\)](#)
- **YETI** Production & Emissions Optimisation by AI.
[TotalEnergies \(Alwyn North\)](#)
- **Digital Twin & Smart Room** Building a digital twin of Elgin Franklin to enhance efficiency and optimise working practices through a data-centric approach.
[TotalEnergies \(Culzean\)](#)
- **Software for Decom scheduling and optimisation** Assesses removal options, suitability of equipment and optimises plans.
[Harbour Energy \(Alison KX\)](#)

Visualisation & Interfacing

- **HoloLens 2** a pair of augmented reality smart-glasses developed and manufactured by Microsoft. Mariner will use HoloLens 2 in combination with Echo for maintenance
[Equinor \(Mariner\), BP \(Clair\)](#)
- **Activity Integration Workbench** AiW improves site execution efficiency and changes users' experience with the AI process. It will transform the way we get work in our activity schedules ready and how we manage work execution. AiW combines data from the core systems of SAP, Primavera and eCoW to provide users with an integrated view of what's needed to execute and performance manage work at site.
[BP \(Andrew\)](#)
- **Anomaly assessment and tracking** The AA&T tool provides end-to-end traceability and reduces the amount of duplication in the current process. The cumulative risk profile will be far more visible, both in terms of local asset risk and a wider discipline view, which will hopefully drive continuous improvement to achieve safer and more reliable operations.
[BP \(Andrew\)](#)
- **COVIZ for 4D visualisation and integration** Integration and visualisation of 4D data. Tools for optimally visualising 4D. Reservoir engineers create simulations to more closely depict reservoir structural, petrophysical, fluid, and production characteristics.
[Harbour Energy \(All Assets\)](#)

10. Net Zero

Number of technologies reported



Flaring & Venting monitoring and reductions

- Operators align with reporting of OGMP 2.0 -- Change from generic combustion factors to site/asset-level specifics
- Methane's future inclusion in UK ETS strong driver for action in flare and gas turbine combustion efficiency
- Flare Gas Recovery and Vapour Recovery facilities critical for ZRF commitments - proven technology, but difficult brownfield

Energy Efficiency

- Cost-effective ways of reducing both fuel consumption & GHG emissions boosting exported production
- Continued focus on tools to support and embed emissions / energy intensity planning and performance management within Operators, as well as compliance

Electrification/ Low Carbon Power

- Electrification is strategic for delivering the 2030 NSTD target
- Platform electrification (grid) is proven technology
- Technologies include power control management for synchronous stable GTG and WTG operations
- Offshore electrification linking assets with local FOW (off-grid), not been done in the UKCS yet

CCUS

- Technologies cover separation, transportation, wells, materials, process, and MM&V (seismic and other)
- CO₂ shipping, offshore offloading

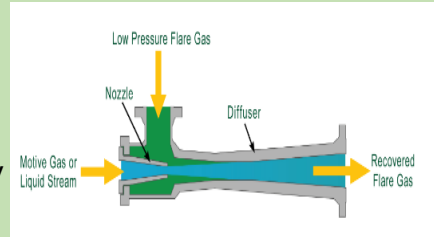
Hydrogen

- Electrolysis, pipelines, blending / deblending and storage
- H₂ shipping, eFuels

F&V Monitoring & Reduction

Eductor Vapour Recovery

- Reduction of flare waste stream by using specialised compression packages to recover gas back into the process stream.
- Use of the latest Eductor Vapour Recovery Compression technology to capture flash gas to reduce flaring.



TotalEnergies, Harbour Energy, KNOC/Dana

Stemless Valves

Axial flow stemless valves could remove fugitive emission and the reliability and integrity issues associated with a conventional valve.

Harbour Energy



Methane Drone survey Use of remote systems e.g. drones to collect data on uncombusted hydrocarbons / methane and fugitives.

Harbour Energy, BP, Equinor, Taqa, Shell, TotalEnergies

MCR Valve Watch Automated online valve monitoring system for critical valves and actuators. Users can remotely monitor valve or actuator performance and correct degradation before it affects safe and reliable operation. ValveWatch incorporates sensors attached to or near the valve and actuator assembly to routinely monitor and record their performance. Gives operators the ability to trend valve seal performance and proactively plan for maintenance or repair.

Shell (Barque, Brigantine, Caravel, Carrack, Clipper, Corvette, Cutter, Galleon)

Energy / Power Efficiency

Electrification of Mech GT Drivers

Review to assess feasibility of changing GTs to e-motors to reduce CO₂ emissions and increase PE and lower OPE.

Harbour Energy



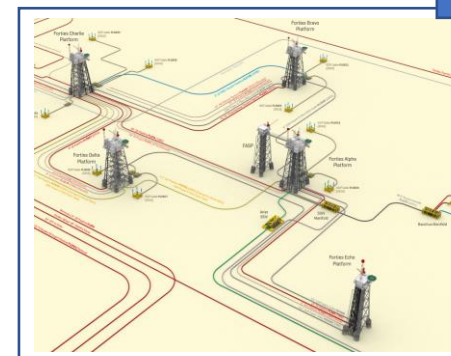
Eco Gen WHR to Power Currently waste heat from simple cycle GTs goes to the atmosphere that could potentially be used to generate electrical power. The challenge is to do this economically on a brownfield asset. Eco Gen is an offering from Siemens that may provide a solution offshore.

Harbour Energy (Britannia)

Power sharing across assets

Power sharing across assets through installation of a subsea power umbilical. Reducing the requirement to run as much power generation equipment lowering GHG emissions and operating costs.

Apache, CNR



Apache Forties ring main linking of platforms via subsea cables to share power generation and reduce number of gas turbines required.

10. Further net zero initiatives

CCUS

CO₂ injection Well Design Low Temperatures

- Cement Sheath Modelling
- Qualification testing for well elastomers

Harbour Energy

CO₂ infrastructure Re-use

- In-line inspection for offshore pipeline repurposing, using intelligent pigs to confirm assumptions and results from fracture and corrosion assessments

Harbour Energy

CO₂ separation

- Capturing process CO₂ from the amine plant vent

TotalEnergies

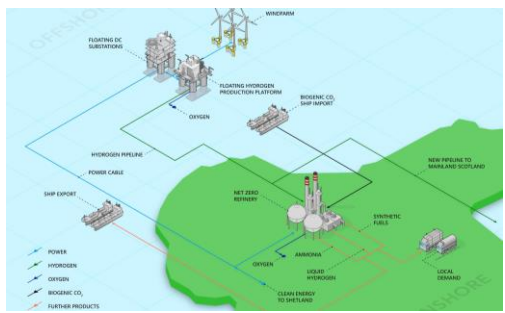
Hydrogen

Offshore Hydrogen

- Green hydrogen hubs are being planned with targeted government funding already beginning to stimulate investment

Hydrogen Production hubs


- ACORN, Bacton Hub, Cromarty Hydrogen Project, DoIPhyn
- Flotta Hydrogen Hub, HyGreen – Teeside, GiGaStack, Sullom Voe



Sullom Voe – H₂ and Low Carbon Fuels

- Application to INTOG leasing round (Aker Offshore Wind)
- H₂ generated at Sullom Voe Terminal (Enquest)

AKER OFFSHORE WIND | SIEMENS ENERGY | DNV | EnQuest

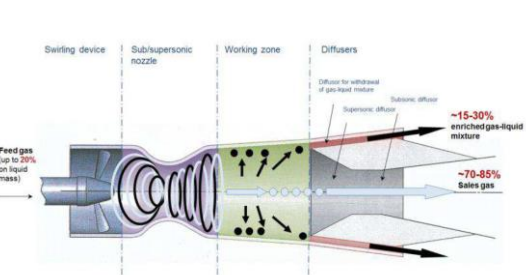


Flotta Hydrogen Hub - Green hydrogen production and export facility in Orkney.

Awarded floating wind option west of Orkney in Scotwind offshore wind leasing round - H₂ is critical to fully monetise wind power capacity.

Hydrogen transported to UK mainland via pipelines (new or repurposed).

TotalEnergies | REPSOL SINOPEC | MACQUARIE | Green Investment Group | RIDG



Supersonic Separators (SSS) Already used by a number of Operators in Russia and China, Malaysia (Shell) for dewatering and heavy hydrocarbon removal applications. Early trials in lab conditions for CO₂ removal for Petrobras/FMC/Engo - Separation of methane/CO₂ achieved.