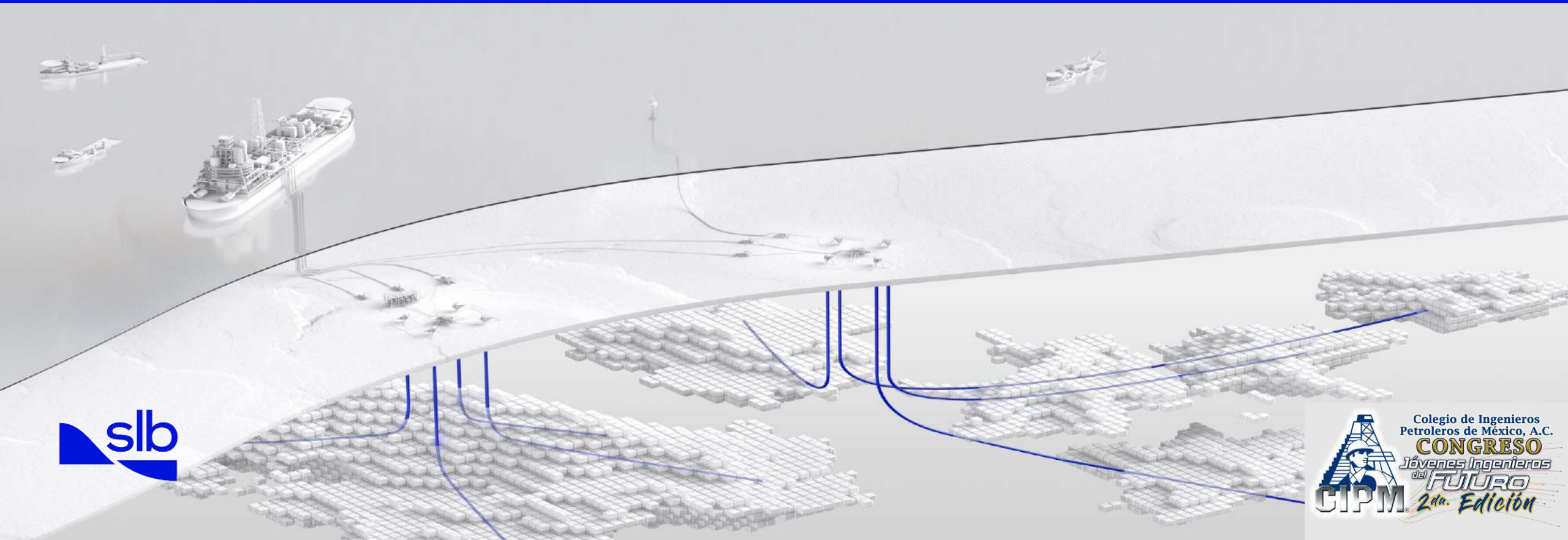
Revolucionando la Ingenieria Petrolera: Machine Learning, Inteligencia Artificial y nuevas tecnologías.

Jorge Granados
Technical Solutions Sales Manager - MCA
Slb-Digital & Integration



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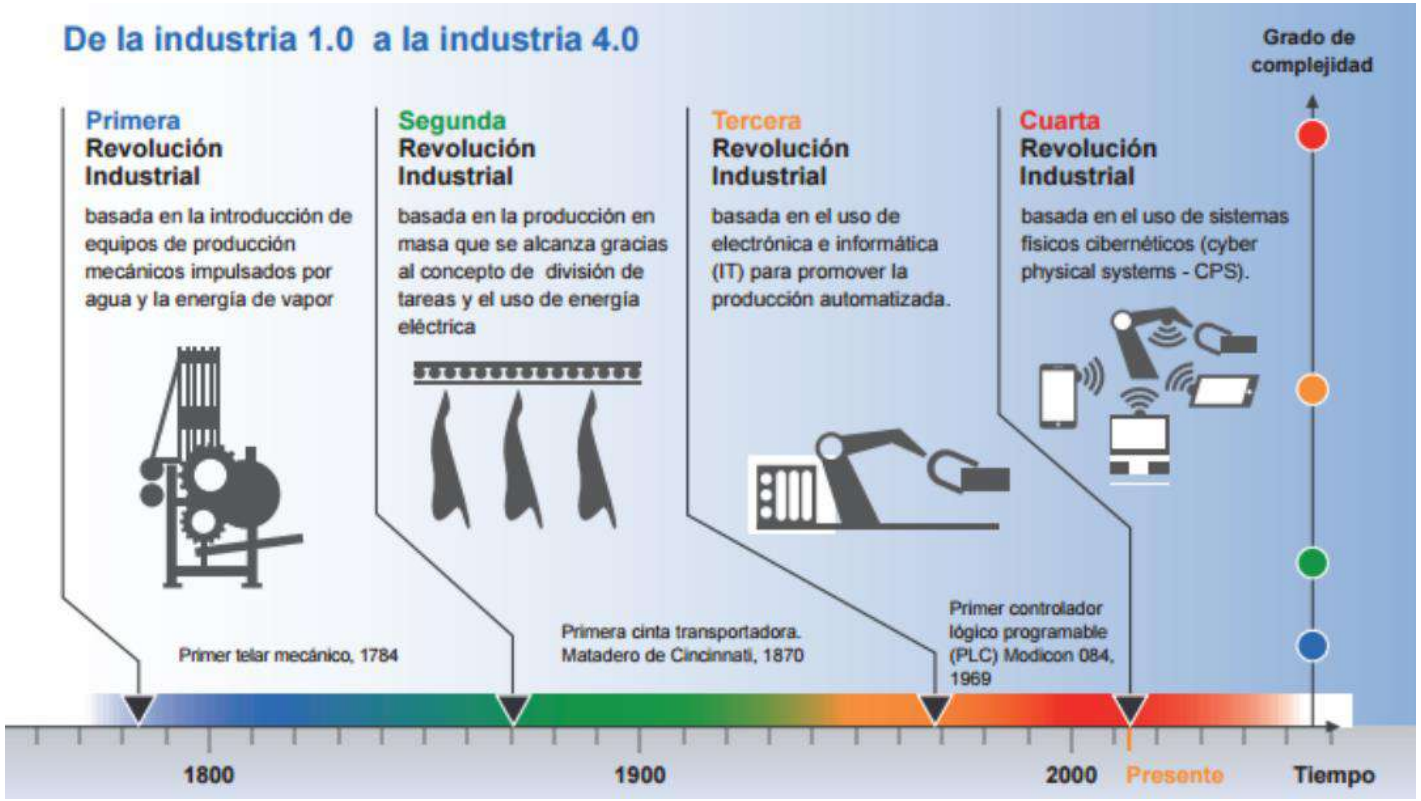
Agenda

- Revoluciones Industriales y era Digital
- Competencias/Herramientas Digitales
- Visión Digital slb
- Presente y Futuro Industria Energética
- Q&A

4ª Revolución Industrial

*La **4ª Revolución Industrial** es un proceso de desarrollo tecnológico e industrial que está vinculado con la organización de los procesos y medios de producción de la sociedad.*

- Automatización e intercambio de datos en la fabricación
- Incluye sistemas ciber-físicos, Internet de las Cosas (IoT), computación en la nube y computación cognitiva
- Interoperabilidad, conectar y comunicar
  - Máquinas, dispositivos, sensores, personas
- Transparencia de la información
  - Copia virtual del mundo físico a través de modelos digitales
- Decisiones descentralizadas
  - Sistemas para tomar decisiones por sí mismos
  - Realizar tareas de la forma más autónoma posible



Uso intensivo de sensores para producir/consumir datos

4ª Revolución Industrial

La generación de Datos nunca duerme…

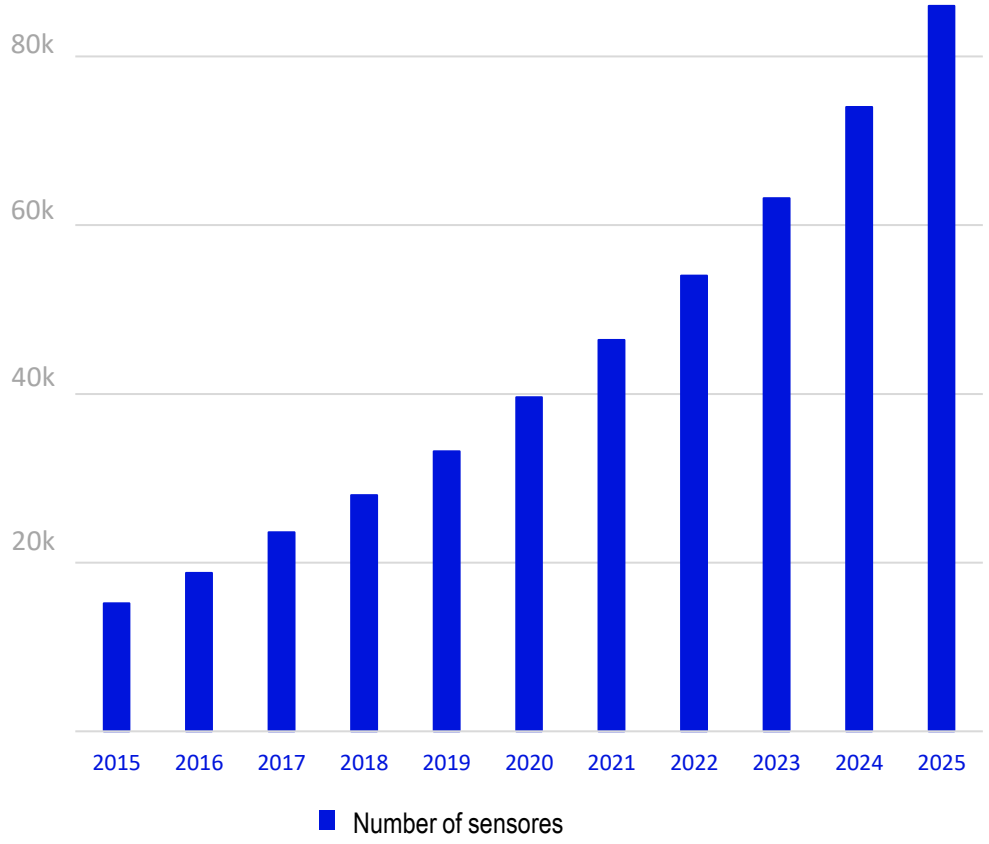
¿Cuántos Datos son generados por minuto?

https://www.digitalinformationworld.com/2023/12/heres-what-happens-on-internet-every.html

*La industria Energética **no** es la excepción*

+80,000

Sensores en una Plataforma offshore moderna.



Source: iot-analytics.com

4ª Revolución Industrial

Paradigmas de la ciencia

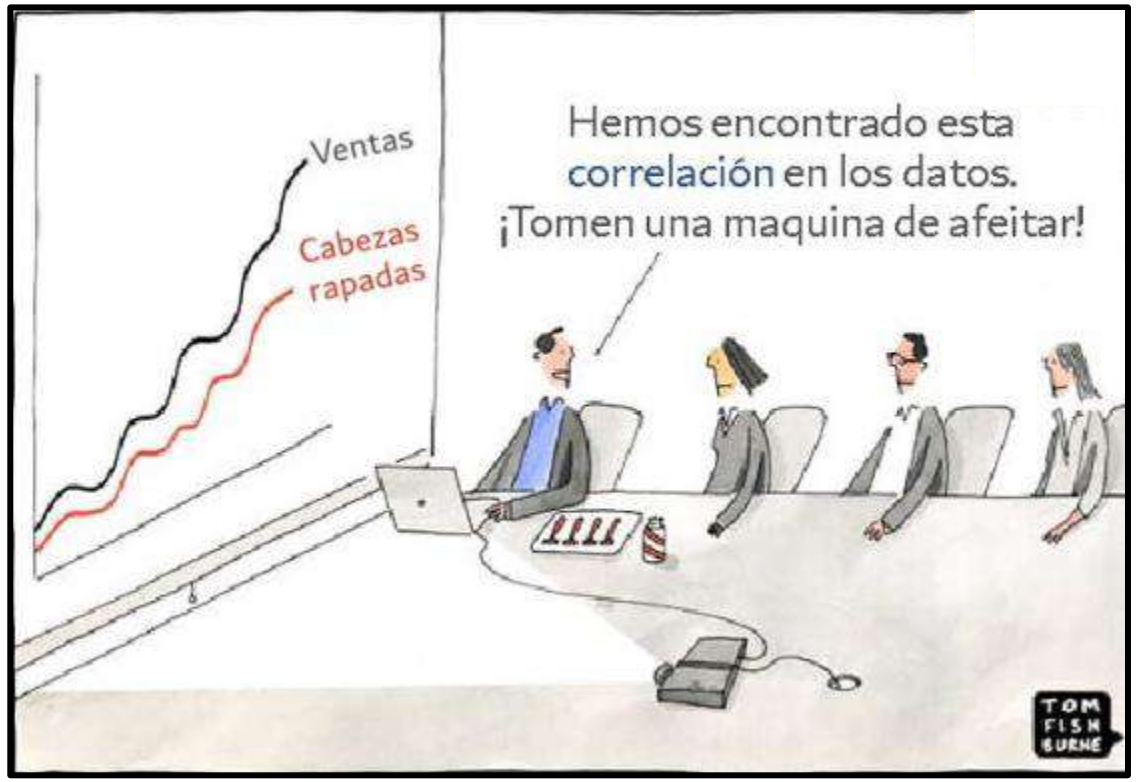
Paradigma	**Primero** *Ciencia experimental*	**Segundo** *Ciencia teórica*	**Tercero** *Ciencia computacional*	**Cuarto** *Ciencia basada en Datos*
Forma	• Empirismo • Describiendo fenómenos naturales • Experimentos	• Modelado y generalización • Leyes de la mecánica clásica, electrodinámica	• Simulación de fenómenos complejos • Mecánica contínua para sistemas heterogéneos • Dinámica de fluidos computacional	• Uso intensivo de datos • Exploración estadística y minería de datos • Detección de patrones y anomalías en big data • Correlación entre variables
Cuando	pre-Renacimiento	pre-computadoras	pre-Big Data	Ahora

Compiled from *Hey et al. (2009)* and modified by *M. Pyrcz (2019)*. R. Kitchin (2014). *Big Data, new epistemologies and paradigm shifts.*

4ª Revolución Industrial

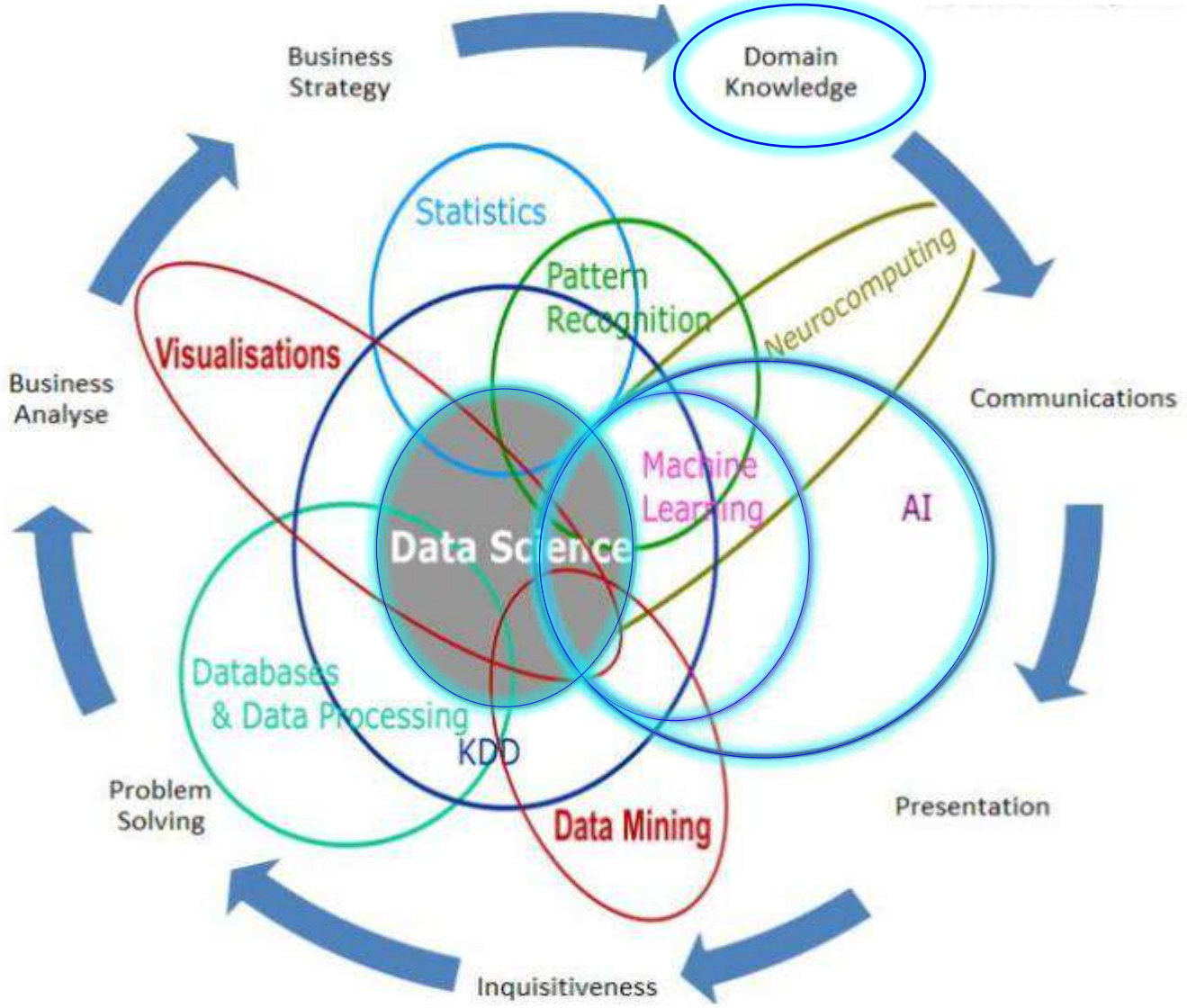
Ciencia basada en Datos

¡¡Correlación no implica causalidad !!

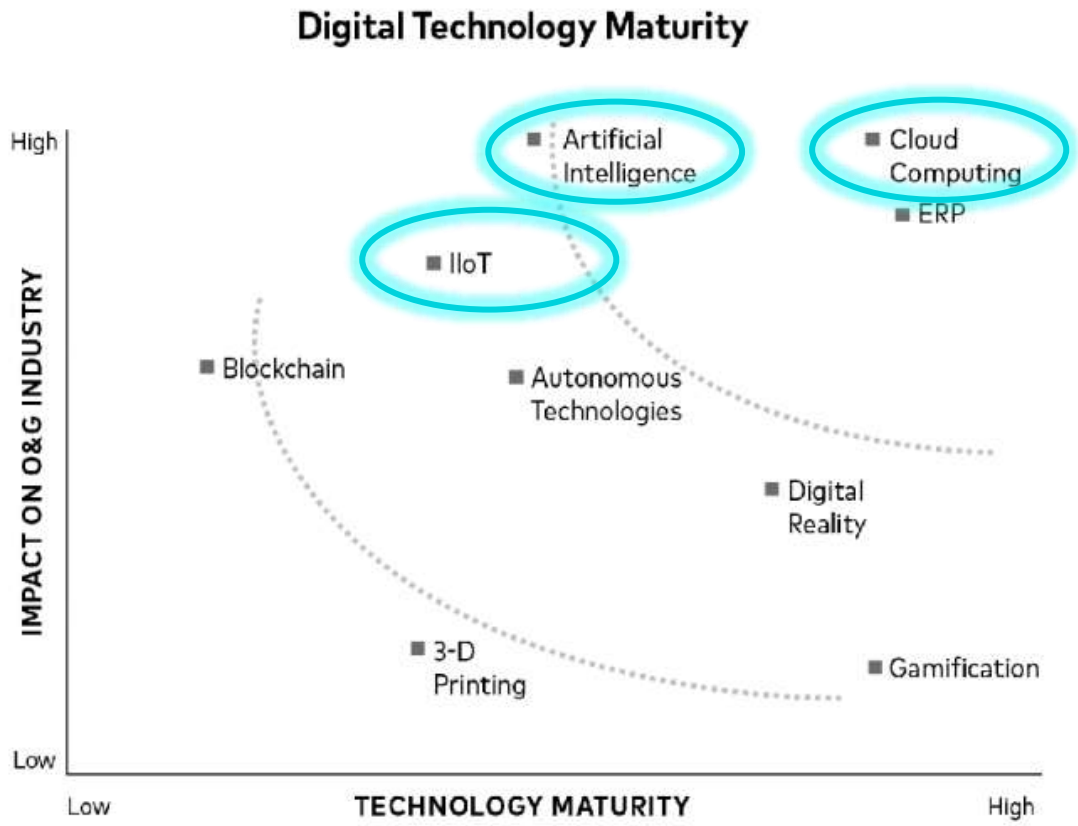


Competencias Digitales

- Ciencia basada en **datos**
- Campo **interdisciplinario** para extraer **conocimientos** o perspectivas de datos (estructurados o no estructurados)
- Unificar **estadísticas**, **análisis de datos** y métodos relacionados
- **Dominio** es fundamental para explicar **causalidad**



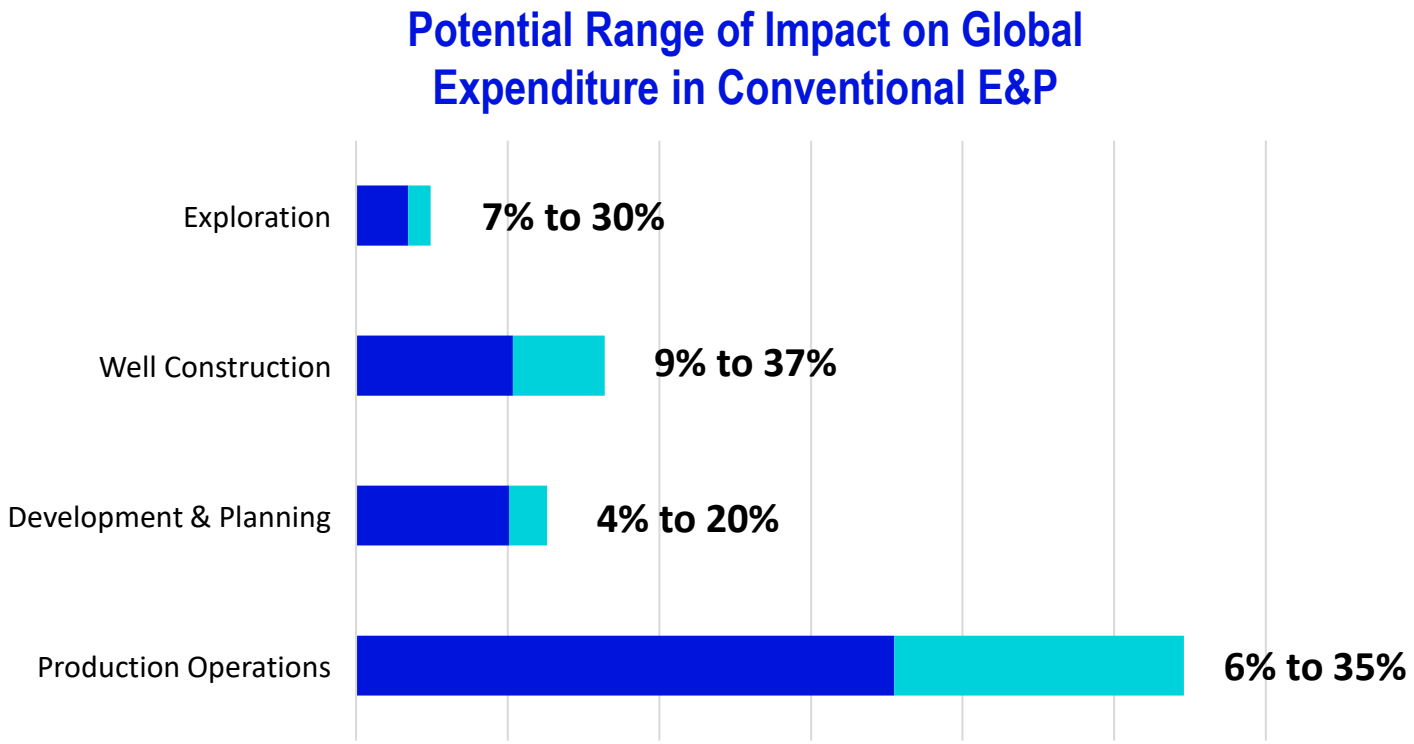
Herramientas Digitales



- Cloud / HPC / Security
- Data Science & Analytics
- Artificial Intelligence ML DL
- IOT / IIOT (IT / OT)
- Automation / Robotics
- Drone / UAV / AUV
- XR (VR / AR / MR)
- 3DPrint, Blockchain, Wearable
- Digital Readiness & Action

Bits, Bytes, and Barrels: The Digital Transformation of Oil and Gas. Geoffrey Cann . 2019

La Promesa Digital



$60B to $290B of potential Savings

*"Overall, **Machine Learning** & **Artificial Intelligence** led the list of emerging technologies most often cited as having the **greatest potential** to increase productivity, reduce risk and provide cost saving benefits."*

*"**Machine learning** solutions is a **top priority** and important strategic intent for approximately **79%** of the operators worldwide.."*

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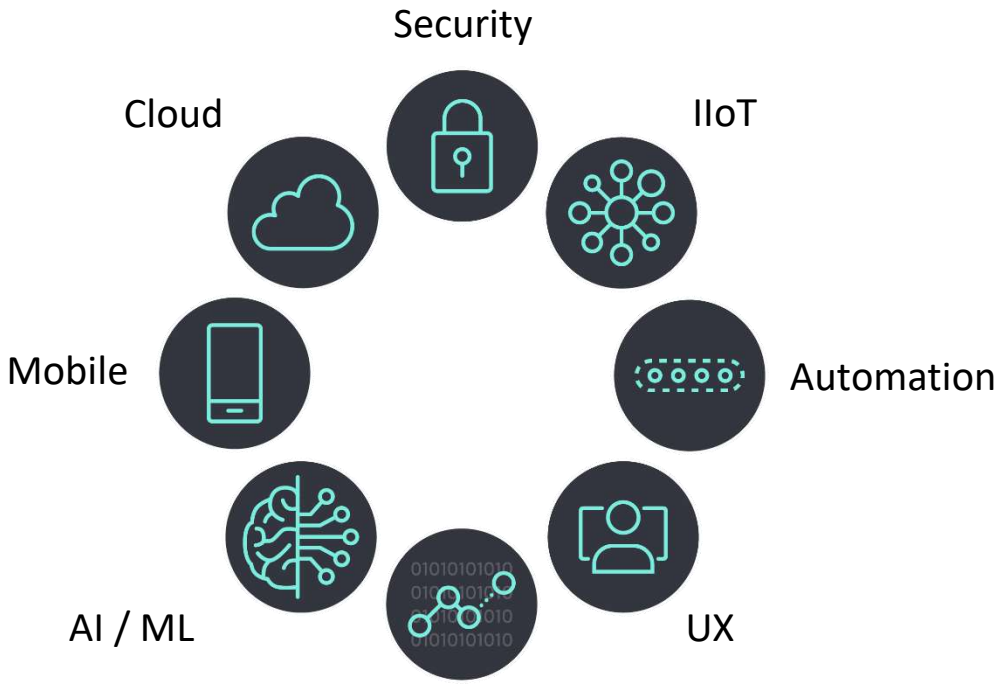
Visión Digital SLB

Ecosistema Tecnológico Digital

TECNOLOGIA DE SOFTWARE

Centro de innovación

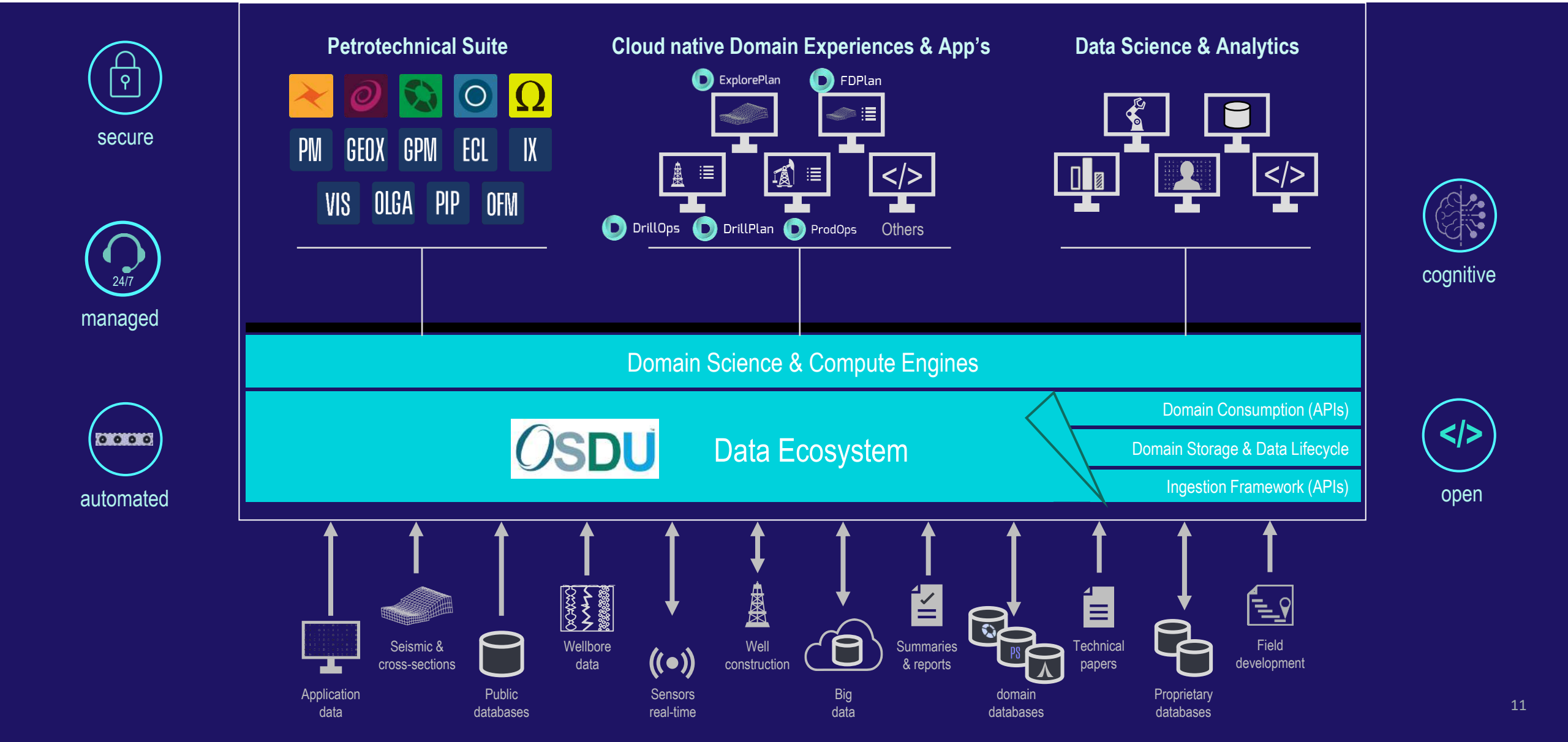


SLB LIMITED

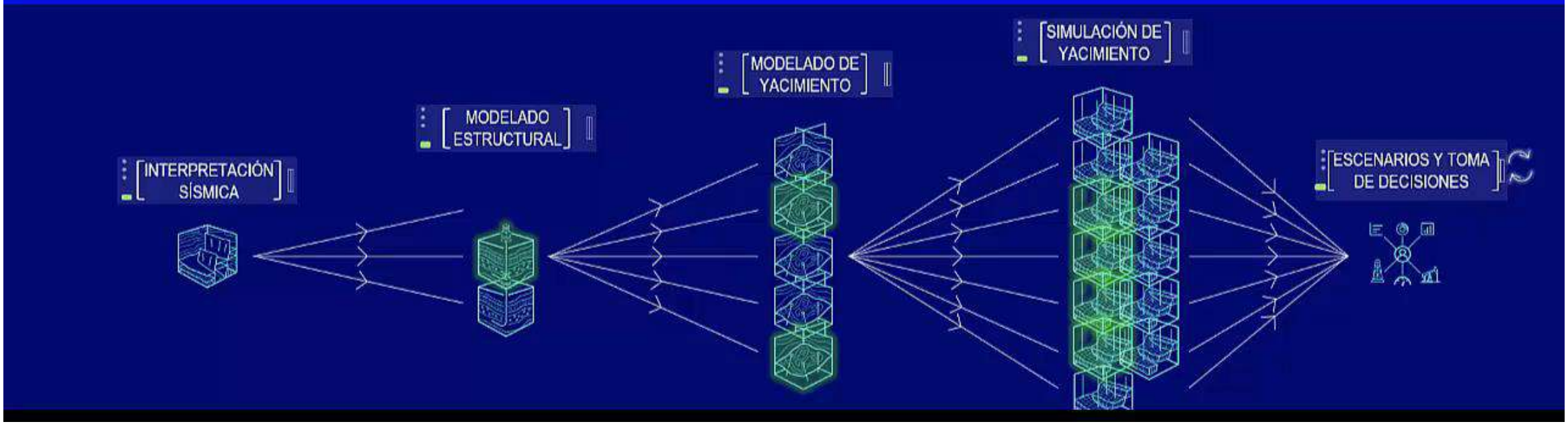
Centro de internet industrial

Ambiente cognitivo E&P-slb

DELFI



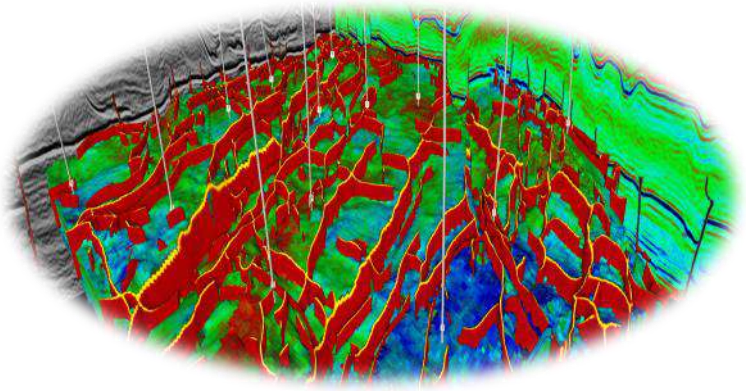
Agile Reservoir Modeling

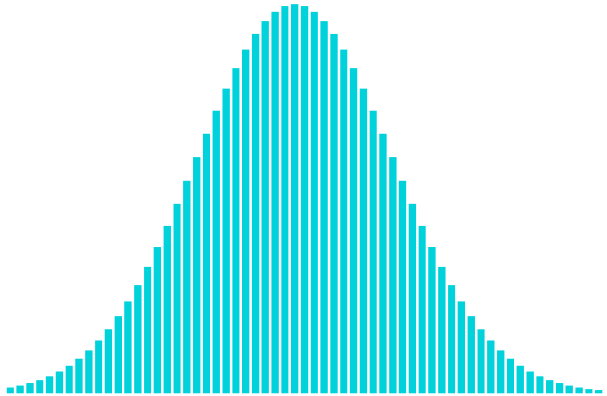


Based on data from NAM (2020). Petrel geological model of the Groningen gas field, the Netherlands. Open access through EPOS-NL. Yoda data publication platform Utrecht University. https://doi.org/10.24416/UU01-1QH0MW

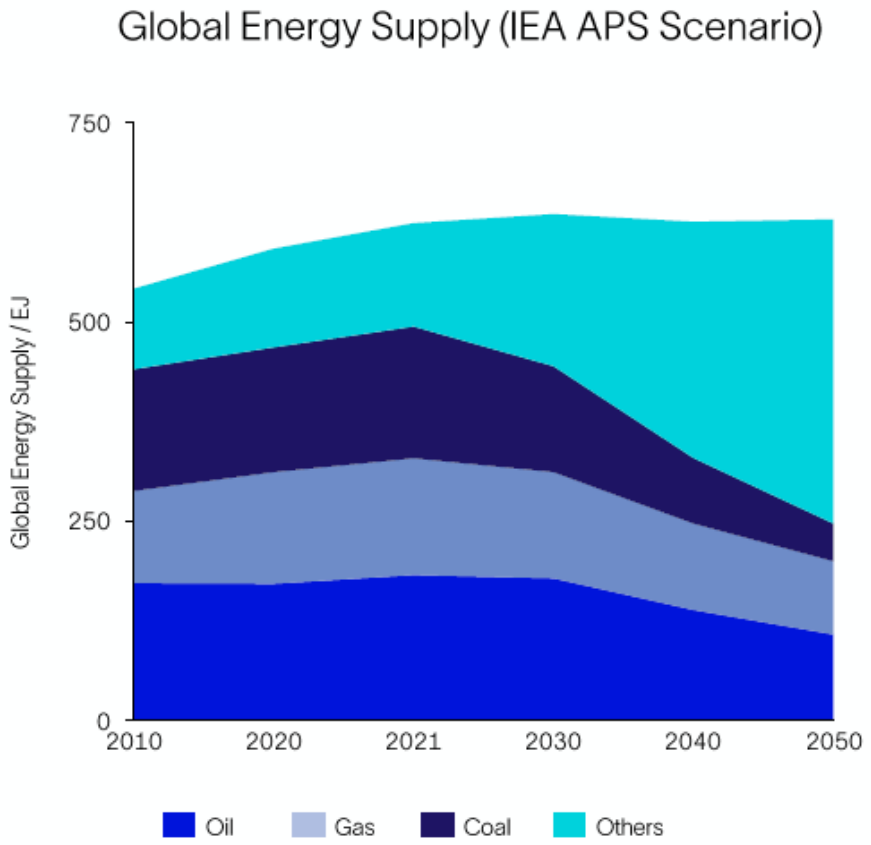
Impacto digital en la caracterización del subsuelo

10x	80%	Muchos	40x	1000s	Integración	70%	Liberación	100%
Mas rápido	Mas eficiencia	Mas escenarios	Mas rápido	Realizaciones	Con simulación	Mas rápido	Petrel Colaborativo	Conectado
Acceso sísmico eficiente	Eficiente caracterización del subsuelo	Cuantificar incertidumbre estructural	Estudios volumétricos realizados	Cuantificar incertidumbre del modelado	Entender conectividad	Estudios de simulación más rápidos	Experiencia de usuario de Petrel mejorada	Apertura para conectarse con otras aplicaciones

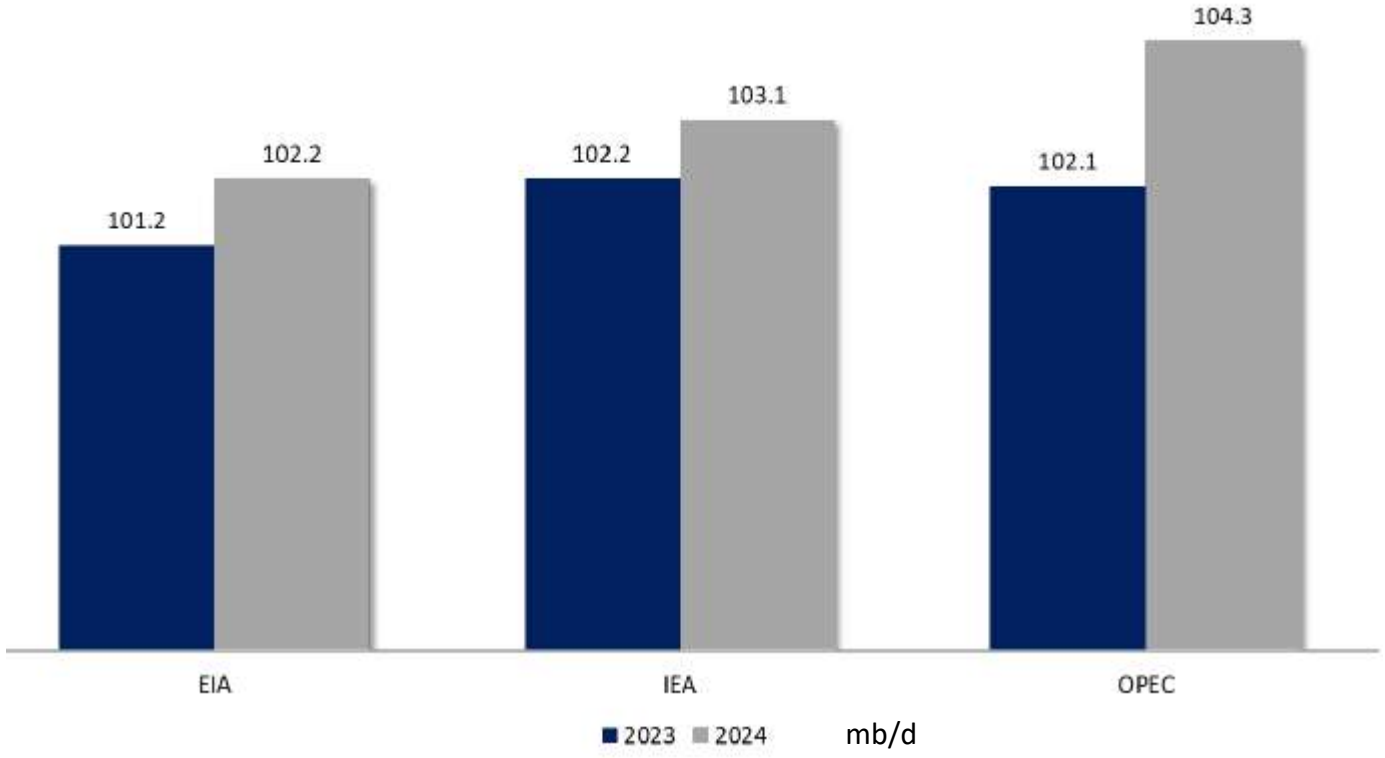




Presente y Futuro Industria Energética



Source for both images: IEA World Energy Outlook 2022

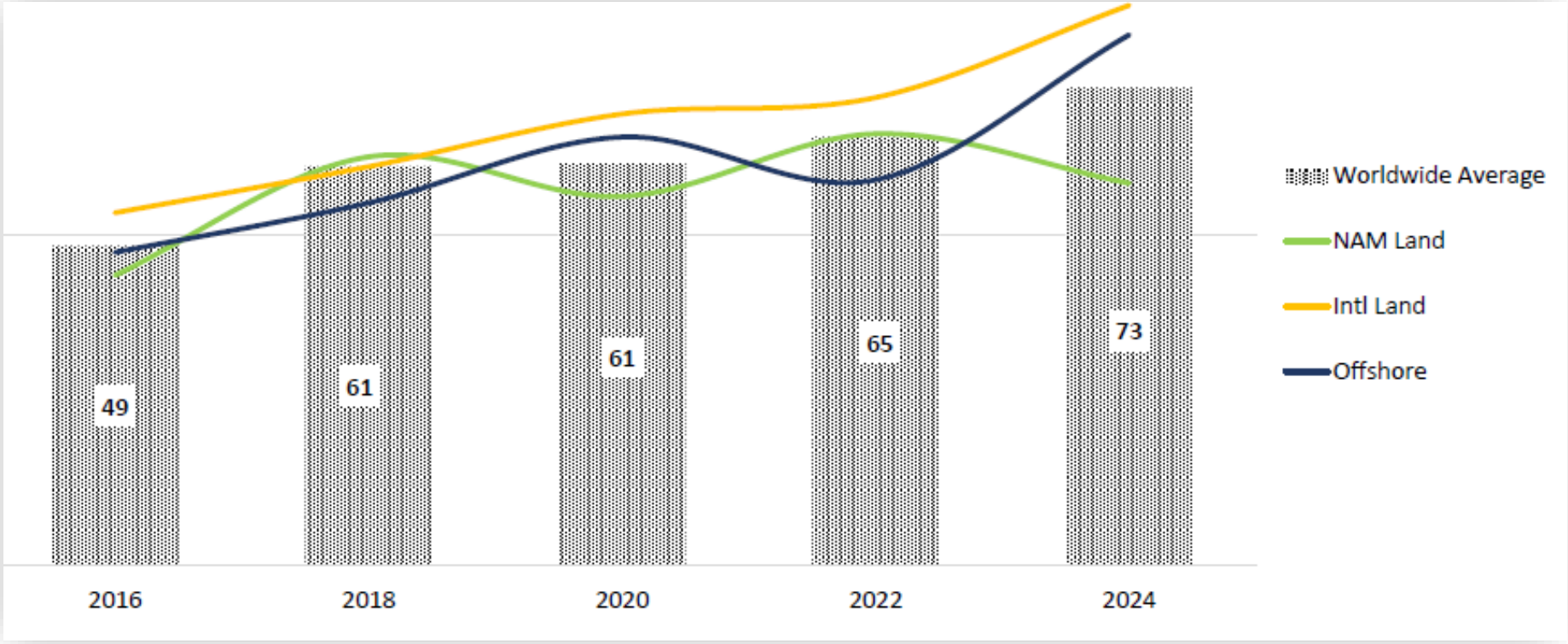


World Liquids Fuels Consumption Expectations mmbd January 2024

Presente y Futuro Industria Energética

G&G Formation Evaluation

- LWD
- Wireline Logging
- Mud / Surface Logging
- Downhole Coring
- Core Analysis Services
- Geological Interpretation
- Seismic Interpretation
- Petrophysics Software
- Geophysical Software
- Depth Velocity Software
- Depth Imaging Software
- Seismic Data Processing
- Reservoir Modeling Software
- Seismic Acquisition
- Multiclient Data Licensing



Incremento de la inversión en tecnología para modelado del subsuelo

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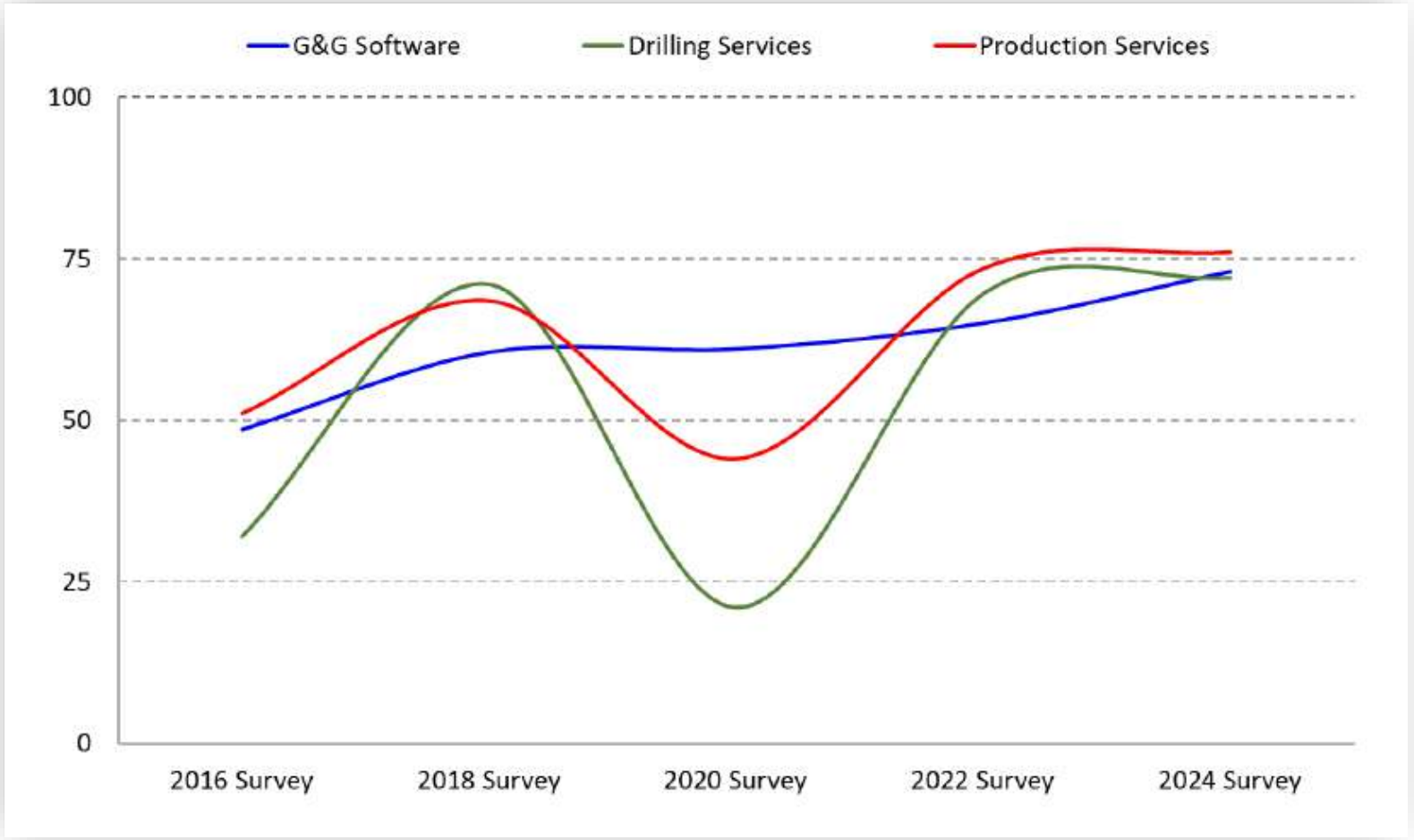
Presente y Futuro Industria Energética



Perfil del mercado para las tecnologías en los últimos ocho años

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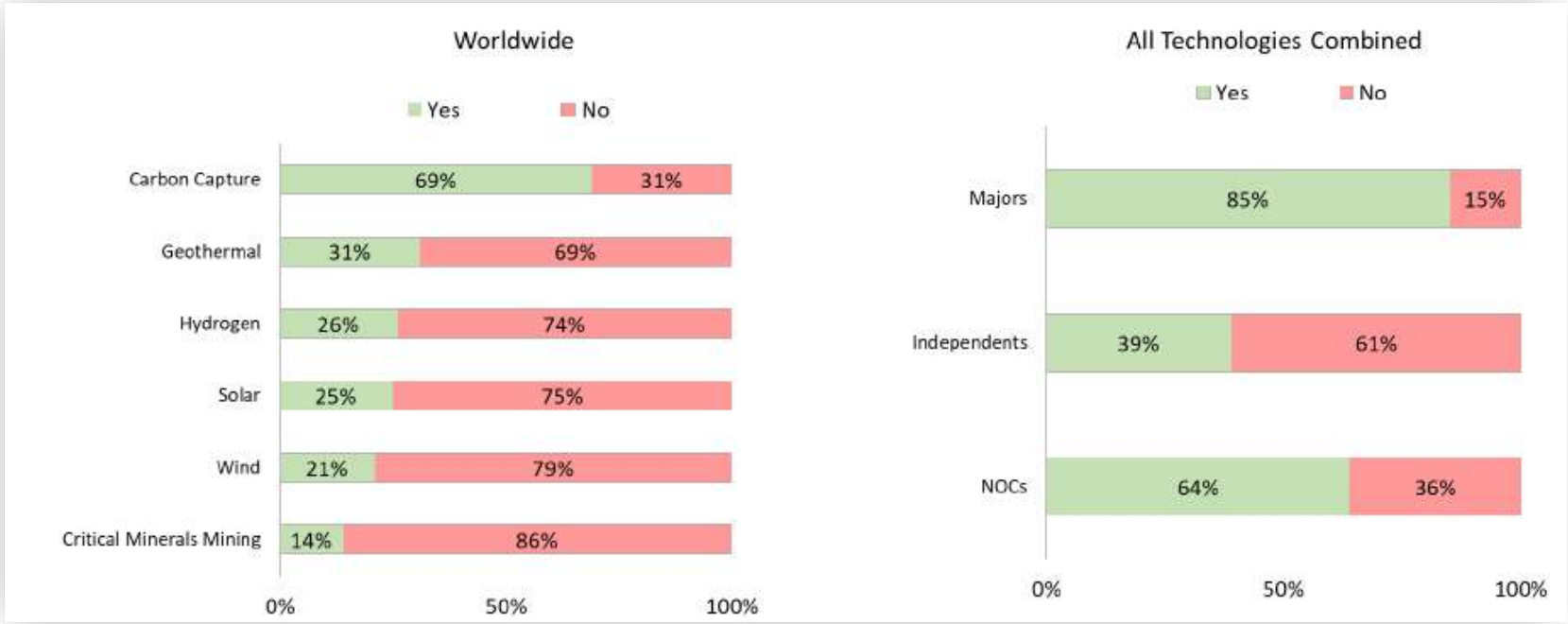
Presente y Futuro Industria Energética



Planes para invertir en nuevas tecnologías energéticas en los próximos 2 a 5 años: en todo el mundo

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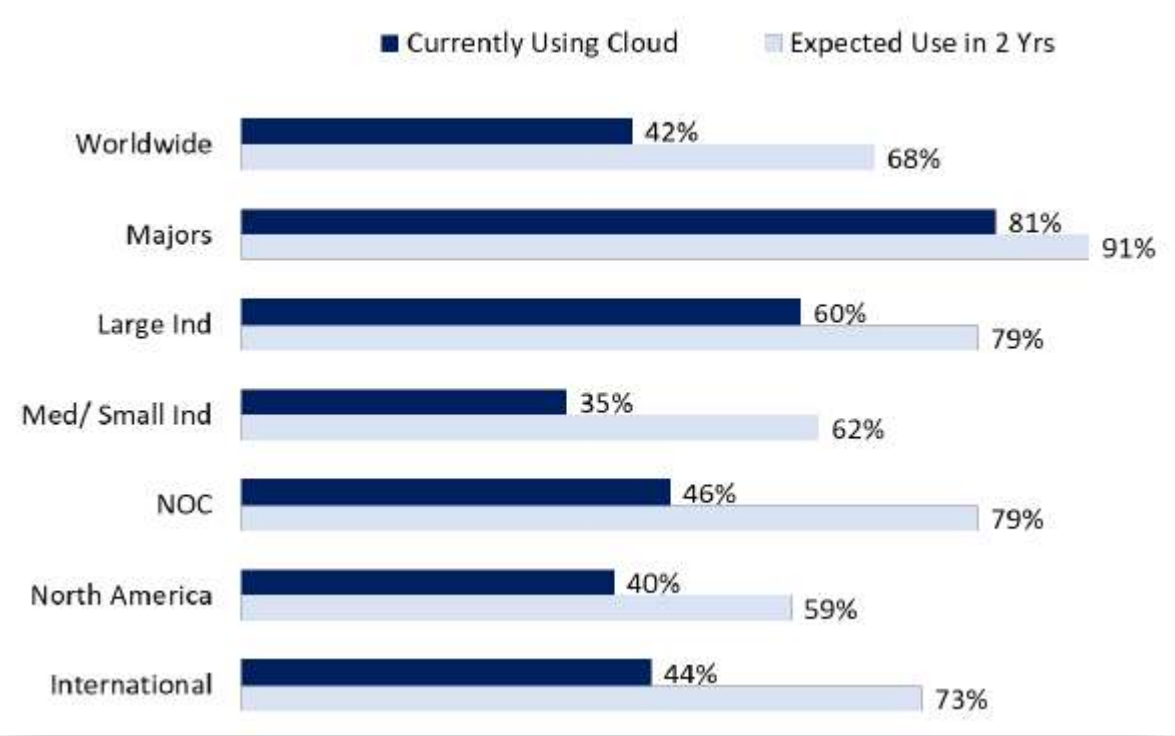
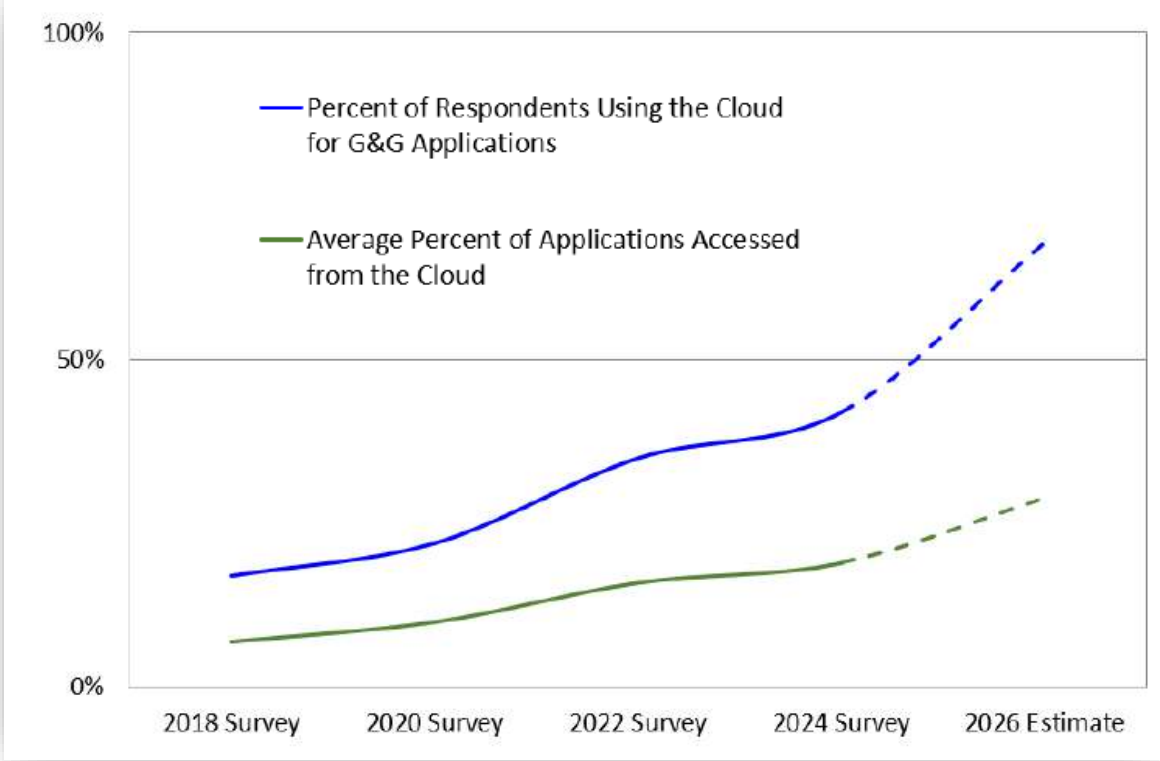
Rol de las especialistas en la transición energética

- **Captura y almacenamiento de emisiones (CCS) CO2 y Metano**
- **Almacenamiento de Gas y otras formas de energía**
- **Energía Geotérmica (Electricidad, Refrigeración de edificios)**
- **Energía Hidráulica (Geotécnica y Exploración)**
- **Minería para minerales, construcción de paneles, turbinas eólicas y componentes electrónicos**
- **Exploración y extracción de litio**

Presente y Futuro Industria Energética



% de empresas que utiliza(rá)n la nube para tecnologías de modelado del subsuelo



Tendencia en el uso de la nube para tecnologías de modelado del subsuelo

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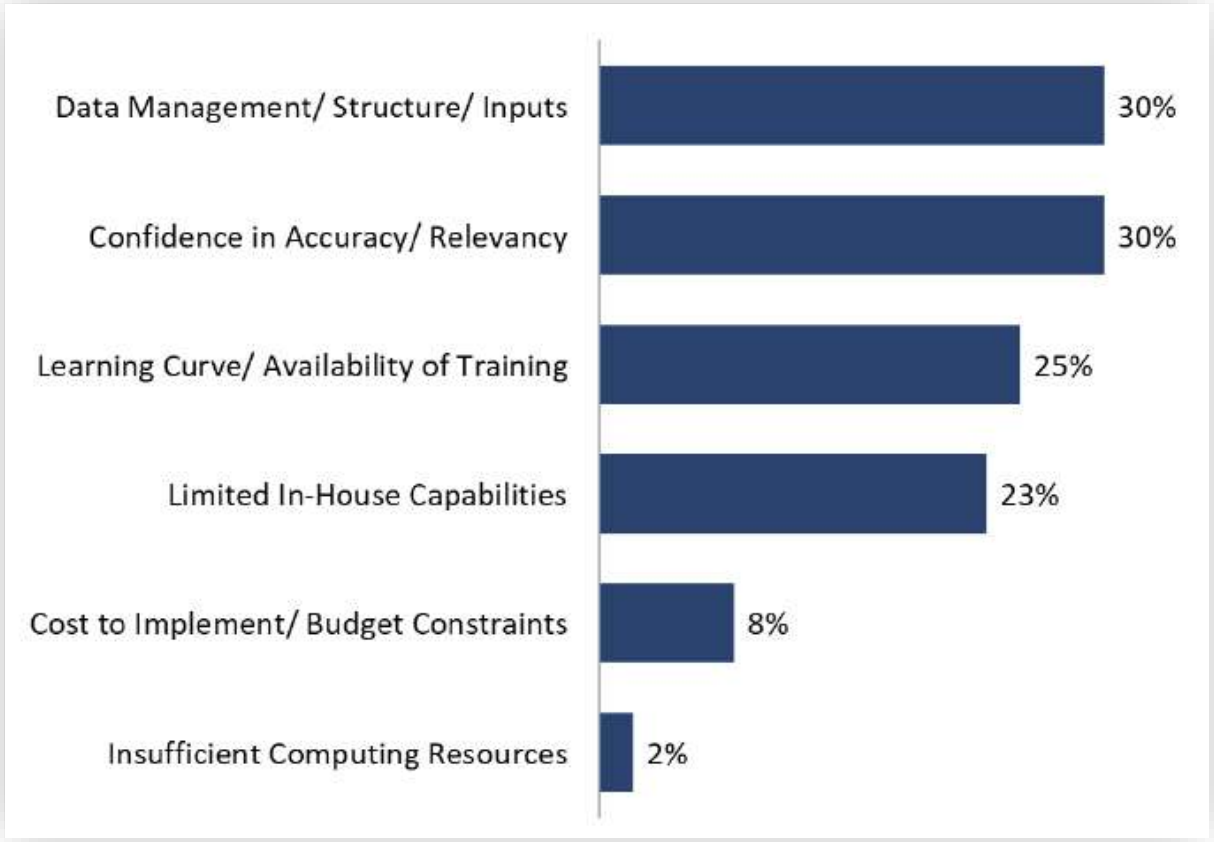
Presente y Futuro Industria Energética



Desafíos encontrados al implementar AI en flujos de trabajo para modelado del subsuelo

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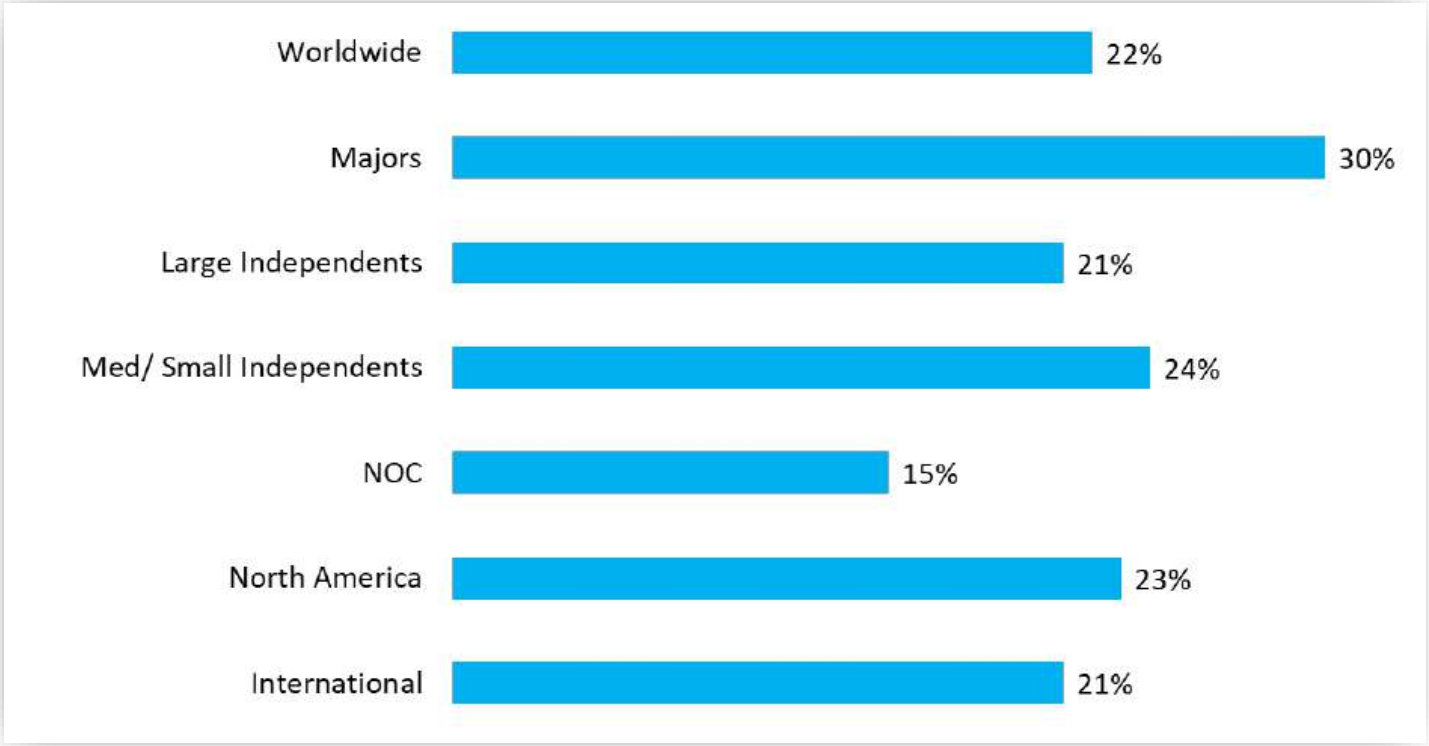
Presente y Futuro Industria Energética



Proporción de especialistas que están mejorando sus habilidades en inteligencia artificial y análisis de datos

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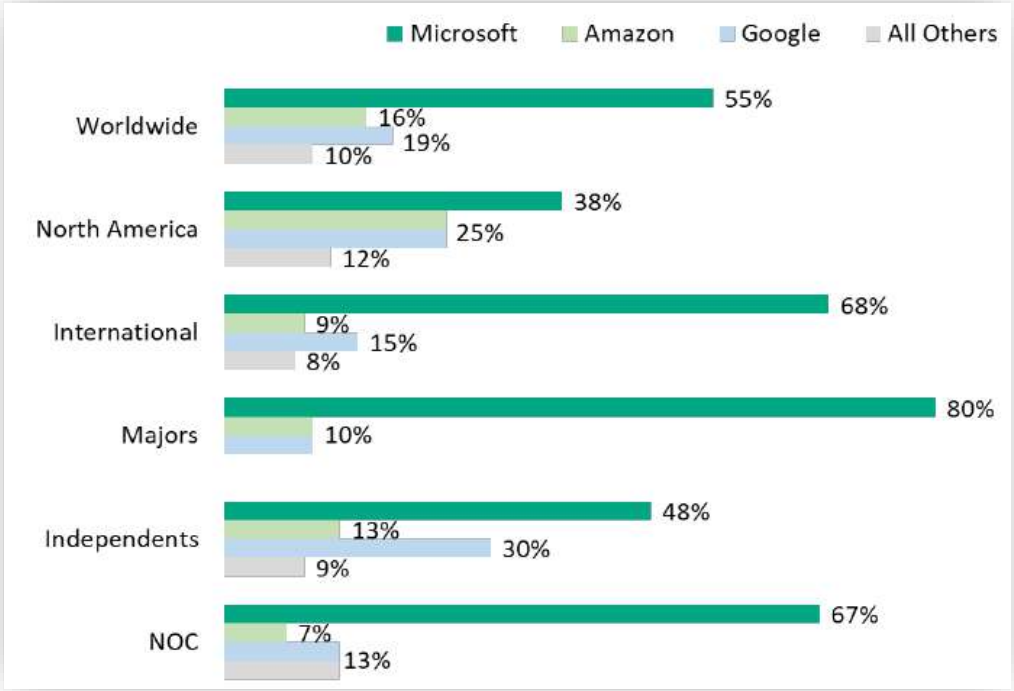
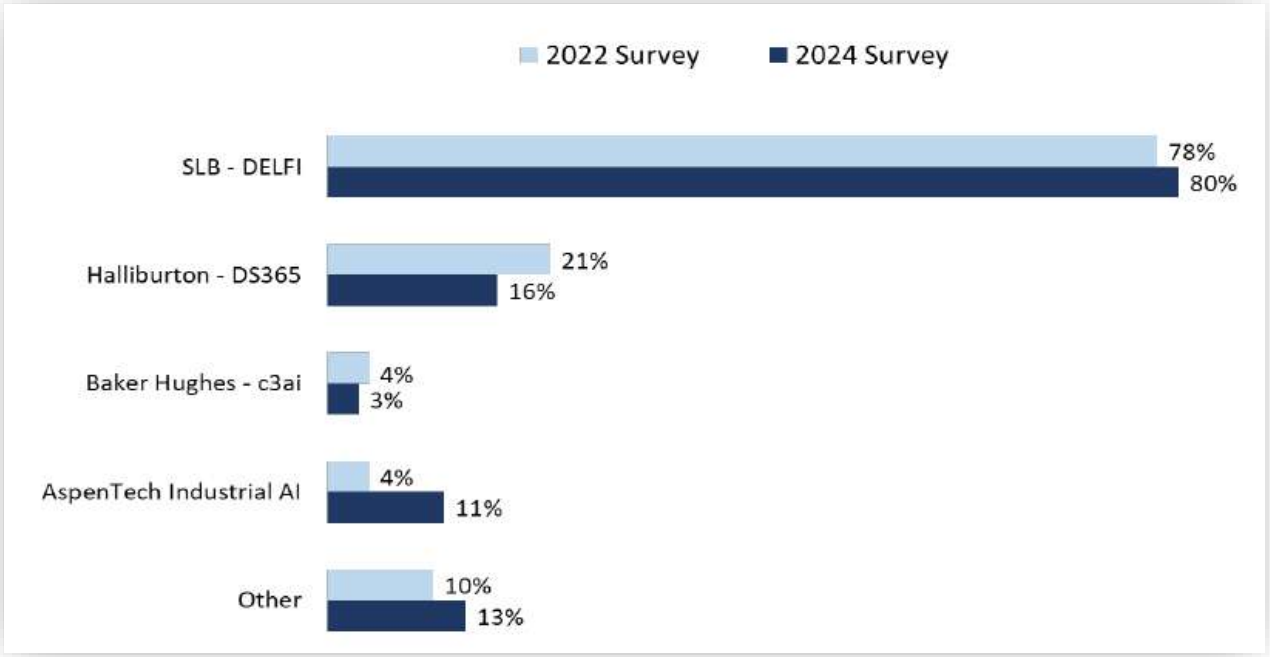
Presente y Futuro Industria Energética



Proveedores de nube utilizados actualmente:
en todo el mundo



Uso previsto de plataformas habilitando AI para flujos de trabajo de modelado del subsuelo en los próximos dos años

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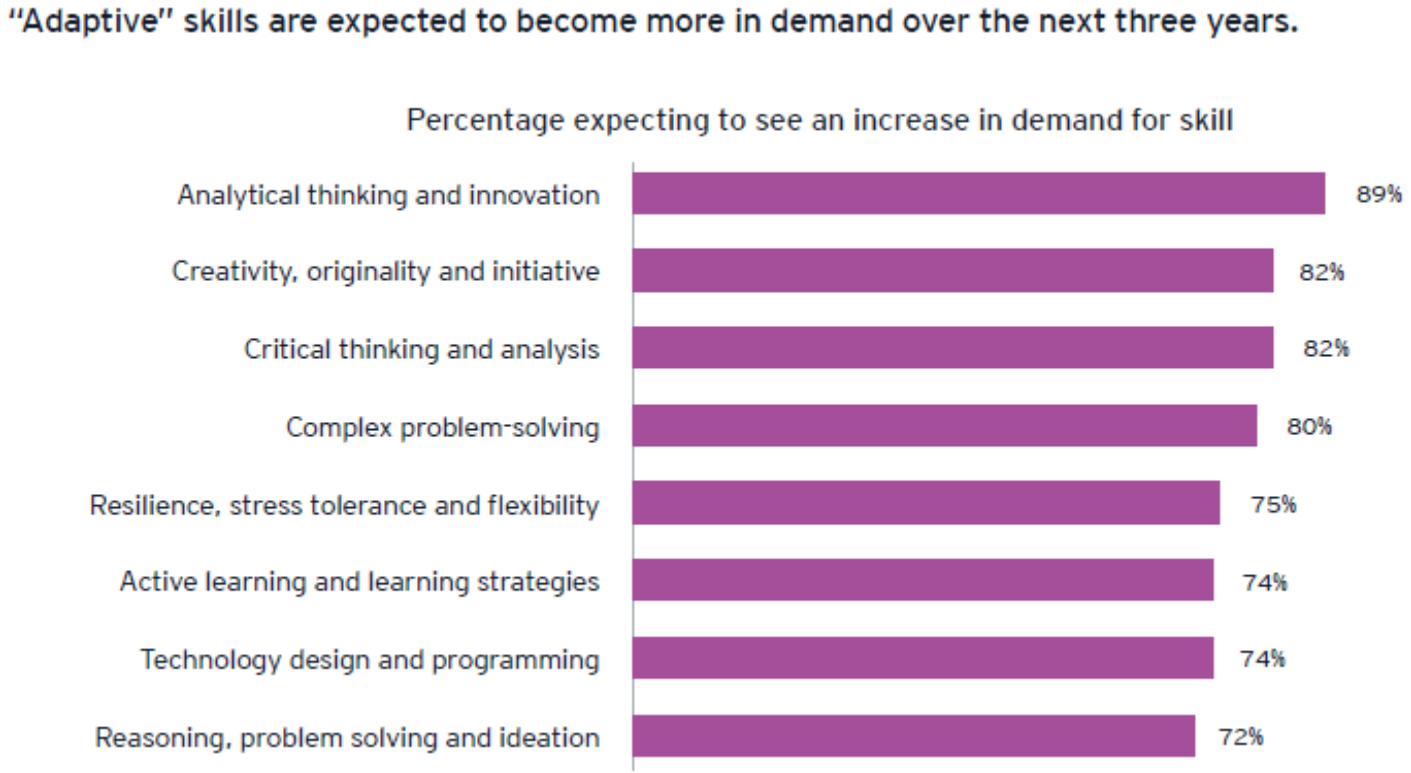
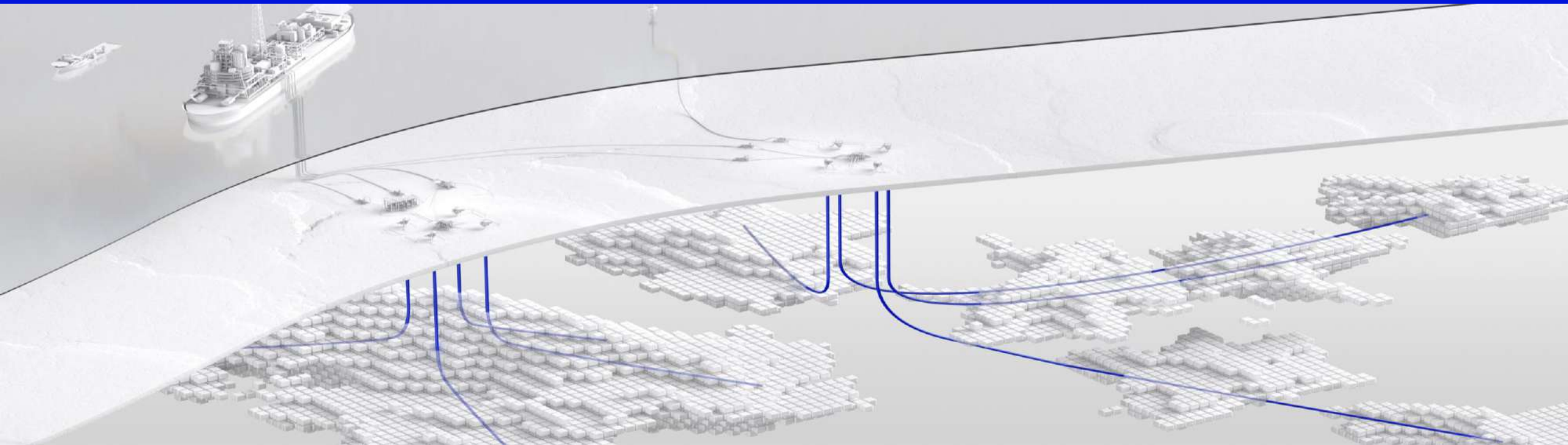
Futuro Industria Energética

- Digital es fundamental
- La brecha de habilidades es real
- La competencia por el talento se intensificará
- Entonces, ¿qué harán las empresas?
- Habilidades adaptativas

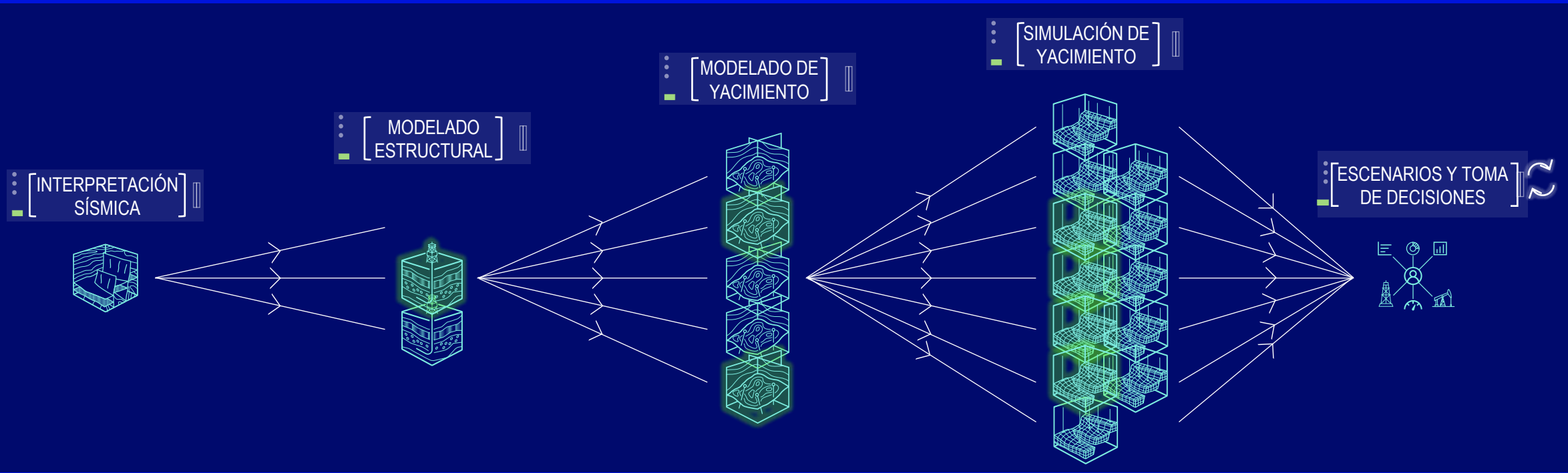


Oil and Gas Digital Transformation and the Workforce Survey. EY
SLB Intelligence

Gracias



Agile Reservoir Modeling



Machine Learning Assisted Fault Interpretation

Machine Learning Assisted Horizon Interpretation

Machine Learning for Property Modeling

Machine Learning & HPC for Reservoir Simulation

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Colegio de Ingenieros Petroleros de México, A.C.
19 de abril de 2024

Herramientas para la interpretación sísmica asistida por Inteligencia Artificial

Montserrat Acosta

HALLIBURTON

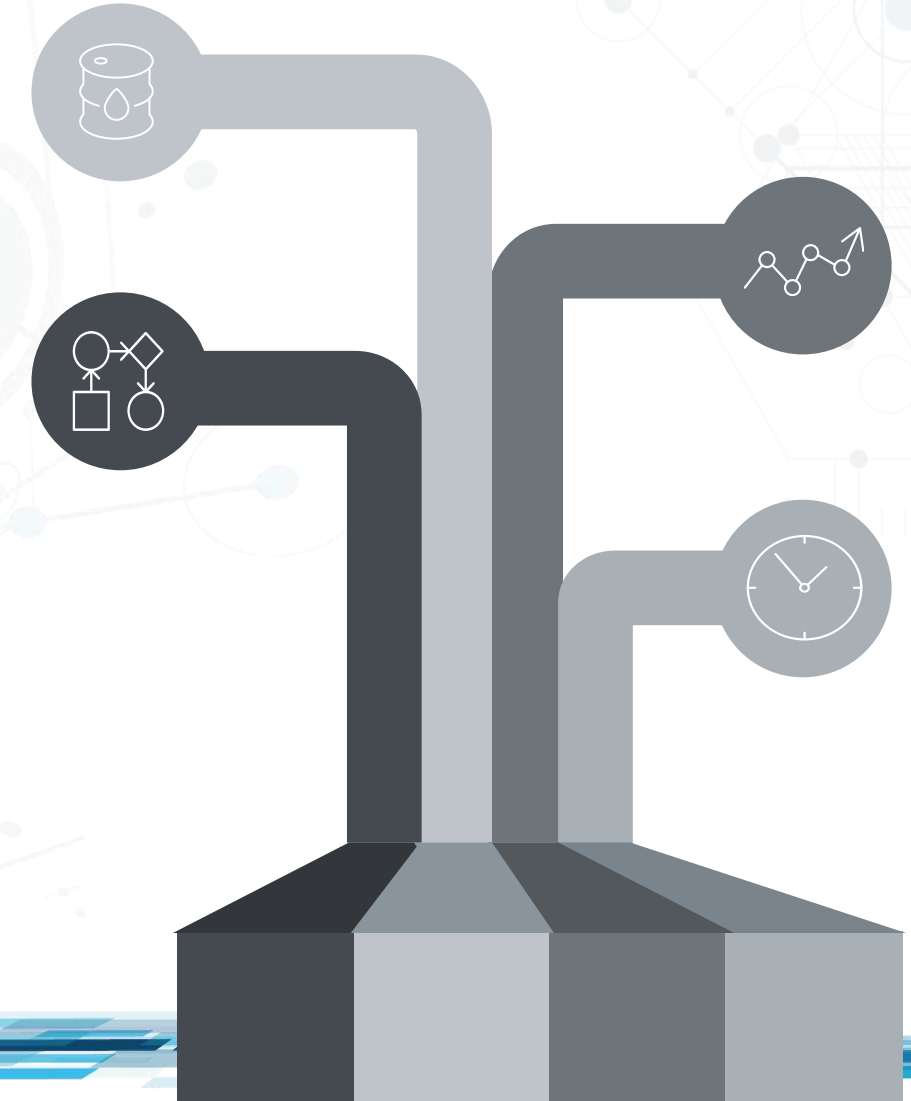
Agenda

Introducción

01 Machine Learning en la industria O&G

Interpretación asistida

03 Atributos, Fallas, Horizontes, Sal, Paleocanales, Inversión



Visión de Landmark

02 Nuestra visión en Geofísica

Conclusión

04 Geosciences Suite, una solución de DecisionSpace® 365

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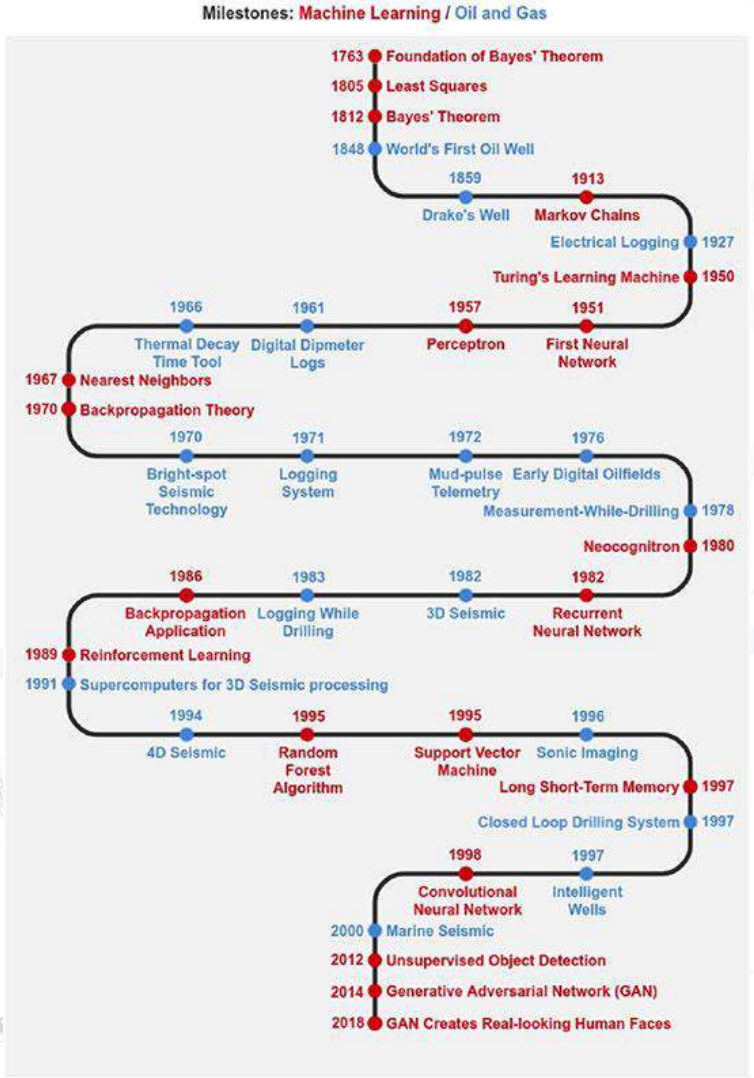
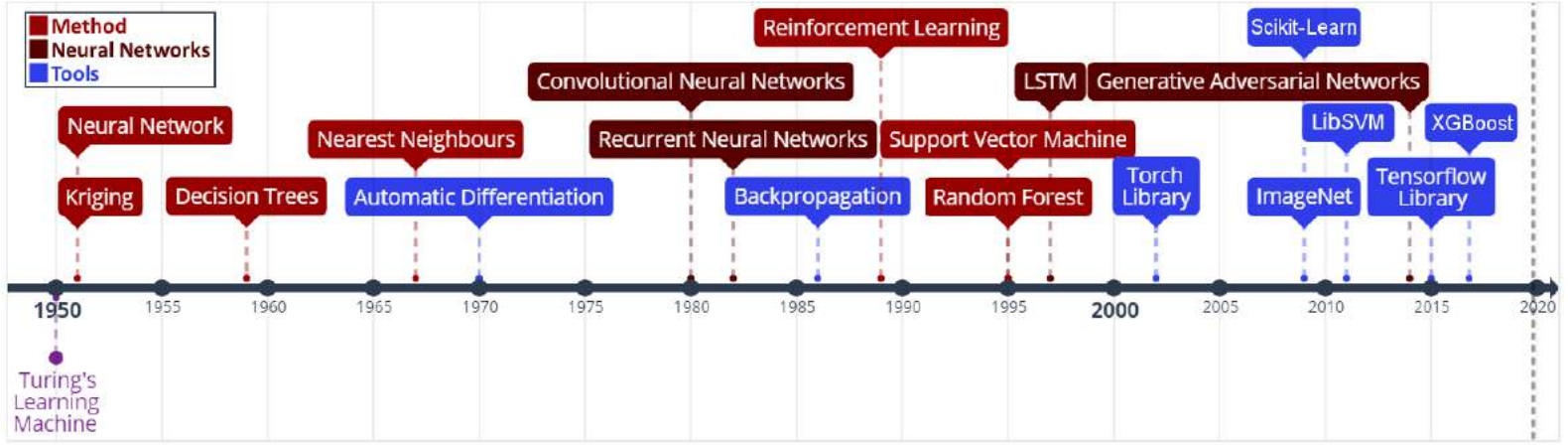
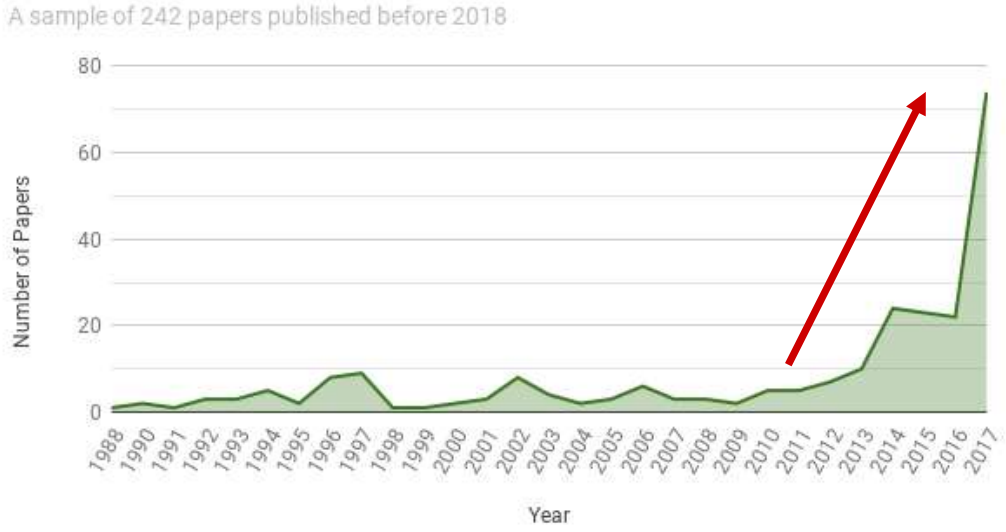
Machine Learning en la industria O&G



Pandey et al, 2020





Papers de ML en Geociencias

Dramsch, 2020
https://arxiv.org/abs/2006.13311
DOI: 10.1016/bs.agph.2020.08.002

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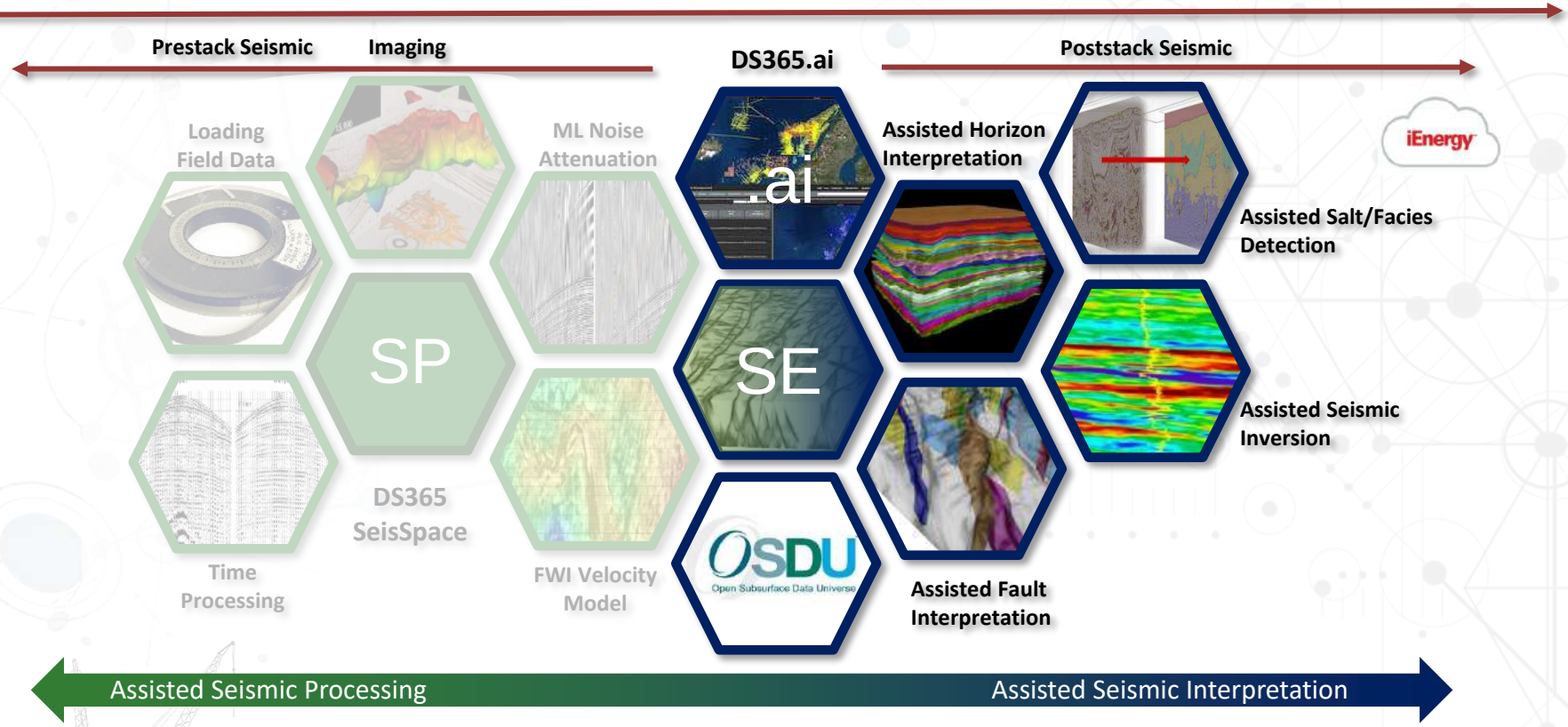
CIPM

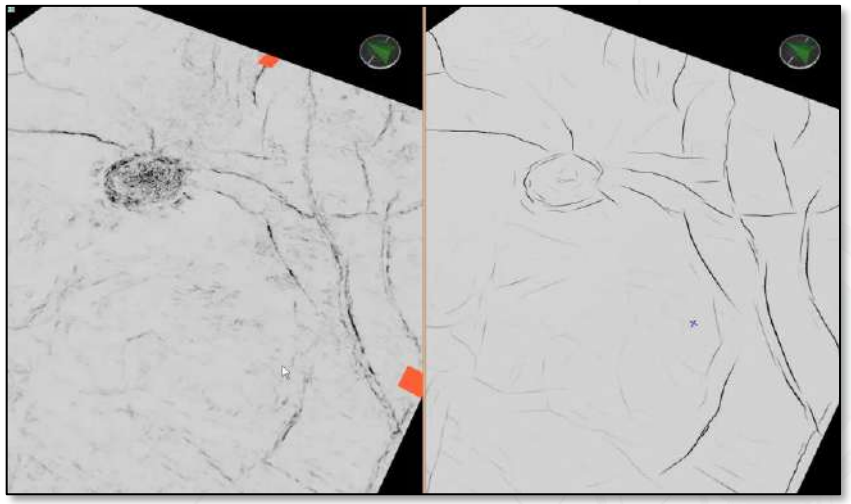
Nuestra visión en Geofísica

El ciclo de vida de la Sísmica



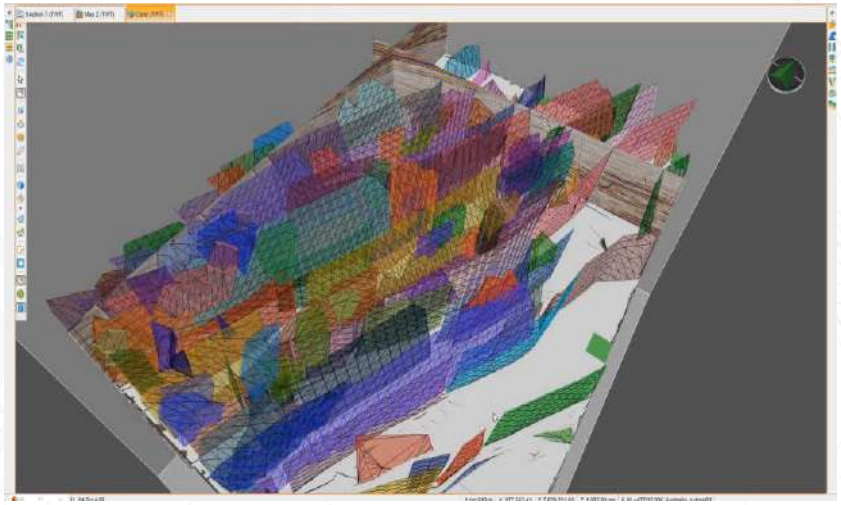
Tecnología y Flujos de trabajo automatizados, nativos de la nube, desde procesamiento pre-apilado hasta la interpretación post-apilado.

Interpretación sísmica asistida



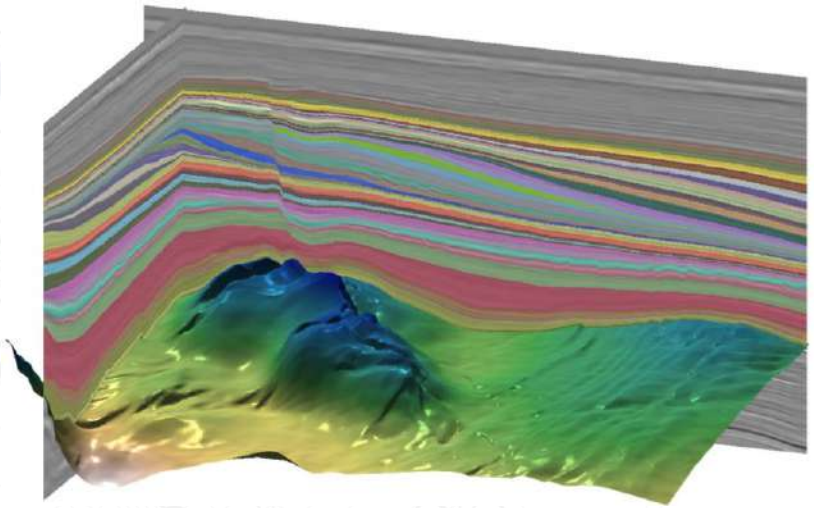
DecisionSpace® 365 Seismic Engine

- Acelera el proceso de análisis del dato sísmico.
- Conserva la fidelidad del dato original.



DecisionSpace® 365 Assisted Fault Interpretation

- Asegura calidad con interpretaciones eficientes.
- Más tiempo al análisis de los resultados.



DecisionSpace® 365 Assisted Horizon Interpretation

- Representación del subsuelo geológicamente más realista.
- Entendimiento detallado en corto tiempo.

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Interpretación asistida de fallas

DecisionSpace® 365 Assisted Fault Interpretation

Acondicionamiento del dato
(Sísmica)

QC

Predicción de las Fallas
(Sísmica)

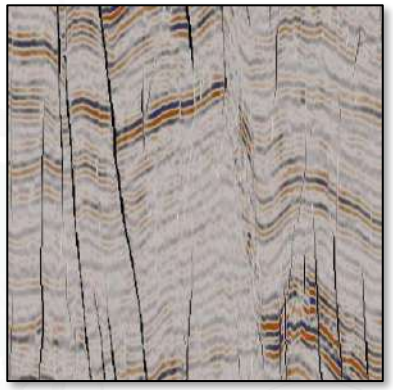
QC

Extracción de las Fallas
Pointset

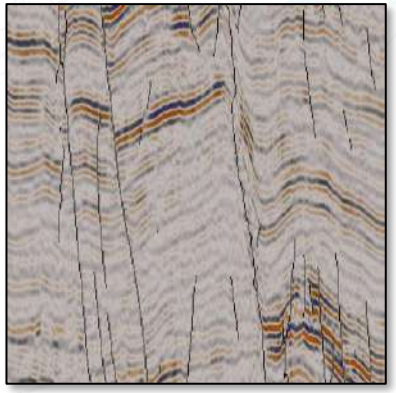
QC

Guardar resultados
Sticks

Predicción de Fallas

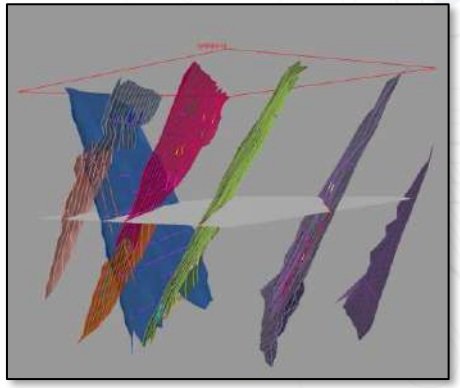


Fault Likelihood

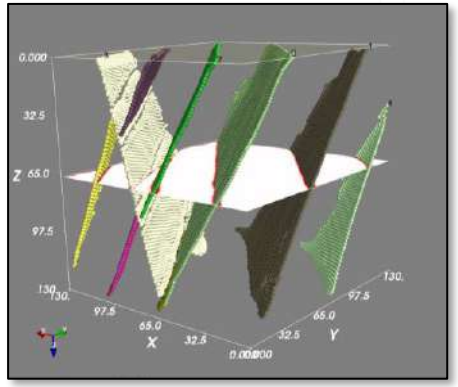


Machine Learning Fault Prediction[1]

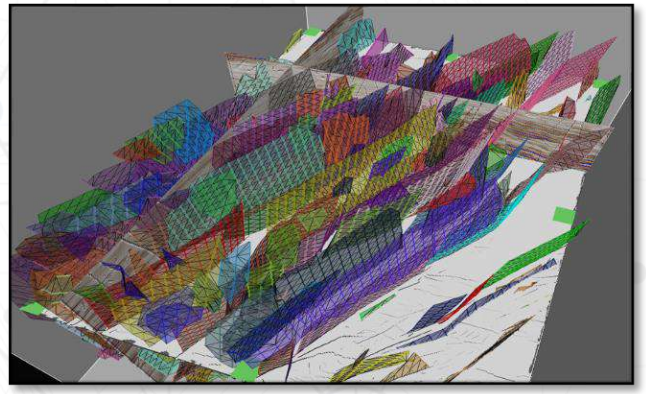
Extracción de las Fallas

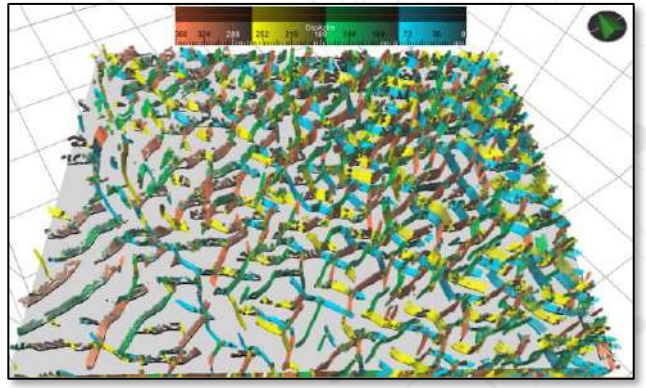


Point cloud-Based[2]



Visualización de Fallas





1 "Seismic Attribute-Guided Automatic Fault Prediction by Deep Learning" F. Jiang, P. Norlund 82nd EAGE Conference & Exhibition 2020

2 "Determining Fault Surfaces from Fault Attribute Volumes". N. Nguyen, A. Jaramillo, 2021-INV-110418-WO01

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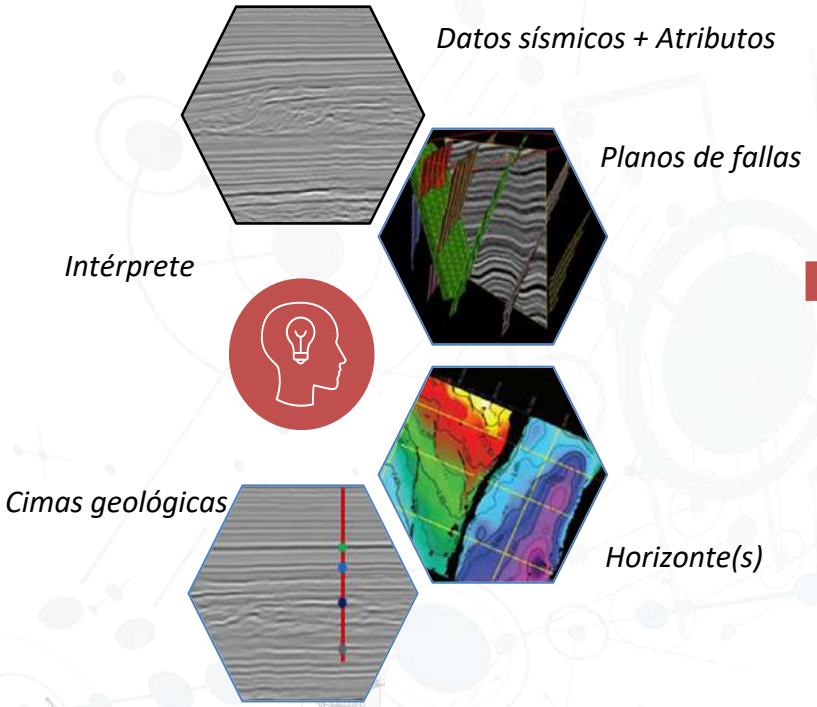
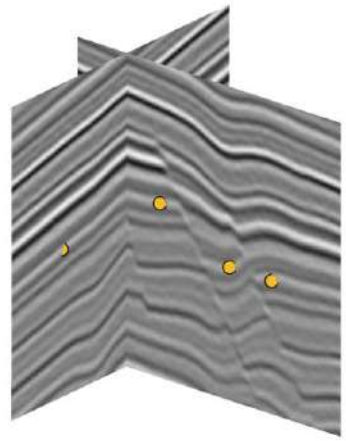
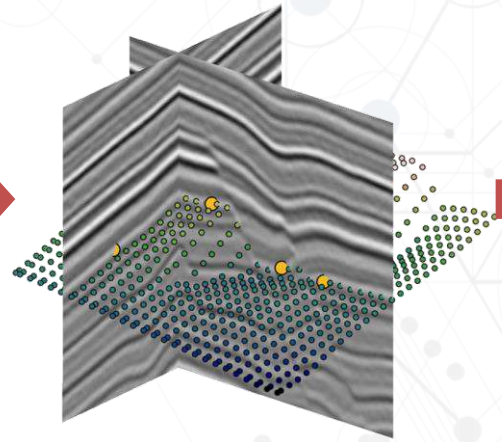
Interpretación asistida de horizontes



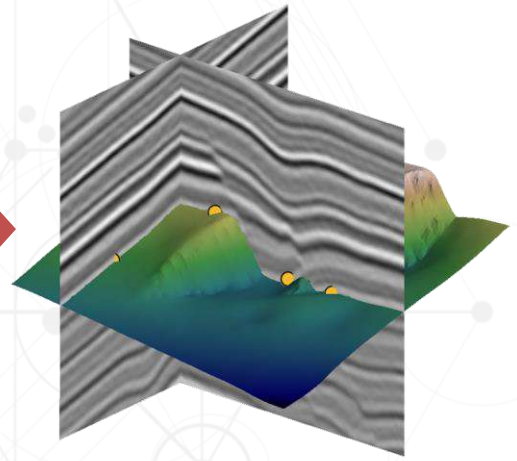
Aprovecha las interpretaciones existentes de pozos y sísmica



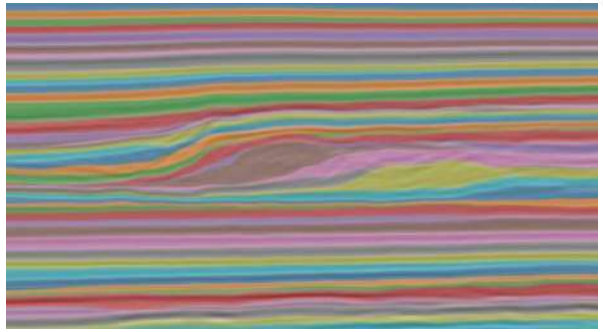
Optimización de horizontes



Seed points



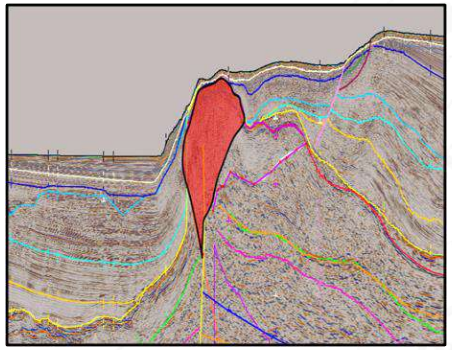
Generación de horizonte



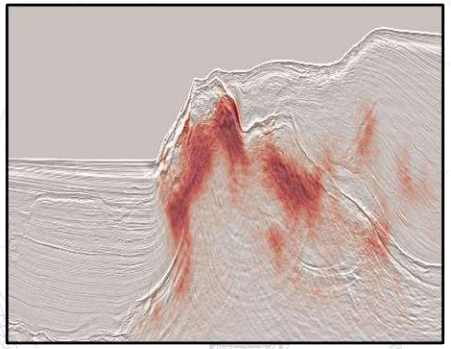
Generación densa de múltiples horizontes

Unlock the potential

Interpretación de Sal -Deep learning



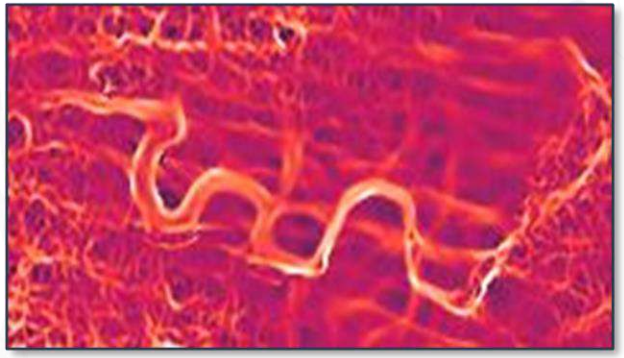
Interpretación Manual



Interpretación ML

Interpretación Probabilísitca de sal.
Multi- atributo, multi- canal, channel Deep Leaning (DL) supervisado.

Detección de Paleocanales -Unsupervised Machine Learning Clustering

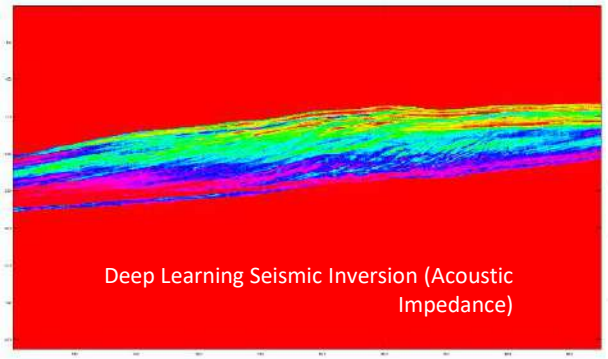


Atributo de Curvatura

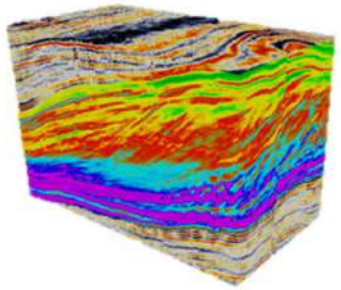
Resultados del Clustering

Interpretación de paleocanales profundos y someros, en geología compleja, en timepo y profundidad.

Deep Learning Seismic Inversion



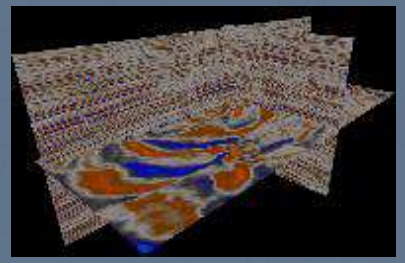
https://www.earthdoc.org/content/papers/10.3997/2214-4609.202310430



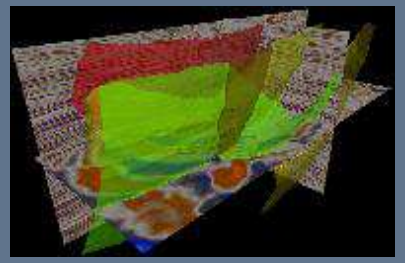
Acelera el proceso de predicción de Impedancia Acústica
Sin modelado de baja frecuencia

Interpretación tradicional

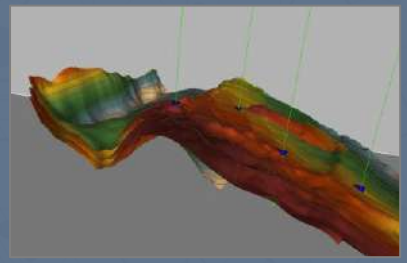
Análisis Manual de Atributos



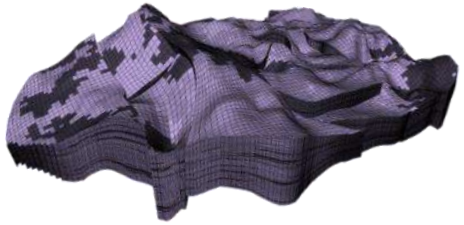
Interpretación manual de fallas



Interpretación manual de horizontes



Días/Semanas



Escenario 1

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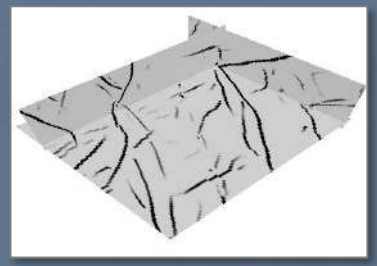
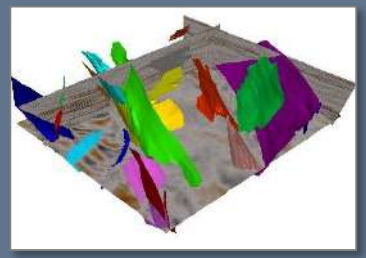
Geosciences Suite, una solución de DecisionSpace® 365

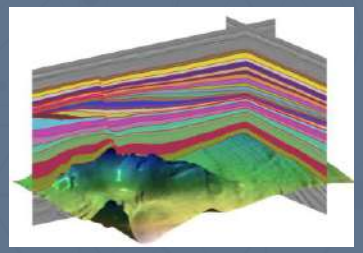
Análisis sísmico, automatizado, escalable



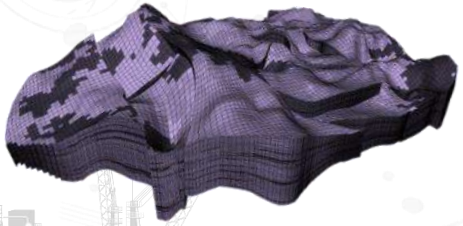
Interpretación asistida de fallas



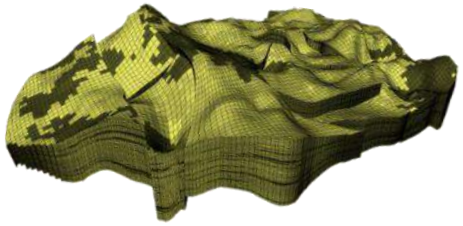
Interpretación asistida de horizontes



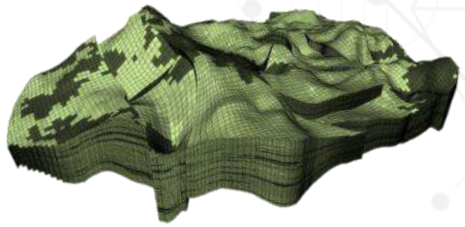
Minutos



Escenario 1



Escenario 2



Escenario 3

OSDU Open Subsurface Data Universe

iEnergy

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19 de abril de 2024

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Technical Sales Consultant
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HALLIBURTON

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19 de abril de 2024

APLICACIÓN DE SENSORES DE PRESIÓN Y TEMPERATURA DE FONDO INALÁMBRICO Y SISTEMA DE COMUNICACIÓN AUTÓNOMO

GRUPO PS®

Importancia de la información P-T

- **Mecánico:**
  - **Falla integridad de pozo**
  - **Falla de accesorios de producción**

- **Yacimiento:**
  - **Alcance de yacimiento**
  - **Permeabilidad**
  - **Daño de formación**
  - **Capacidad de flujo**

- **Producción:**
  - **Determinación de incrustaciones y asfáltenos**
  - **Determinación de infiltración de agua**
  - **Selección de estrangulador**
  - **Selección de sistema de levantamiento artificial**
  - **Optimización de desempeño de levantamiento**

¿ Por qué usar sensores de fondo P-T ?

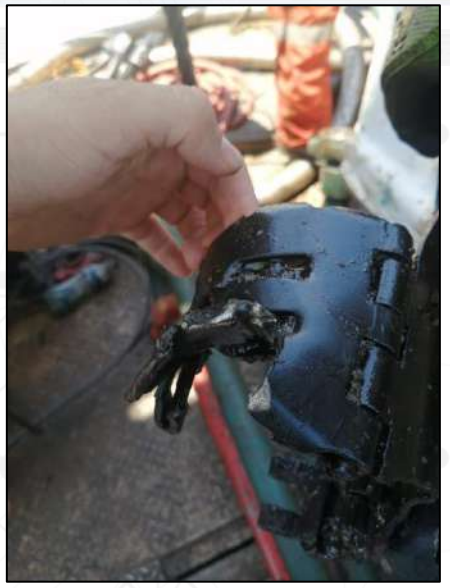
- Monitoreo y gestión de yacimientos
- Optimización de la producción
- Monitoreo de la integridad del pozo
- Detección temprana de problemas de producción
- Previsión y planificación de la producción
- Optimización de los sistemas de levantamiento artificial
- Caracterización del fluido del yacimiento
- Soporte para la selección de estrategias de recuperación mejorada
- Reducción de costos operativos
- Seguridad mejorada y desempeño ambiental
- Análisis constante de presión
- Toma de decisiones basada en datos

Proceso de instalación sensores convencionales

- **Equipos en superficie para instalación.**
- **Instalar sensor en tubería de producción.**
- **Asegurar el cable en tubería de producción.**
- **Instalar los accesorios de producción.**
- **Instalar los equipos de transmisión en superficie.**
- **Programación de los equipos para transmisión en tiempo real**
- **Verificar el funcionamiento del sistema integral**

Riesgos de los sensores convencionales

- **Entrenamiento del personal.**
- **Instalación de sensores con cable y grapas.**
- **Instalación de línea en accesorios de producción.**
- **Mantenimiento de equipos de apoyo.**
- **Problemas de confiabilidad debido a daños mecánicos y fallos eléctrico.**



Sensores inalámbricos

Arquitecturas Innovadoras

Las plataformas electrónicas líderes impulsan el ecosistema de sensores de fondo digitales.

Sistema de Transmisión

Transmite datos críticos de producción para el monitoreo de pozos terrestres (onshore) en tiempo real

Soluciones Versátiles

Nuestros sensores se adaptan tanto a entornos convencionales como no convencionales de alta presión y alta temperatura.

Tecnología patentada

Los datos se transmiten con una señal electromagnética inalámbrica a través de la formación

Tecnología Robusta

Diseño y Calidad de la tecnología resistente a entornos de hostiles de altas vibraciones.

Datos ininterrumpidos

Transmisión de datos durante años según la frecuencia de muestreo y la geología del subsuelo.

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Ventajas de los sensores inalámbricos

Diseño inalámbrico sin repetidores

No requiere calibración del pozo, producción o geología.

Múltiples programas de muestreo

Programas flexibles y variables para grandes volúmenes de datos de producción.

Transductor híbrido de alta calidad

Ofrece un rendimiento mejorado de P-T, vibración e Inclinación.

Sistema de Firmware Avanzado

Se centra en la supervisión del estado del diagnóstico del rendimiento del sistema.

Transmisión inalámbrica en tiempo real

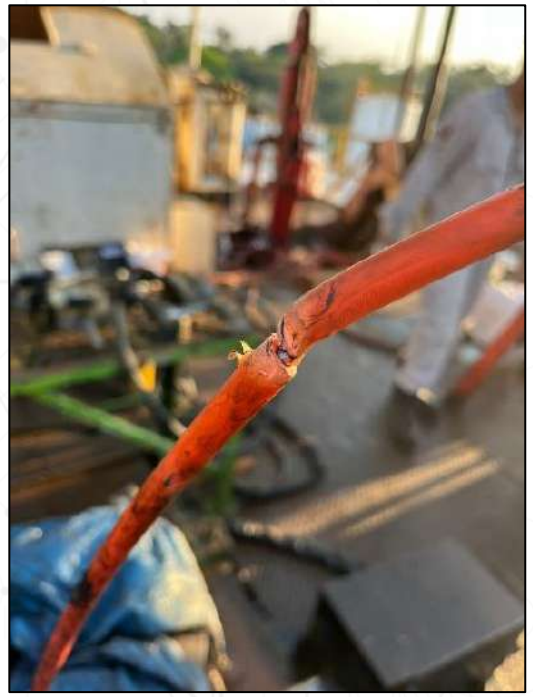
Para almacenamiento de datos de P-T, vibración e inclinación en Plsystem.

Bajo consumo de energía en fondo y Superficie

Gestión de frecuencia de muestreo para conservar la vida útil de la batería.

Sin cables - sin mandriles - sin complicaciones

- **No hay necesidad de accesorios y equipos para completar terminaciones complejas.**
- **Al eliminar la necesidad de cable, reduce los costos en tiempo y material de la terminación del pozo.**
- **Elimina fallas relacionadas con cables y puede simplificar las reparaciones.**
- **Solo se requiere enroscar el sensor inalámbrico en el extremo de la tubería de producción y colocar varillas (receptores) de tierra en la superficie para recibir la señal.**



Especificaciones técnicas

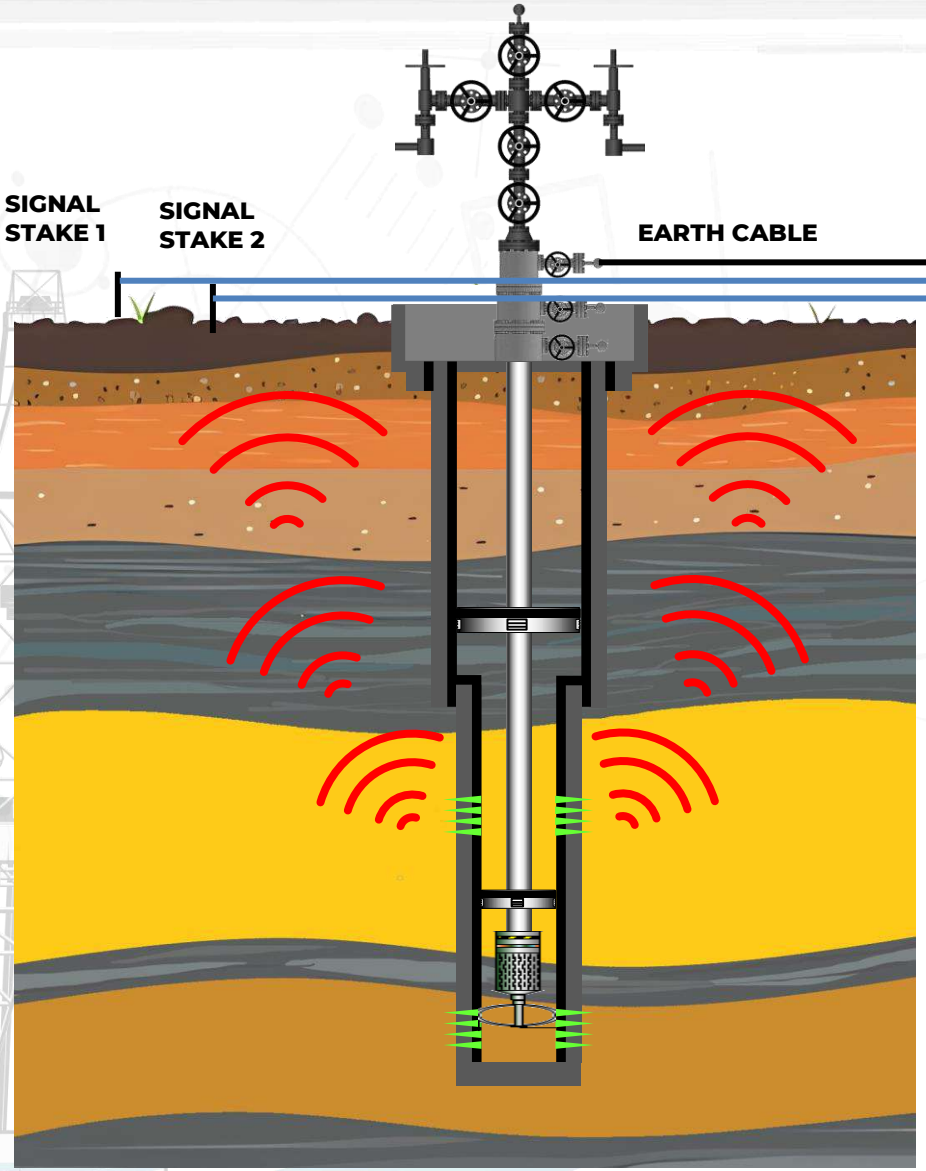
Especificaciones del sistema

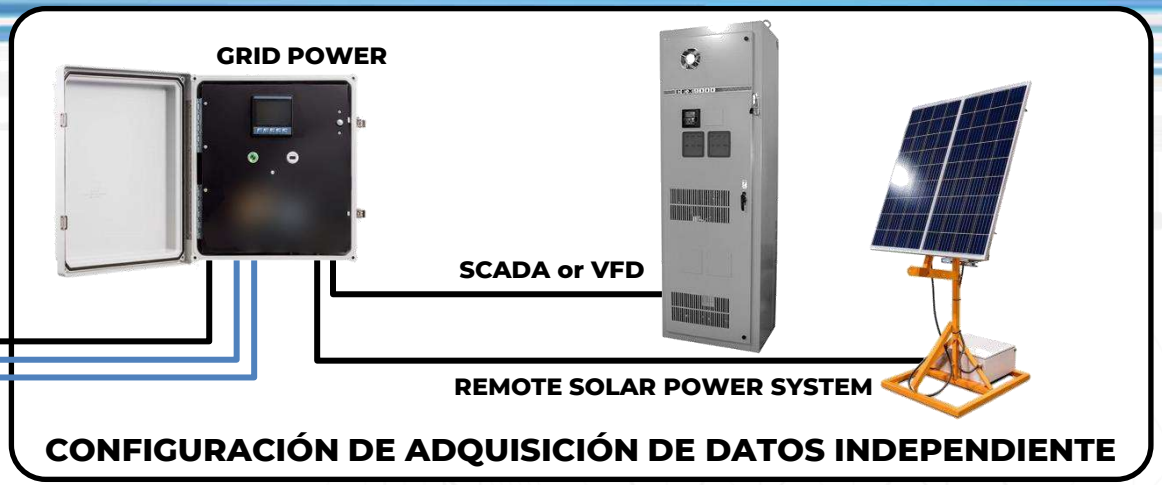
Tipo de sensor	Inalámbrico
Sensor	Sensor único
Medición	Temperatura - Presión - Inclinación – Vibración
Tubería	2 3/8" y 2 7/8"
Rosca	EUE 8 HRD o Premium
Máxima presión	10,000 psi
Máxima temperatura	125 °C

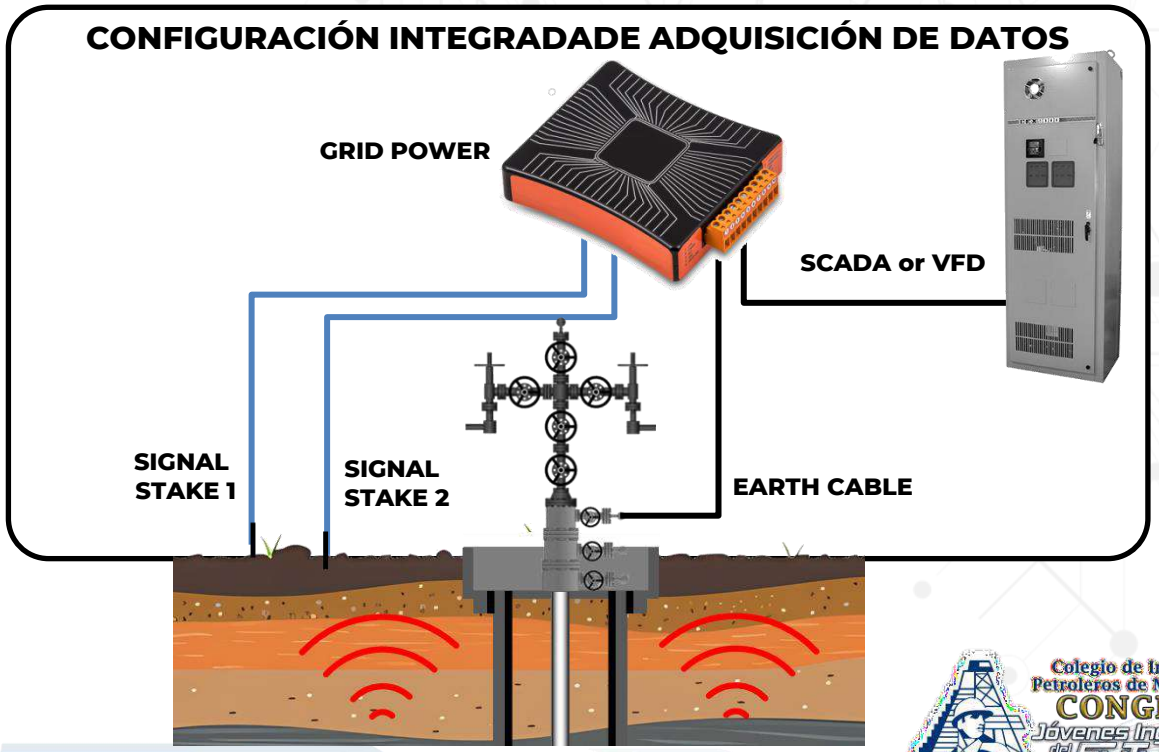
Cálculo de la vida útil

Frecuencia de muestreo	Toma de datos por día	Vida de la batería meses(años)	Total de muestras
1 hora	24	26.6 (2.21)	19,433
6 horas	4	65 (5.41)	7,908
24 horas	1	82.5 (6.87)	2,522

Transmisión de datos







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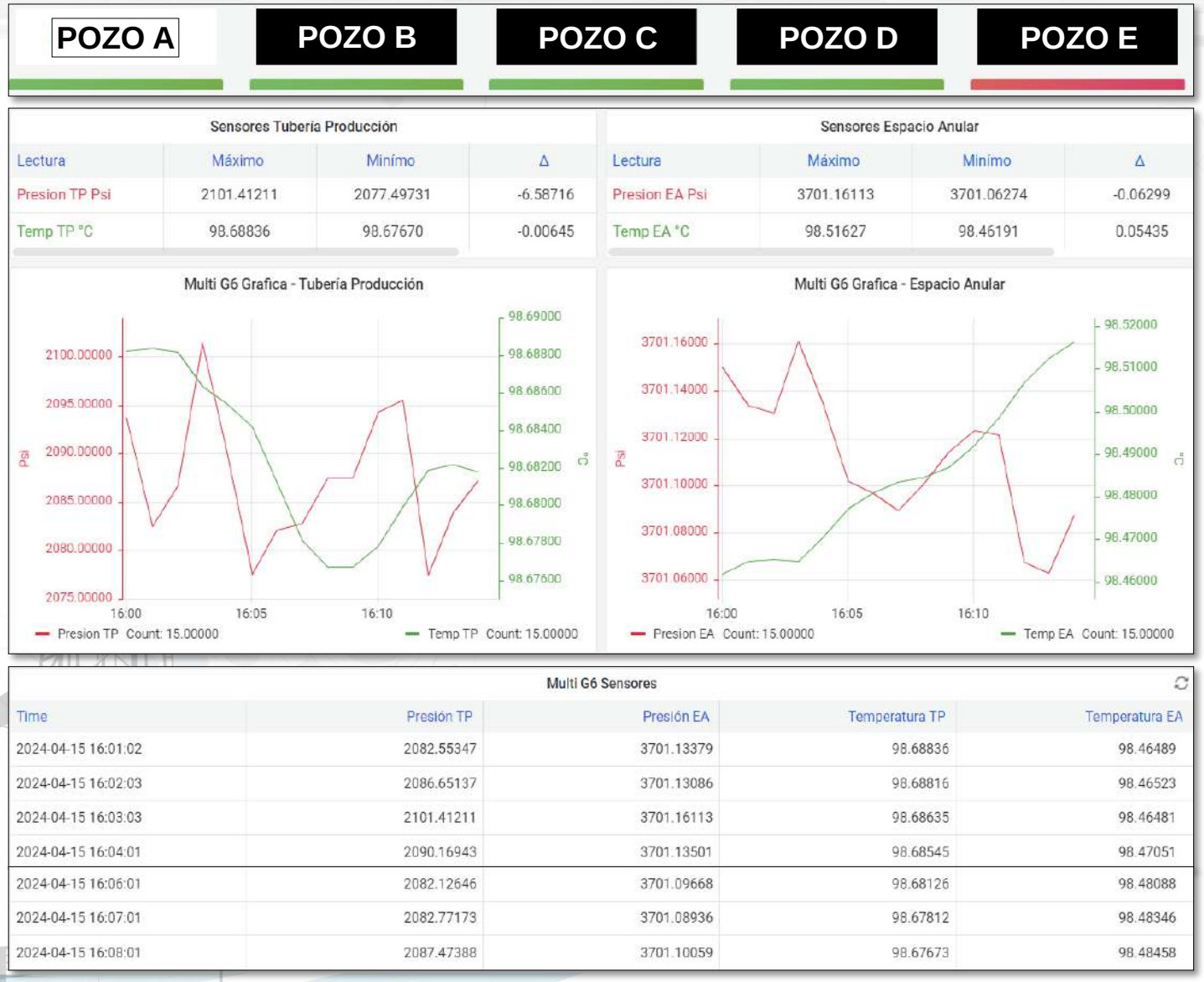
Visualización de los datos



Servicio de captura, recolección, transmisión a través de una plataforma de visualización en tiempo real.

- **Interpretación amigable**
- **Tiempos de carga mínimos**
- **Fiable**
- **Personalizable**
- **Garantiza la seguridad de datos**
- **Compatibilidad multiplataforma**
- **Asistencia técnica personalizada**

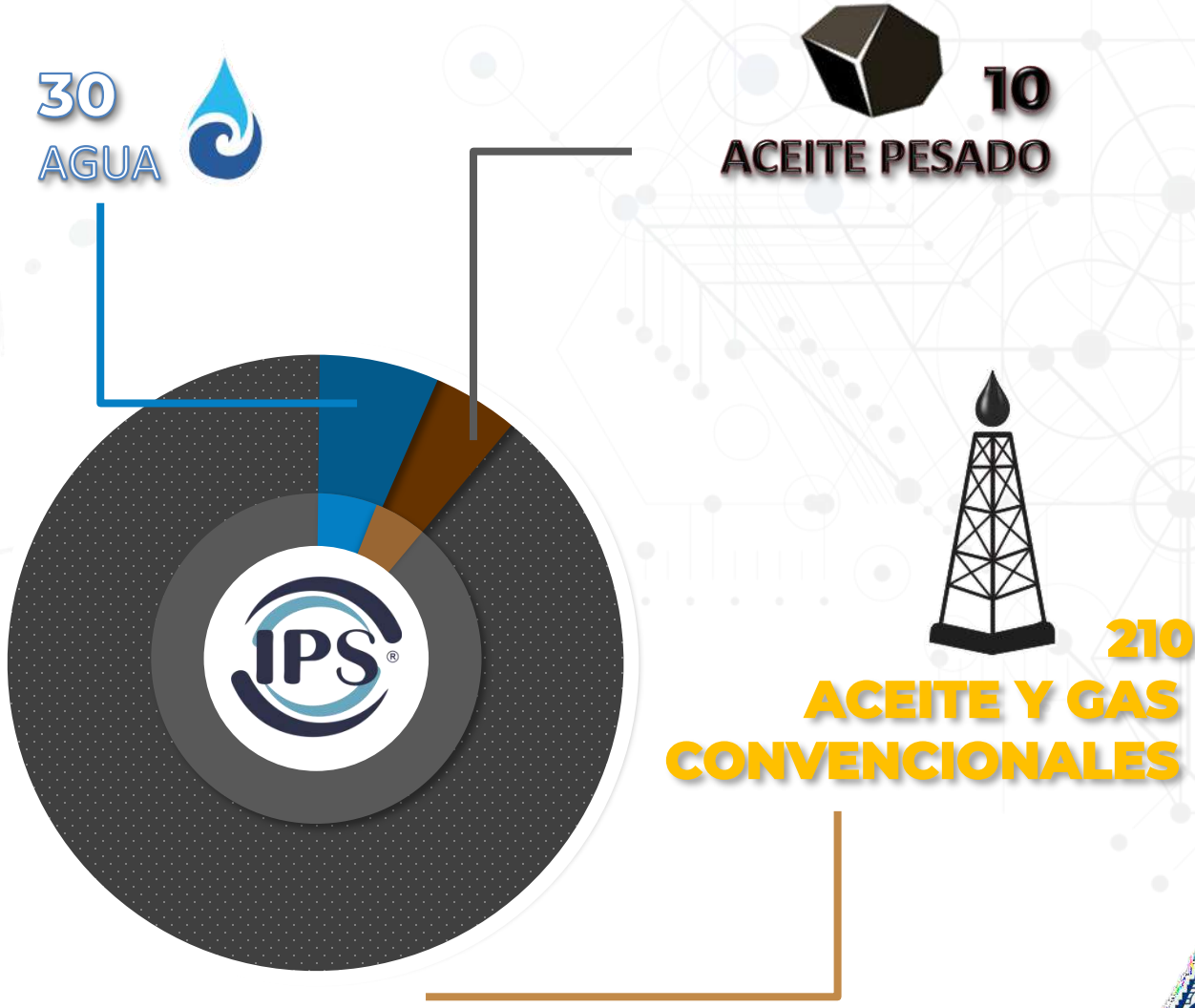
Pozos intervenido (2021-2024)

250 de trabajos realizados con un promedio de éxito del 100%

190 instalaciones en pozos de vibración extrema

Instalados a profundidades de 2,000 m

México cuenta con las condiciones para trabajar con sensores inalámbricos en pozos terrestres.



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WFRD-V3 Post Tool-Optimización de los tiempos de cementación de Liner y complemento.

Ing. Jose Antonio Patiño Delgadillo.
Gerente Técnico de ventas México para LH-CEM-OCHC.

Contenido

Nuestra Presencia en México.
Cementación multietapa para Liner y Complemento.
Cementación de liner y complemento vs V3 PT.
Animación paso a paso.
Propuesta de Valor.
Historial de trabajos.
Preguntas.

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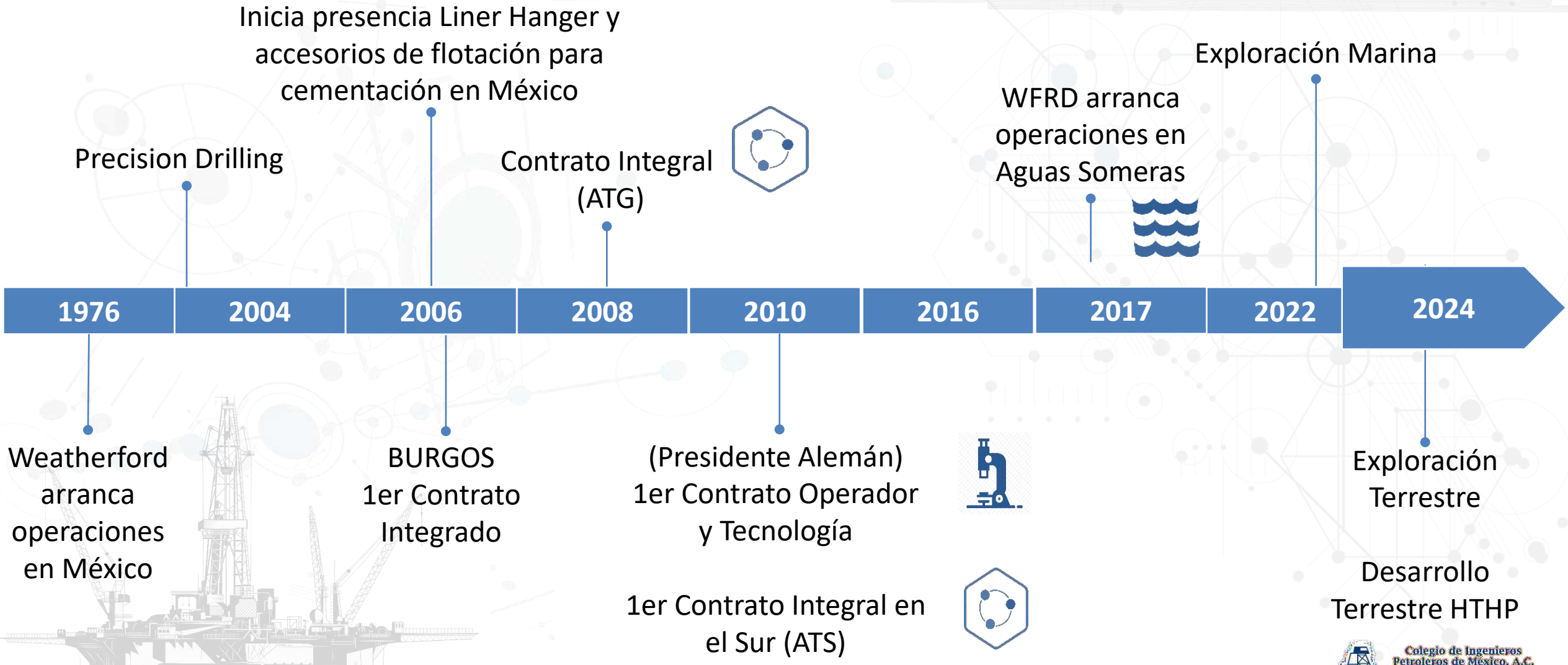
Nuestra Presencia en México



V3 POST TOOL – Cementación multietapa para Liner y Complemento

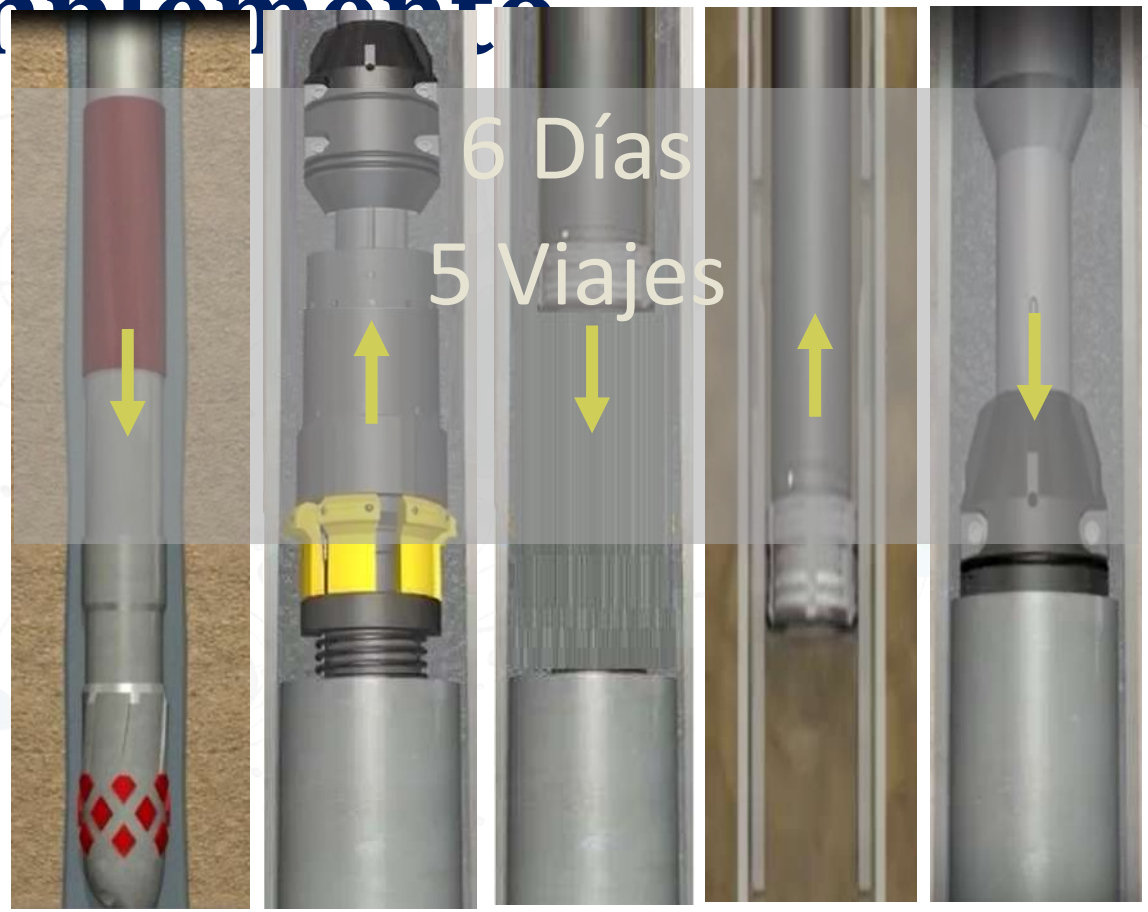
Los sistemas de cementación por etapas de Weatherford proporcionan reducción de tiempos operativos, asegura la integridad del cemento en pozos que requieren un aislamiento zonal selectivo. Ofrecemos tecnologías accionadas hidráulica y mecánicamente en sartas de revestimiento o Liner. Evitan la pérdida de circulación reduciendo la presión hidrostática total en zonas sensibles, a la vez que proporcionan un aislamiento al gas para garantizar la integridad del pozo durante toda su vida útil.

Retos del sector abordados:

- ✓ Reducción de hasta 5 días del tiempo de reparación (al menos $160.000 dólares por día).
- ✓ Reducción del riesgo operativo.
- ✓ Sistema multietapa con revestimiento integral.
- ✓ Sello secundario de cemento para sistemas de complemento en un solo viaje.
- ✓ Sistema con Alto Colapso y estallido.
- ✓ Sistema de sello con validación V0.
- ✓ Zonas de Aislamiento (Agua / Gas / Aceite). Zonas Corrosivas.

CMP2024_312

Cementación de liner y complemento



6 Días

5 Viajes

Colgador/Liner Introducción y Cementación.

Recuperación de herramienta soltadora.

Viaje de limpieza y confirmado de Boca de Liner.

Recuperación de sarta de limpieza.

Introducción de complemento y cementación.

VS

V3 POST TOOL

01 viaje.

02 días.

Propuesta de Valor

60 a 65%

Etapa Liner y complemento

↓ Reducción del tiempo de equipo perforación de hasta **4 días.**

↓ Herramienta para conformar BL **no requerida.**

↓ Viaje de complemento **no requerido.**

↓Instalación y desinstalación de unidades de cementación para complemento **no requerido.**

↑ Mejora en los indicadores de desempeño **KPI.**

↓ Riesgos operativos y pérdida de herramientas (LIH) **Mitigado.**

↓ Horas hombre.

3 a 5%

Inicio de la producción

↓ Reducción de **costo por barril.**

↑ Producción adelantada.

↓ Consumo de Energía **(Huella de carbón).**

↑ ROI (Retorno de la inversión).

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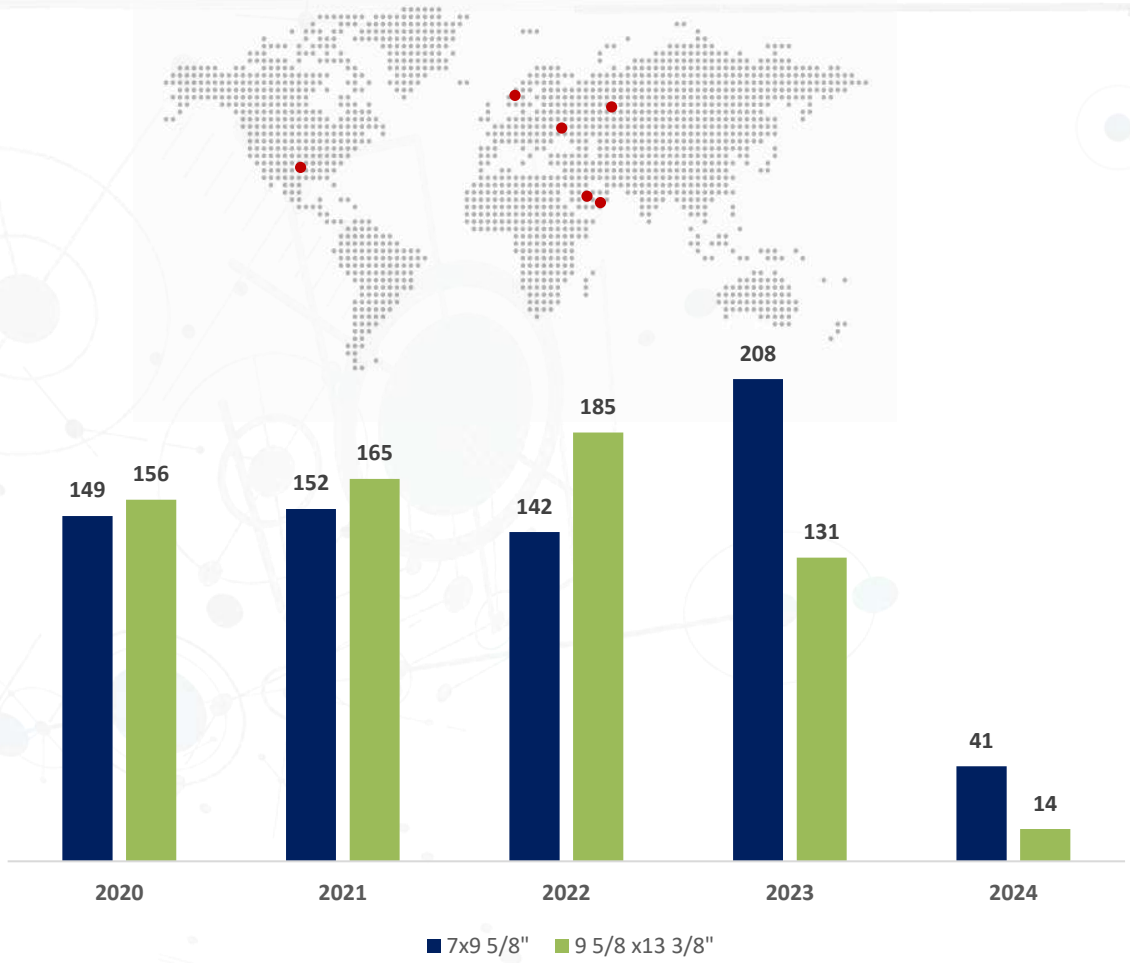
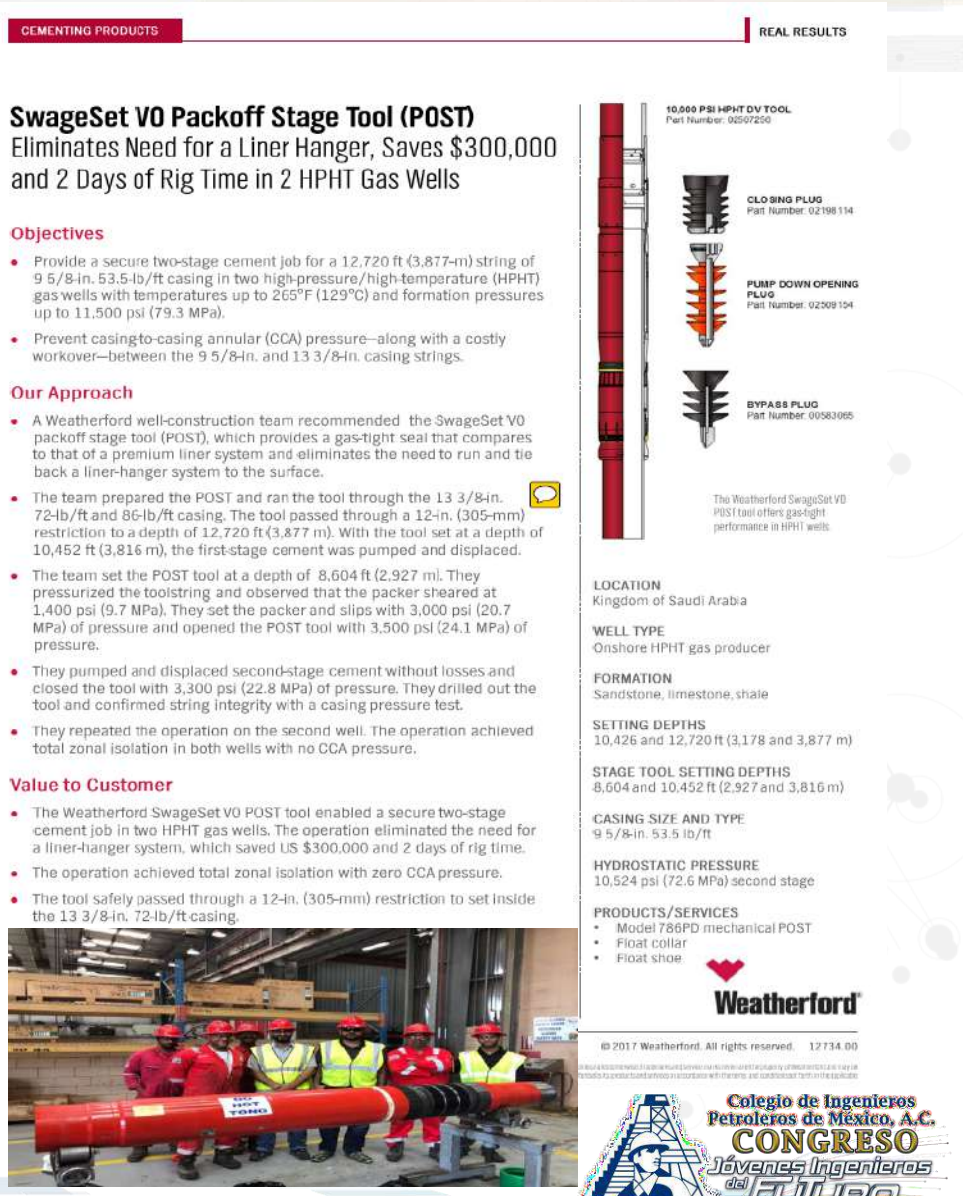
Historial de trabajos



Más de **800 trabajos** en los últimos 5 años.

Con una **confiabilidad** del 98.5%



CEMENTING PRODUCTS

REAL RESULTS

SwageSet V0 Packoff Stage Tool (POST)

Eliminates Need for a Liner Hanger, Saves $300,000 and 2 Days of Rig Time in 2 HPHT Gas Wells

Objectives

- Provide a secure two-stage cement job for a 12,720 ft (3,877-m) string of 9 5/8-in. 53.5-lb/ft casing in two high-pressure/high-temperature (HPHT) gas wells with temperatures up to 265°F (129°C) and formation pressures up to 11,500 psi (79.3 MPa).
- Prevent casing-to-casing annular (CCA) pressure—along with a costly workover—between the 9 5/8-in. and 13 3/8-in. casing strings.

Our Approach

- A Weatherford well-construction team recommended the SwageSet V0 packoff stage tool (POST), which provides a gas-tight seal that compares to that of a premium liner system and eliminates the need to run and tie back a liner-hanger system to the surface.
- The team prepared the POST and ran the tool through the 13 3/8-in. 72-lb/ft and 86-lb/ft casing. The tool passed through a 12-in. (305-mm) restriction to a depth of 12,720 ft (3,877 m). With the tool set at a depth of 10,452 ft (3,816 m), the first-stage cement was pumped and displaced.
- The team set the POST tool at a depth of 8,604 ft (2,927 m). They pressurized the toolstring and observed that the packer sheared at 1,400 psi (9.7 MPa). They set the packer and slips with 3,000 psi (20.7 MPa) of pressure and opened the POST tool with 3,500 psi (24.1 MPa) of pressure.
- They pumped and displaced second-stage cement without losses and closed the tool with 3,300 psi (22.8 MPa) of pressure. They drilled out the tool and confirmed string integrity with a casing pressure test.
- They repeated the operation on the second well. The operation achieved total zonal isolation in both wells with no CCA pressure.

Value to Customer

- The Weatherford SwageSet V0 POST tool enabled a secure two-stage cement job in two HPHT gas wells. The operation eliminated the need for a liner-hanger system, which saved US $300,000 and 2 days of rig time.
- The operation achieved total zonal isolation with zero CCA pressure.
- The tool safely passed through a 12-in. (305-mm) restriction to set inside the 13 3/8-in. 72-lb/ft casing.

10,000 PSI HPHT DV TOOL
Part Number: 02507250

CLOSING PLUG
Part Number: 02198114

PUMP DOWN OPENING PLUG
Part Number: 02509104

BYPASS PLUG
Part Number: 00583065

The Weatherford SwageSet V0 POST tool offers gas-tight performance in HPHT wells.

LOCATION
Kingdom of Saudi Arabia

WELL TYPE
Onshore HPHT gas producer

FORMATION
Sandstone, limestone, shale

SETTING DEPTHS
10,426 and 12,720 ft (3,178 and 3,877 m)

STAGE TOOL SETTING DEPTHS
8,604 and 10,452 ft (2,927 and 3,816 m)

CASING SIZE AND TYPE
9 5/8-in. 53.5 lb/ft

HYDROSTATIC PRESSURE
10,524 psi (72.6 MPa) second stage

PRODUCTS/SERVICES
- Model 786PD mechanical POST
- Float collar
- Float shoe

Weatherford

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Colegio de Ingenieros Petroleros de México, A.C.
19 de abril de 2024

Preguntas

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Colegio de Ingenieros Petroleros de México, A.C.

19 de abril de 2024

Revolucionando la Ingeniería Petrolera: Machine Learning, Inteligencia Artificial y nuevas tecnologías

Cesar Pulido

Digital Solutions Director Americas

Baker Hughes

Agenda

- Overview of Baker Hughes
- What is AI & ML ?
- AI in action @ Baker Hughes
- Some references.....where to go
- Q&A

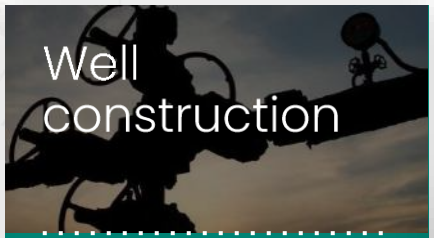
Baker Hughes

Our business segments

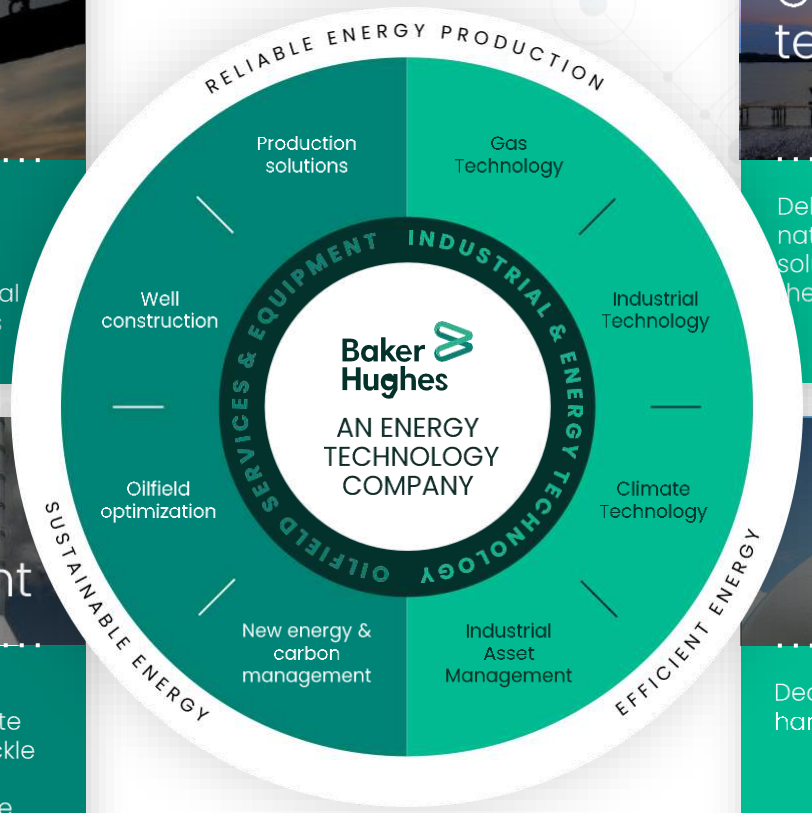
Production solutions

Smart integrated well solutions for optimized, reliable operations and production for our customers day in, day out

Well construction



We bring wells from appraisal to production quickly, efficiently, and sustainably for operational and commercial success



Gas technology

Delivering leading reliable natural gas and LNG solutions that operate at the highest efficiency

Industrial technology

Improving industrial productivity and ensuring reliable quality and safety

Oilfield optimization

Integrated production and intervention management solutions drive field-wide efficiencies and reduce emissions for optimal recovery

New energy & carbon management

Digitally enabled technologies to accelerate geothermal solutions, tackle emissions from energy infrastructure and provide storage and management solutions for hard-to-abate sectors

Climate technology

Decarbonizing energy and hard-to-abate industries

Industrial asset management

Driving more intelligent operations with industrial & energy asset performance management and process optimization

We take energy forward—making it safer, cleaner, and more efficient for people and the planet

120+
countries

~55,000
employees

$556M
in research and development

2,200
patents granted

What is Artificial Intelligence (AI) and Machine Learning (ML) ?

AI

Dat

Science

People

Predictive Analytics

Gen AI

ML

What is Artificial Intelligence (AI) and Machine Learning (ML)?

Logic-based algorithms represent the core of traditional programming. Computer Scientists were trained to think of algorithms as a logical series of steps or processes that can be translated into machine understandable instructions and used to solve problems.

AI algorithms enable new classes of problems to be solved by computational approaches faster, with less code, and more effectively than traditional programming approaches. Image classification tasks, for example, can be completed with over 98% less code when developed using machine learning versus traditional programming

There are different sub-fields within specialty AI, including ML, optimization, and logic. ML describes a class of algorithms which leverages powerful statistical learning techniques that operate on data. The power of machine learning is that the algorithms can be quite generic; just a few algorithms can address and solve many problems. Additionally, ML algorithms can learn from data, and can therefore reduce the need for complex logic and code

ML algorithms take a different approach from traditional logic-based approaches. ML algorithms are based on the idea that, rather than code a computer program to perform a task, it can instead be designed to learn directly from data.

What is Machine Learning (ML) and Artificial Intelligence (AI)?

Machine Learning

Approaches	Classification	Regression	Unsupervised Learning: Dimensionality Reduction	Unsupervised Learning: Clustering	Reinforcement Learning[8]: Decision-making
Traditional Algorithms	• Support vector machines (SVM) • XGBoost • Gradient-boosted decision trees (GBDT) • Random forest	• Linear regression • Ridge regression • Random forest	• Principal component analysis (PCA)	• K-means • Gaussian mixture model (GMM) • Density-based special clustering (DBSCAN)	• Monte Carlo • Markov decision process • Temporal difference learning
Deep Learning Algorithms *(examples of neural networks)*[9]	• Multi-layer perceptrons (MLPs) • Convolutional networks • Long short-term memory (LSTM)	• Multi-layer perceptrons (MLPs) • Convolutional networks	• Auto-encoders	• Deep Gaussian mixture model (DGMM)	• Deep Q-learning • Hidden Markov models (HMM)

BakerHughesC3.ai

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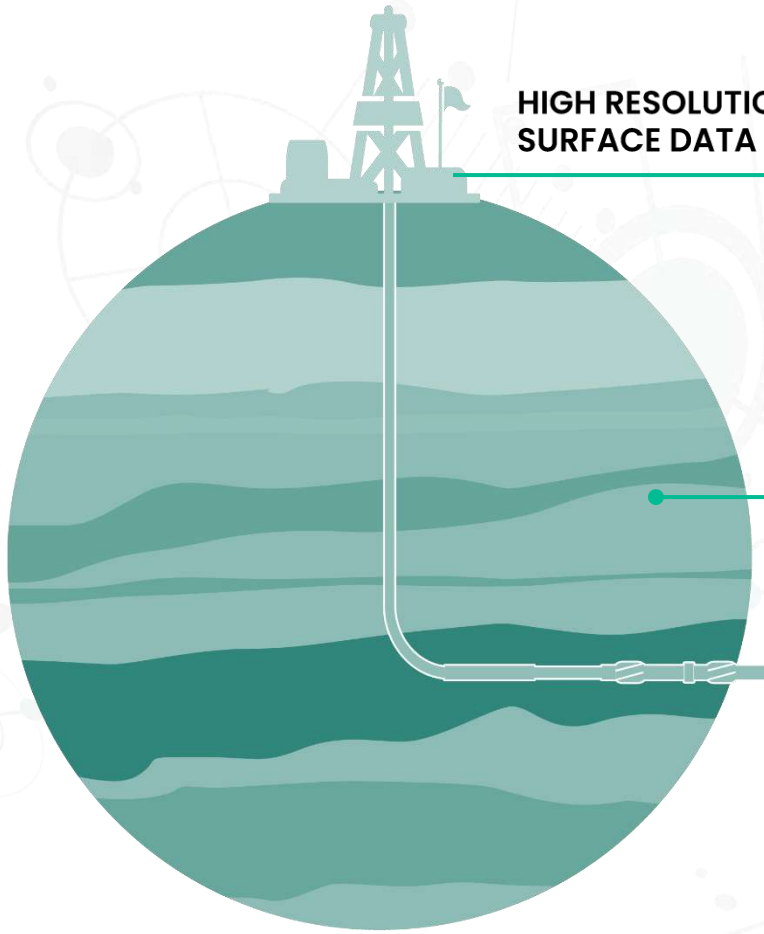
AI in action @ Baker Hughes

The Ecosystem



HIGH RESOLUTION SURFACE DATA

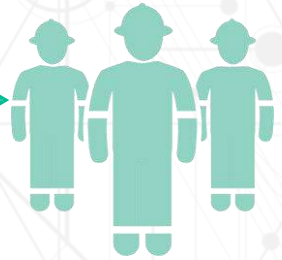
- Cloud-based scalable data architecture
- Match surface data, formation characteristics, and downhole data
- Automated data cleansing

WELL DESIGN AND FORMATION DATA

DOWNHOLE DATA

ANALYTICS AND VISUALIZATION

SME INSIGHTS AND ACTIONS



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i-Trak™ – the industry's largest portfolio of automated monitoring, advisory and autonomous control applications fully integrated with digital pre-well planning and customer platforms

Deployed on
200+
rigs globally

More than
>1.5M
meters drilled

Rig control

Partnerships with NOV, HMH, Bentec and others.

Worlds first

automated reservoir navigation system

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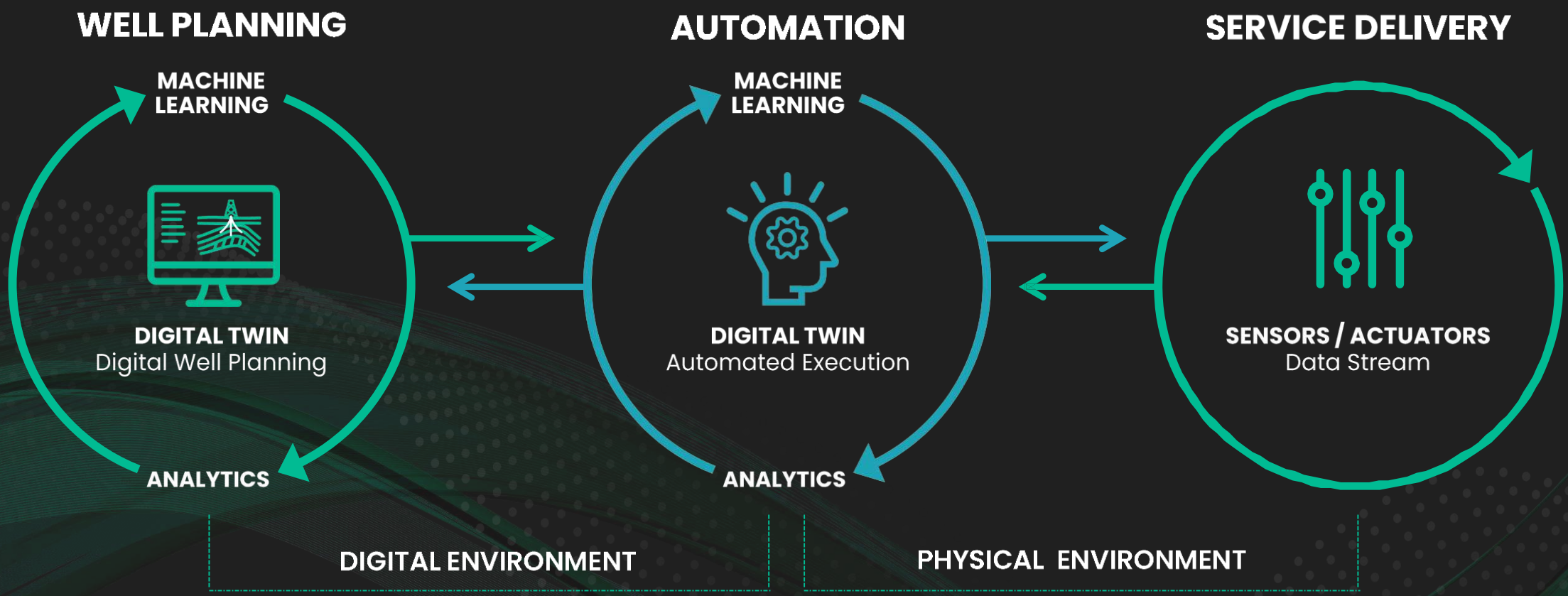
Pre-job digital models drive service delivery



An end-to-end digital ecosystem spanning the full well construction value chain, seamlessly interfaced with your E&P digital platforms

E&P Planning applications (petrophysical, well design, drilling engineering etc.)

WITSML data-stores or other data-lakes

3rd party monitoring applications

3rd party sensors & services

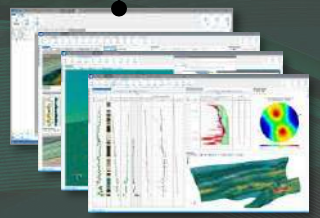
Customer Enterprise Systems

Interoperability - common data models and communications protocols

Baker Hughes Digital Ecosystem

Pre-job	Real-time – Remote	Real-time - EDGE

Technical planning: JewelSuite Drilling Engineering



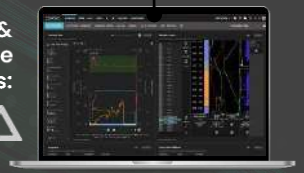
Technical planning: JewelSuite Applications; Subsurface modelling, Geomechanics, Reservoir Stimulation & offset analysis

Planning orchestration: Well Engineering Center

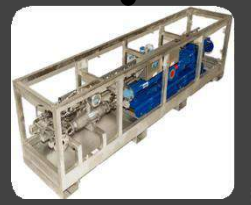
Digital Twin: JewelSuite Drilling Eng. RT

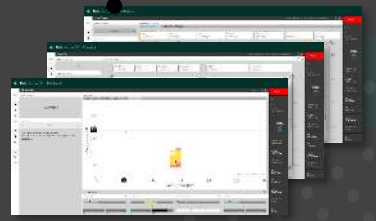
Automated Advisory: i-Trak

Monitoring, KPIs & performance analytics: CORVA

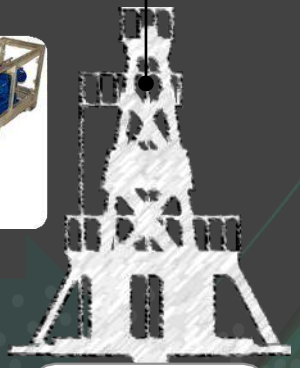


Automated Fluid Monitoring: i-Trak





Automated Control: i-Trak



Rig systems: Rig OS & ADCS Systems

D-WIS

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Leucipa is laser focused on what will improve your business

Increasing production

Maximize pump, well, and field-level performance and production outcomes

+

Reducing lifting costs

Consume fewer resources and minimize repair or workover costs

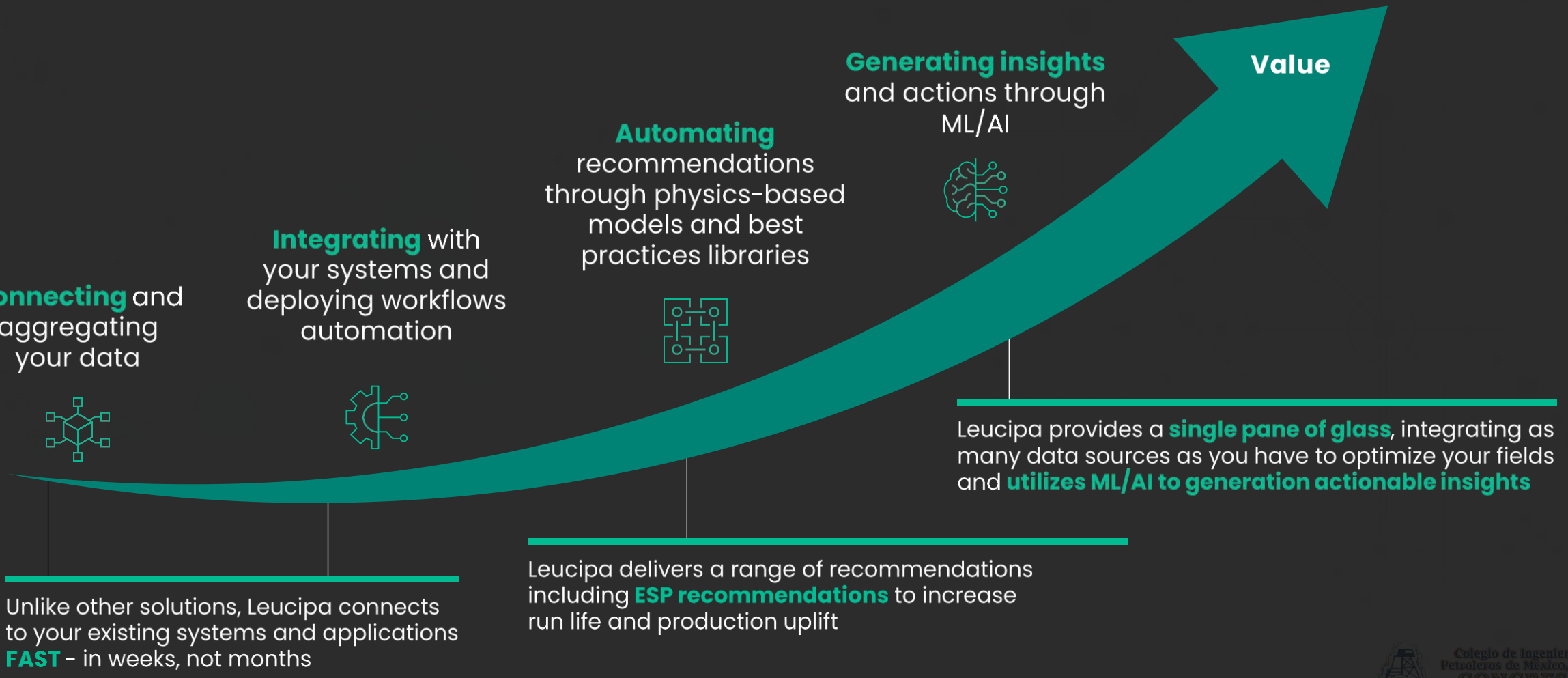
+

Achieving emission goals

Optimize power consumption and increase efficiency of operations

TRUSTED OUTCOMES WITH AUTOMATION

Leucipa is a state-of-the-art automated field production solution that delivers unparalleled value by



Integrate our systems to enable production automation

Leucipa brings full Field Optimization boosting production, increasing assets' run-life, while reducing emissions and operating costs

This requires visibility across multiple data sources and systems, field-level job ranking and scheduling as well as orchestration across 6 different disciplines:

Artificial lift
Production optimization and predictive failure analytics for multiple artificial lift types

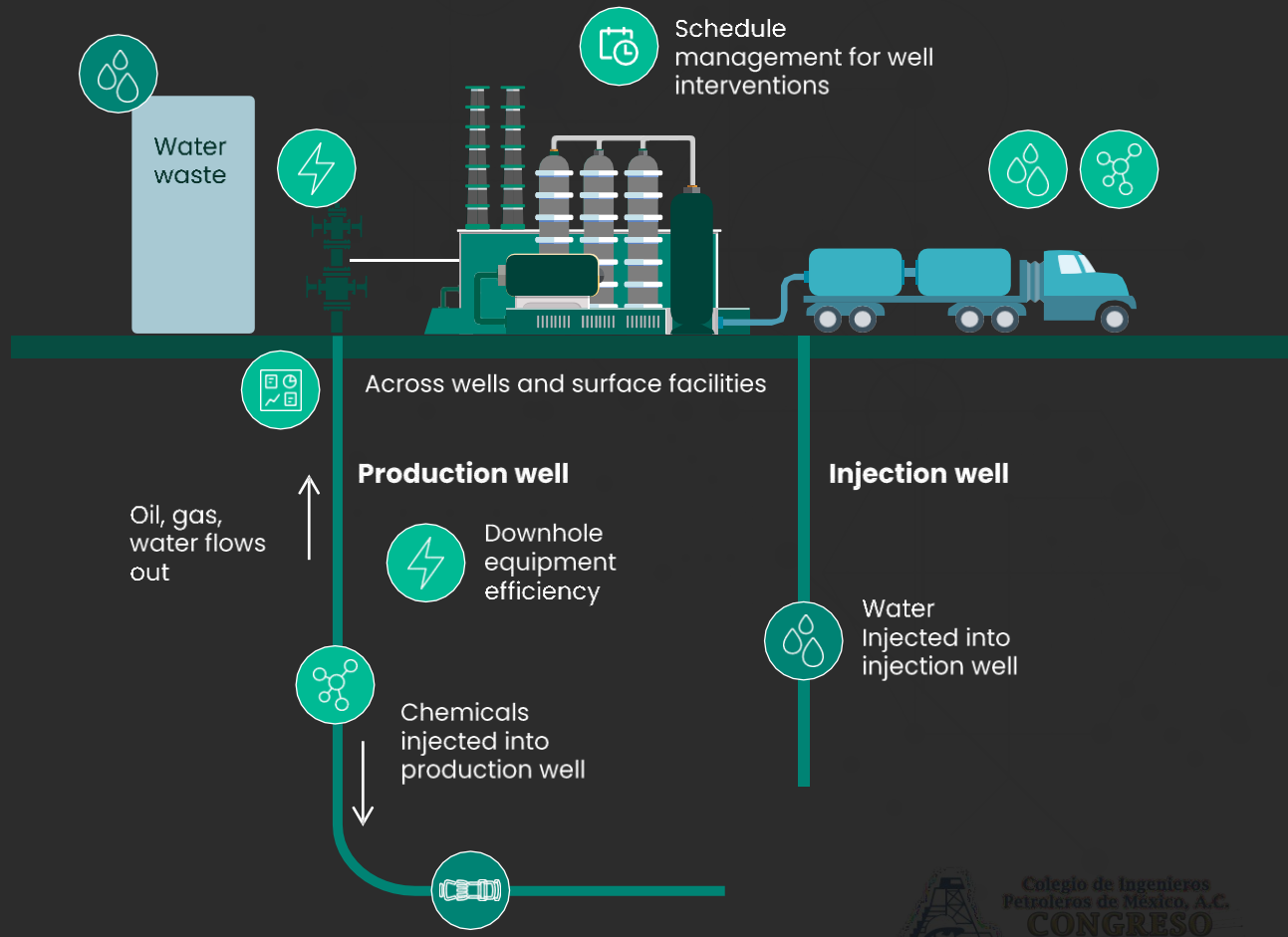
Life of field activity scheduling
Management tool with core field metrics and prioritization of work schedules

Chemicals
Service integration to drive equipment reliability and lower cost of treatment

Field intelligence
Advanced analytics to predict interactions of wellbores and surface facilities

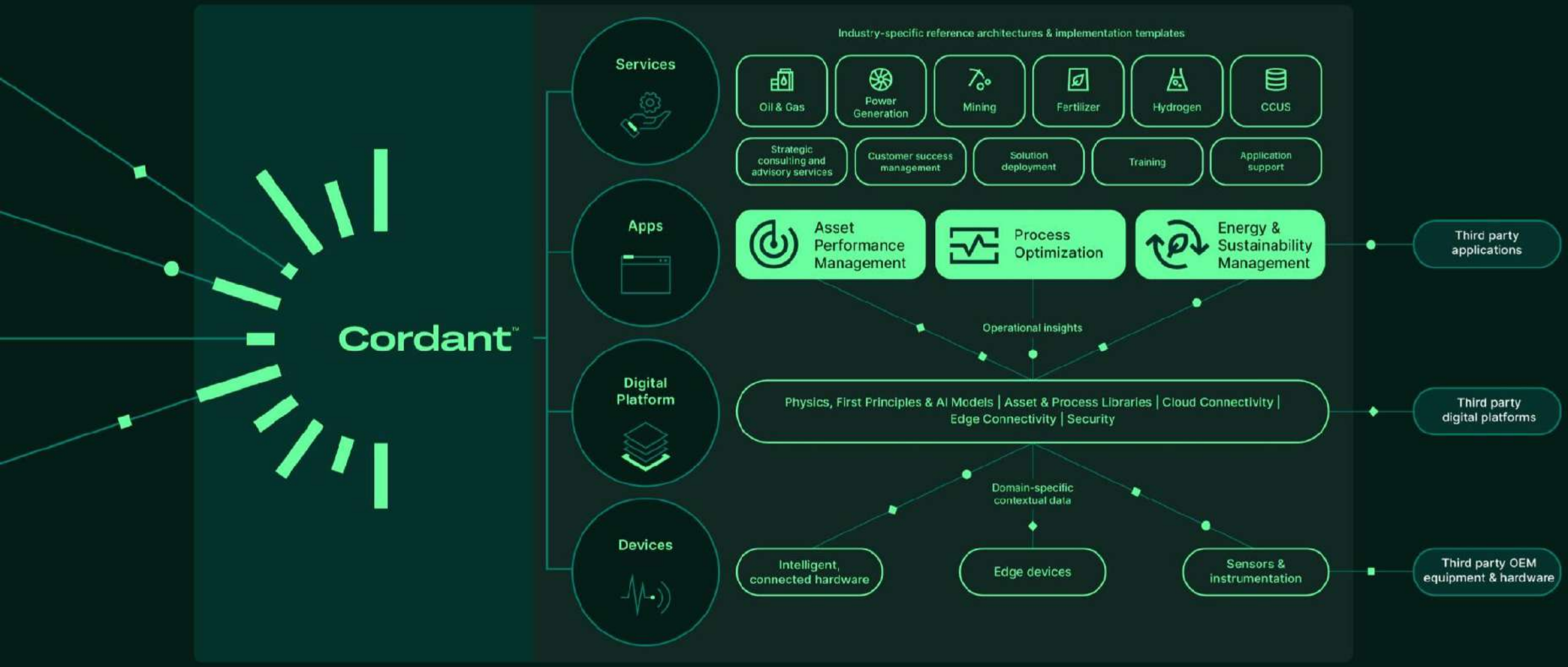
Fluids handling
Field-level water handling enhancement and throughput using well data

Power & Emissions
Optimizing for lowest power cost per barrel produced Emissions forecasting, tracking and optimization



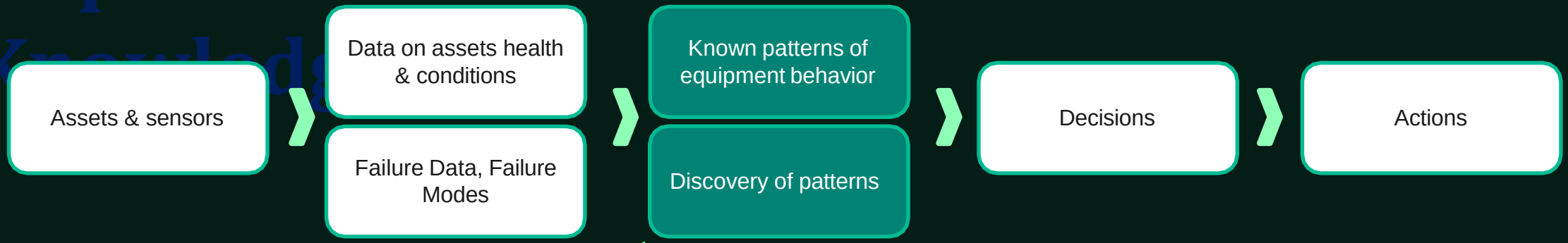
Cordant™ Solutions

Amplifying performance through digital technologies



Predictive Maintenance requires Data and Knowledge

Monitoring, Investigation, Predictions, Conclusions



Traditional approach

Physics-based / Rules-based models

Use physics equations or rules to describe behavior

- High level of explainability
- Very accurate if **failure is known**
- Needs deep understanding of assets
- **Specific for equipment types**
- **May not factor in process influence** and complex dynamics
- **Very high maintainability** by humans

Data-driven approach

Machine Learning models

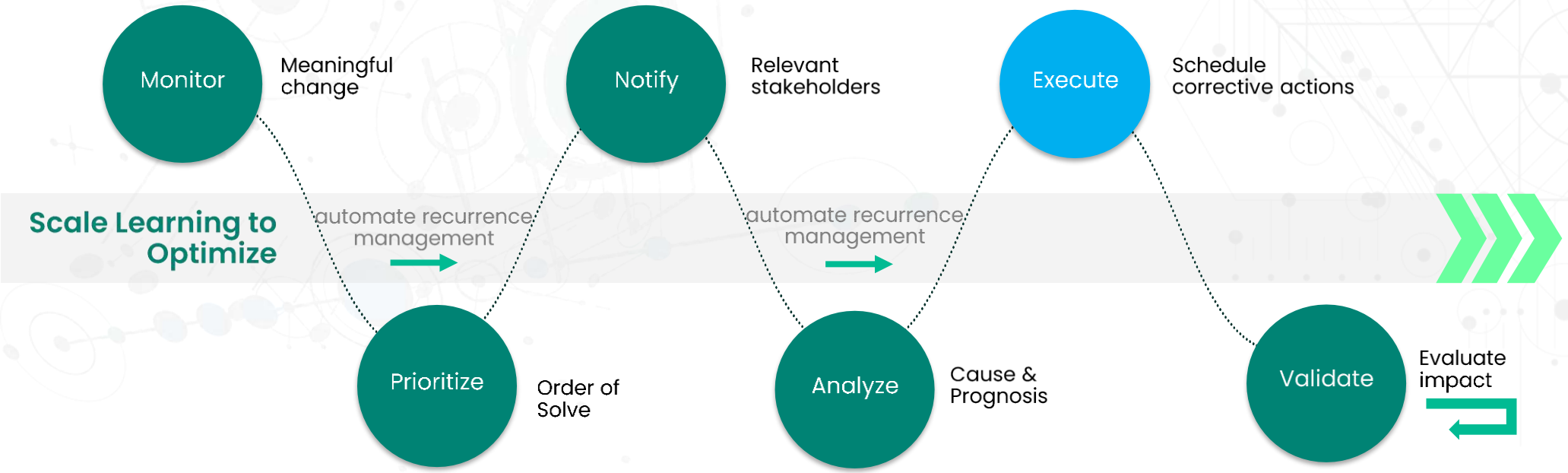
Discover patterns in the data and associate them with certain behavior

- Works for **known and unknown failures**
- Requires **high volume** of **good quality data**
- Can **combine process data** with equipment data easily
- Suitable for **complex multivariate behavior modeling**
- Can combine physics in the ML models
- Easier maintainability with higher scalability

Cordant™

Holistic asset health management

System-driven consistent and collaborative work practice with analytic supported continuous improvement workflow



55%

reduction **in machine failures**

30%

improvement **in machinery availability & life**

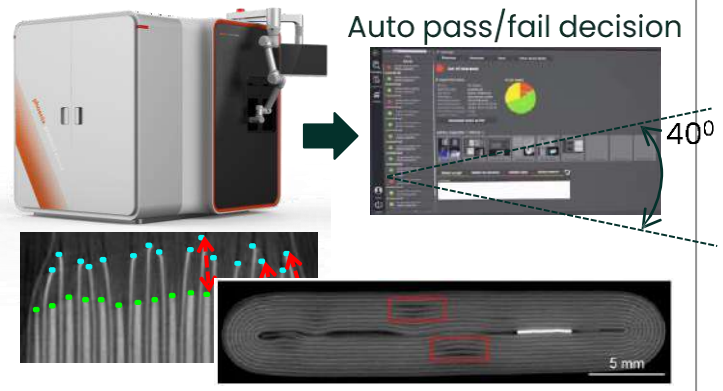
40%

reduction **in unplanned downtime**

Other examples of Data Science & AI at Baker Hughes

Intelligent Inspection

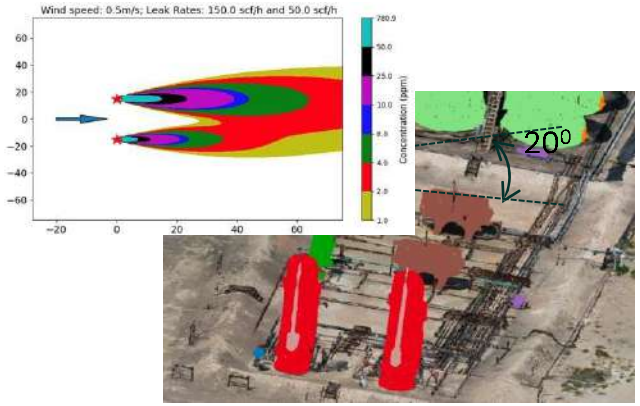
Waygate



- Deep learning-based computer vision models trained to automatically detect defects in visual, CT and X-ray inspections
- Perform quantitative analysis and compare against QC standards
- 95% analysis time savings

Emission Management

Avitas



- Hybrid data & physics-based algorithm to model plume dispersion from point sources
- Ability to localize methane leaks on site considering wind and multiple leak sources
- Automated UAV-based inspection of wellsites

Predictive Failure & Anomaly Detection

Asset Health

- Machine Learning-based analytics
- Asset Failure Prediction using current and historical operation data from sensors
- Anomalous Event Alerts with remedies to minimize premature failures and extend equipment run life

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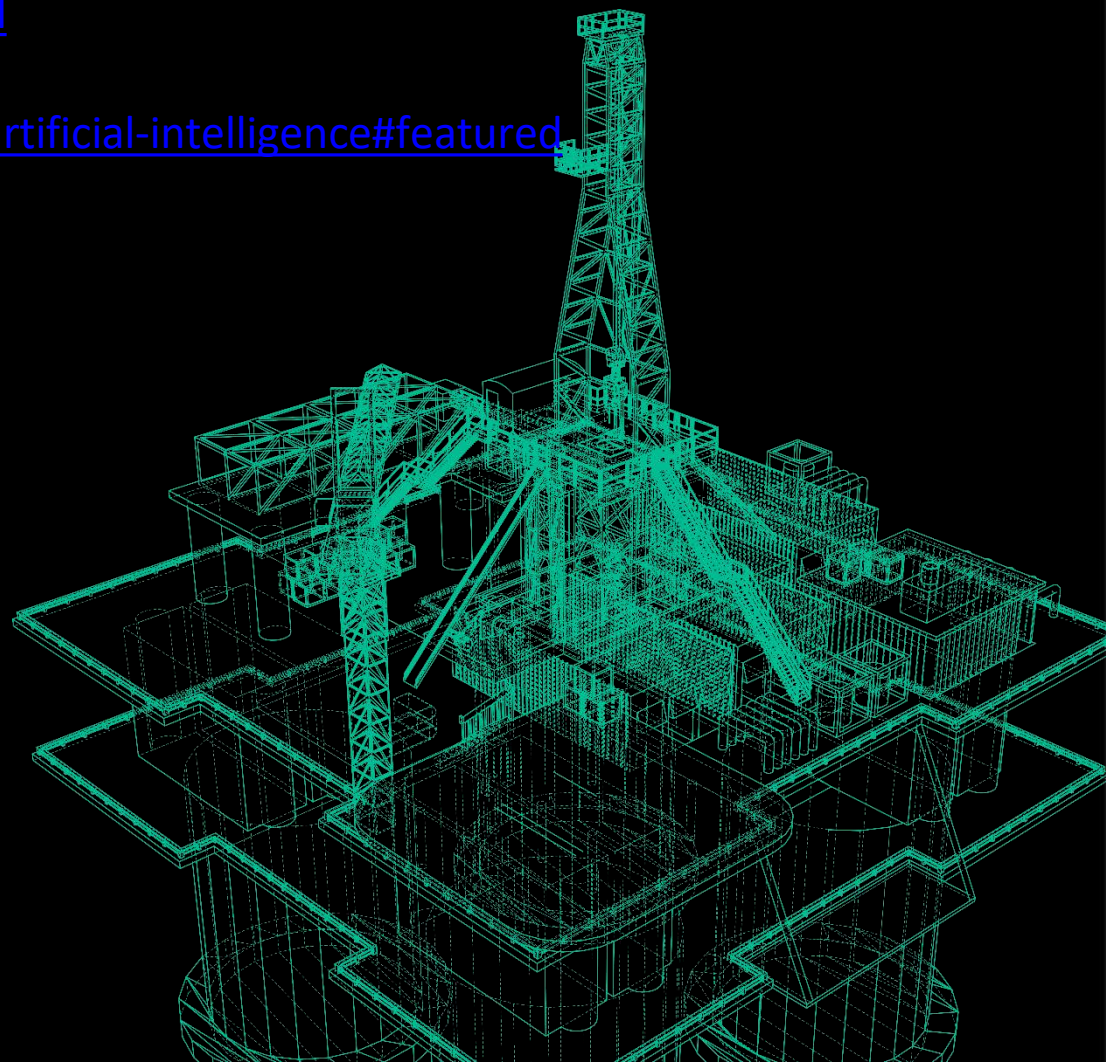
Some references …..Where to go

https://www.bakerhughes.com/oilfield-services-and-equipment-digital

https://www.bakerhughes.com/cordant https://www.edx.org/learn/artificial-intelligence#featured

https://sloanreview.mit.edu/video/how-to-succeed-with-predictive-ai/



Muchas gracias

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19 de abril de 2024

ENI México

Drilling for Performance with a Digital Plan

Ing. Dayra Amador Sáenz

Drilling Beyond the Limits

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Drilling Beyond the Limits

Drill beyond the Limit consists in a methodology for **systematically reducing the time** to drill wells/drilling phase **while still achieving well objectives.**

In 2022 a **pilot** has been deployed **in Egypt branch** representing the **first ever application of this methodology in Eni with well time reduction** from identified initiatives of **4% vs. average actual time** (preliminary estimate from local team)

2024 the **challenge is to employ** the methodology of **Drilling beyond the limits in** the **Mexico** branch.

The approach

1) WELL SELECTION

2) OPTIMIZATION APPROACH

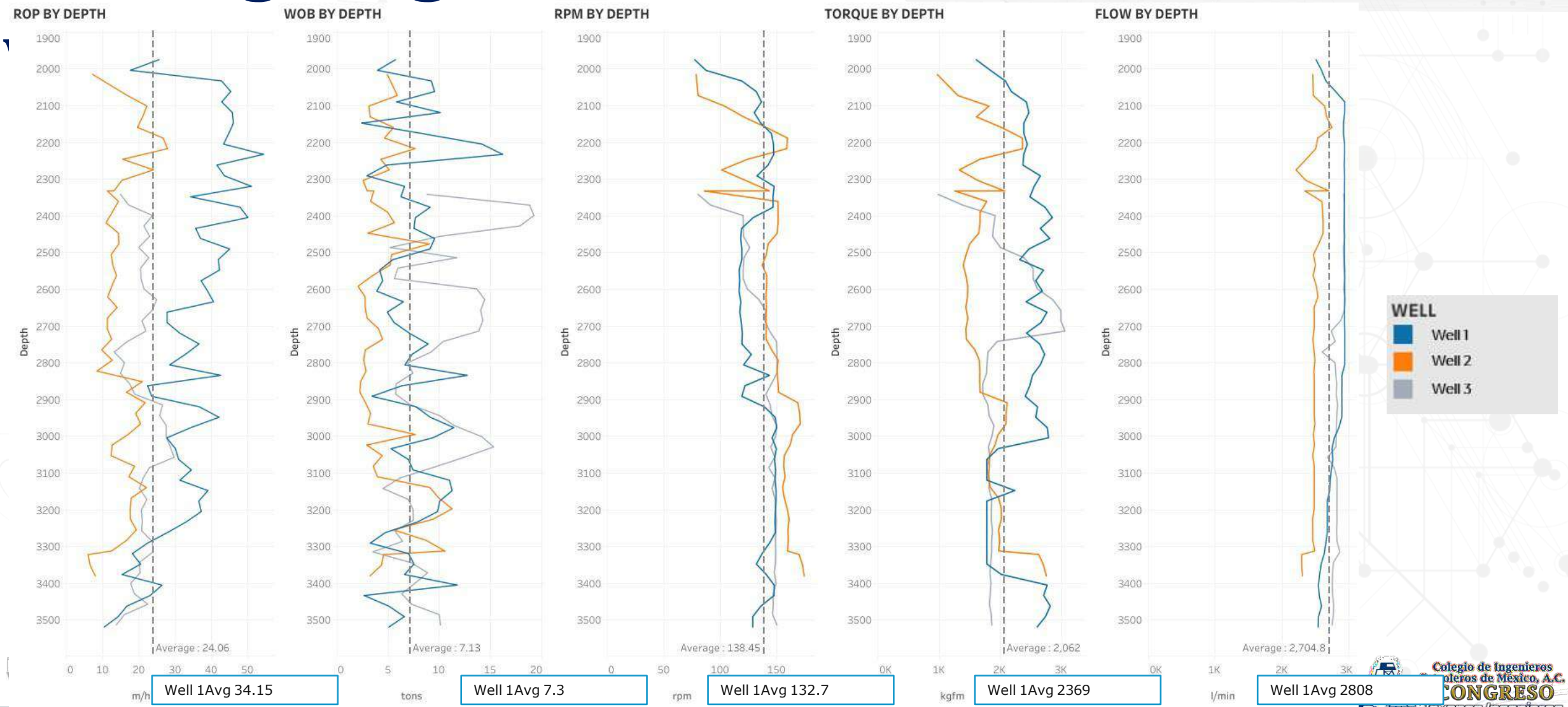
- Drill a single phase (12 ¼” phase of Amoca 15) with unconstrained parameters.
- To push on a new performance benchmark, We applied automatization products (automatic drilling)
- Test the limits of equipment (BHA, fluid system…)
- Implement new practices (reduce survey frequency or real time survey acquisition, avoid backreaming)
- No compromising safety and integrity of the well

3) MONITORING

- Performance monitored by Eni id3 proprietary tool and compared similar wells

4) RECORD AND APPLY LESSONS LEARNED

Drilling stage outcome

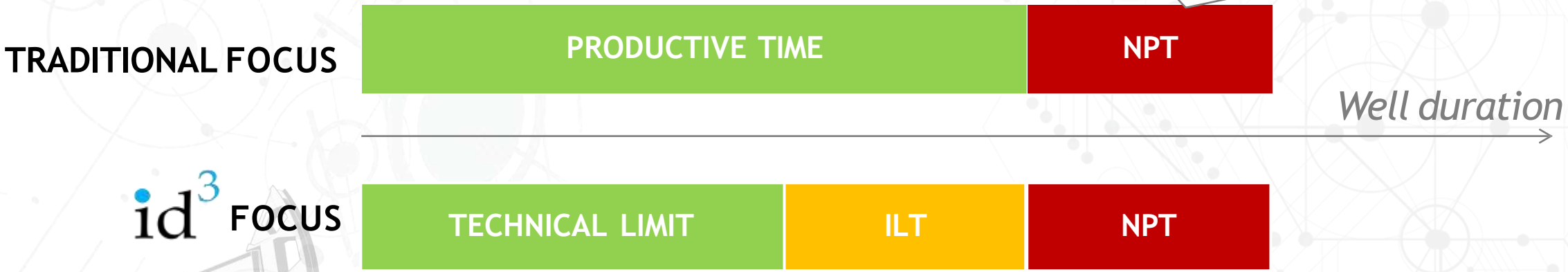


Well 1Avg 34.15	Well 1Avg 7.3	Well 1Avg 132.7	Well 1Avg 2369	Well 1Avg 2808

id^3

id3 Purpose – Enhance Performance

NPT
Any interruption of a planned operation, resulting in a time delay



TECHNICAL LIMIT
Achieved in a flawless operation (using the best people, planning and technology)

INVISIBLE LOST TIME
Difference between actual operational duration and technical limit (requires high frequency data analysis)

id3 Philosophy

Make the best of all available information coming from the rig site

PROs / CONs	Mudlog Data	Daily Reporting
Reliability	Automatic / Impartial Limited activities detection	Interpreted/Subjective Codified / Standard
Sampling	High granularity (5 sec)	Long time frame (>30 min)
Usability	Continuous quality Purely quantitative Need for data retreatment	Discontinuous quality Descriptive / Complete Ready to use

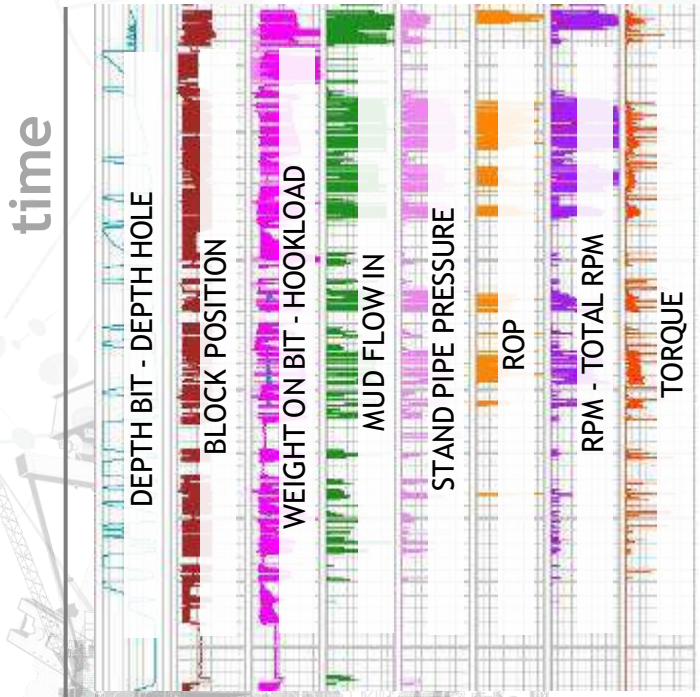
Id³: How it works

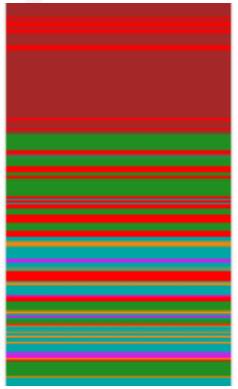
Combine complementary sources to maximize the benefit

1. Build an objective and accurate **time breakdown** with extreme granularity (up to 5 secs)
2. Calculate **impartial Key Performance Indicators** (KPIs) on one or more wells
3. Combine **qualitative and quantitative information** in **one single system**

Merge Rig Sensor & Reporting Data

Standard surface logging data are interpreted in operation





DRILLING

CIRCULATION

REAMING

OTHER ACTIVITIES

DRILLING

DRILLING

DRILLING

EQUIPMENT TEST

Apply **logical preeminence rules** by type of operations, to make the best of each data source reliability

DRILLING

CIRCULATION

REAMING

OTHER ACTIVITIES

EQUIPMENT TEST

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Integrated Activity Planning (IAP)

Integrated Activity Planning (IAP)

What is Integrated Activity Planning?

Focus on **asset / facility** in **Production**
From various functional plans to **one Integrated and Optimized plan**

Which are the benefits?

- Work **prioritization and scheduling at optimum time**
- **Avoidance of inefficiency losses,** e.g. activity clashes or duplications
- **Support achievement of asset targets**
- **Standardized unique** Tool **Primavera Cloud**

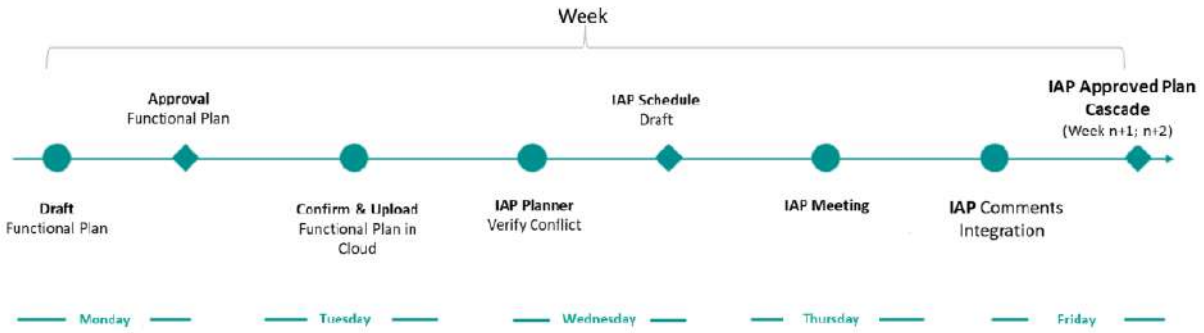
Lifecycle

Exploration → Development → Handover to operations → First period production → Running production → Running production s preparation to decommissioning

- Ivory Coast
- Mexico
- USA
- UK

IAP Experience Eni Mexico

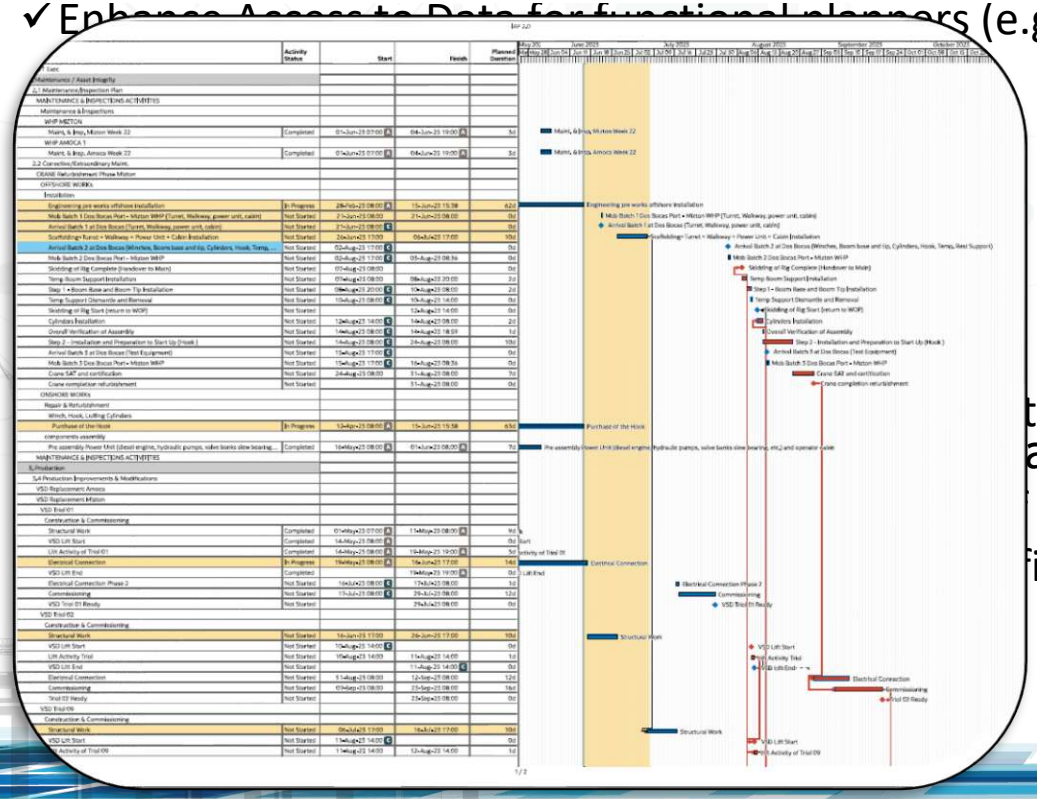
Scheduling overview



Planning

of OPS and DEV (e.g. Re-Prioritization VFD installation,

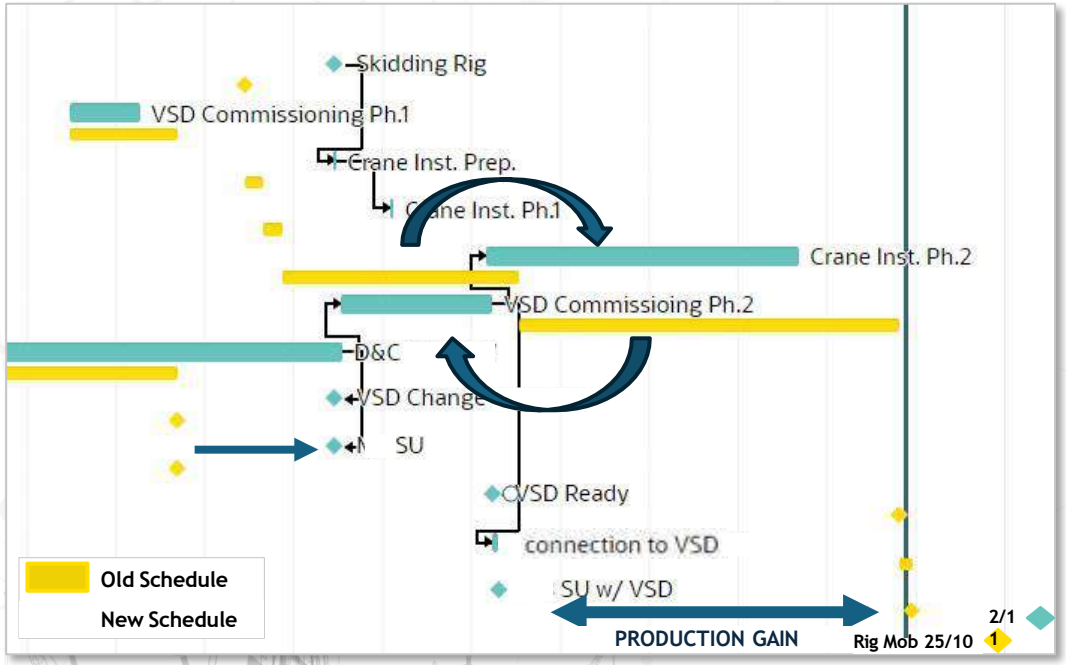
✓Enhance Access to Data for functional planners (e.g. Drilling Schedule, Procurement Plan, Shutdown Window,



teraction between Functional planners
and Maintenance assets
Optimization and
ficiency up to a 51%

IAP Mexico Case Study

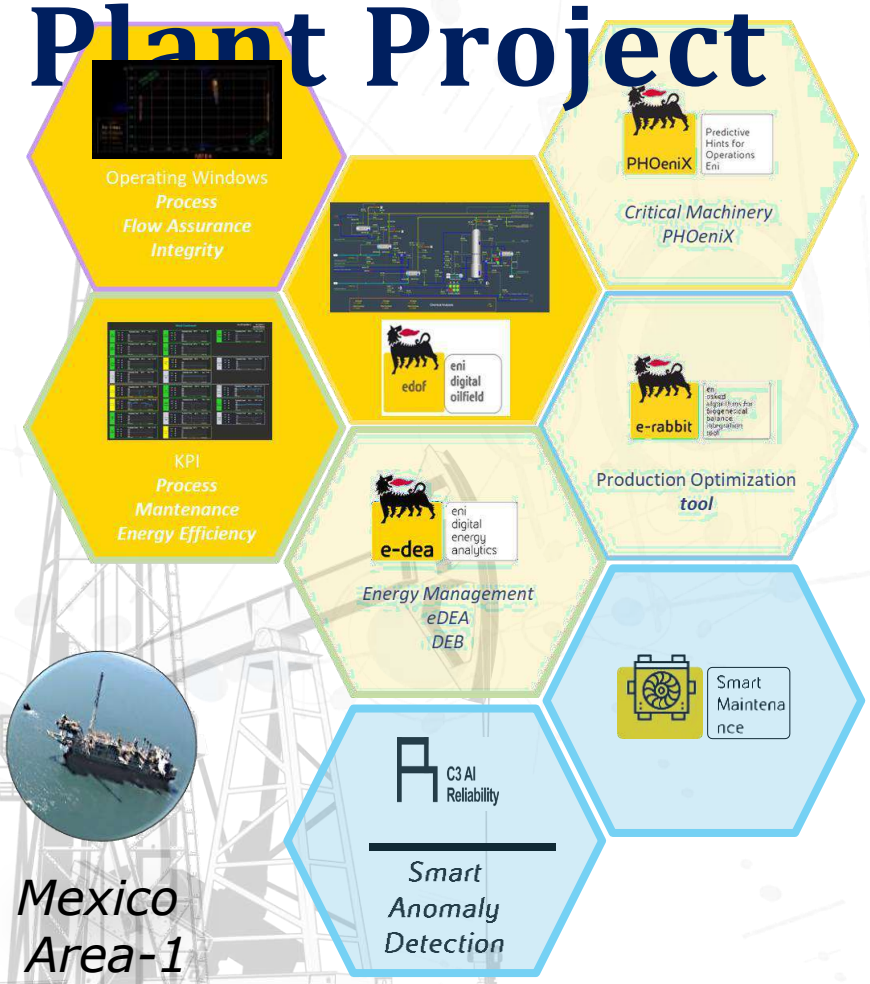
Eni Mexico - VST Schedule



Crane Installation @Platform

Digital Plant Project

Digital in Eni Mexico - the Digital Plant Project



- First **single source of truth** tool with ***predictive*** and **Advanced Analytics models**
- Multidisciplinary and comprehensive **asset monitoring**
- Impacts on ***production***, asset ***availability***, ***emissions***

Digital Plant Eni Mexico - Benefits

LEVERAGE ON

- Advanced analytics tools
- Predictive algorithms
- Big data analysis
- Real time monitoring and alerting

OIL&GAS EXPERT

ARTIFICIAL INTELLIGENCE & DATA SCIENCE

REAL TIME DATA & PRODUCTION SCENARIO

OBJECTIVES

- Minimize operational risks
- Increase energy efficiency
- Improve productivity
- Increase safety and plant availability

Digital Plant Eni Mexico – First Implementation

Eni Mexico & Digital Plant

- **Complex asset** for **production and reservoir management**
- Introduction of solutions such as Digital Plant to enhance **Asset Operator Coordination**
- **Increase local skills** for managing Digital tools and reading outputs

Asset Operations & Integrity

- Structured and Systematic approach enabled by a Production Optimization tool (scenarios & simulations)
- Mointoring of Asset Integrity & Safety

Center of Excellence (CoE)

- Center of Excellence (CoE) oriented to the use of the Advanced Analytics and valorization of Human Capital & Upskills

Eni Mexico Digital Transformation
Pillars and Drivers

Advanced Analytics Focus & Contribution

Achieve Operational Efficiency through advanced analytics and predictive modeling algorithms:

- Reliability (Produced and Sea Water Treatment, ESP/VSD, Fuel Gas System)
- eDEA for energy management
- Phoenix for Critical Machinery
- Smart Alarm & Maintenance

Business Continuous Improvement

Enable the cross functional continuous improvement by introducing a real-time monitoring dashboard for a set of KPIs and facilitate the timely addressing of actions.

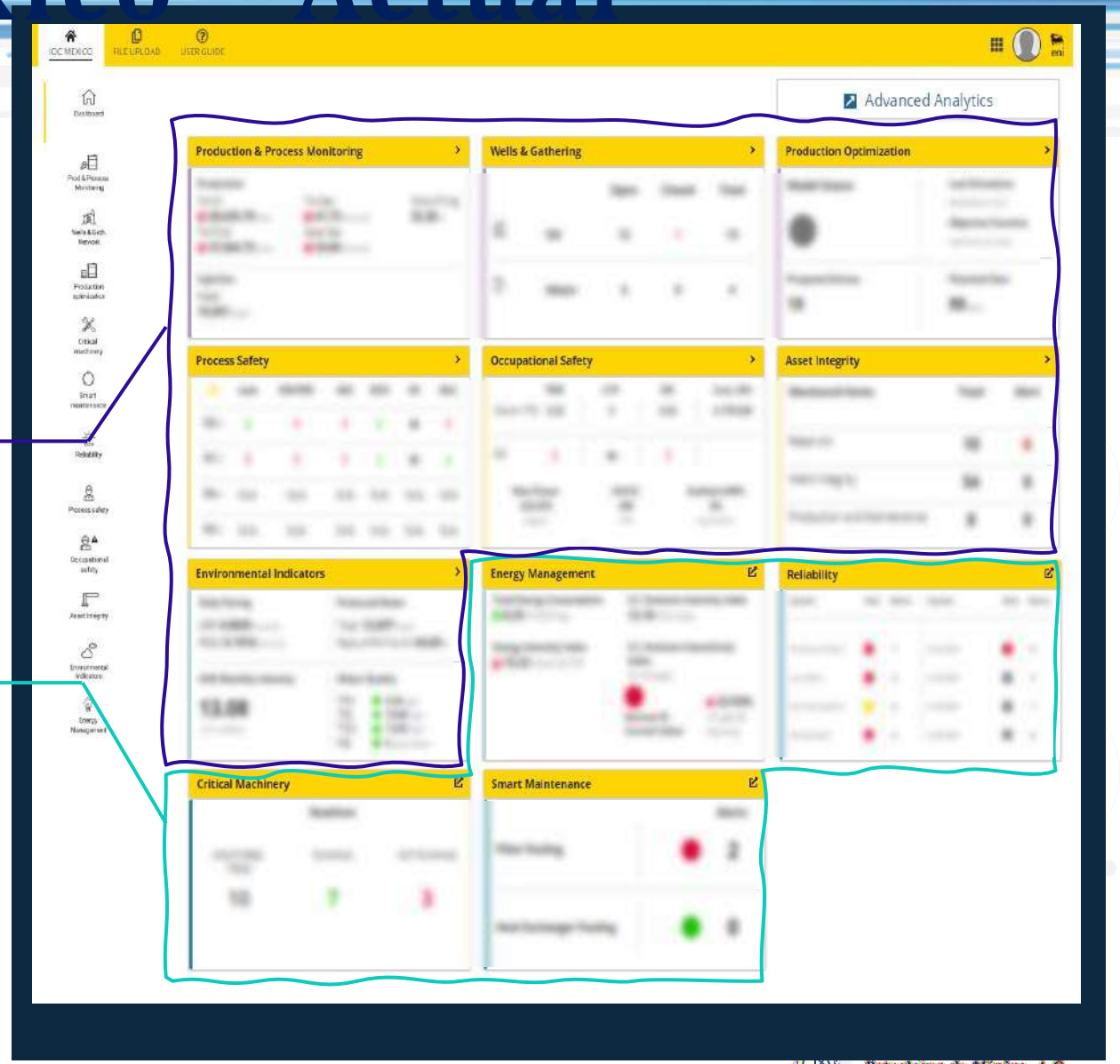
Digital Plant Eni Mexico – Actual Dashboard

One single environment that integrates information from **different corporate systems and group them into:**

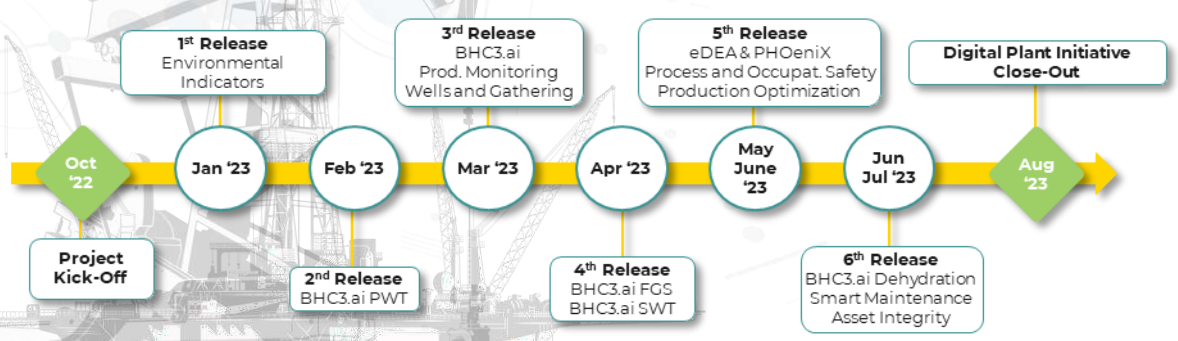
11
Thematical Cards

7 Cards
Integrated Operations Center

4 Cards
Advanced Analytics



First Implementation – Eni Mexico



The Advanced Analytics Tool

Smart Maintenance

PHOeniX — Predictive Hints for Operations Eni

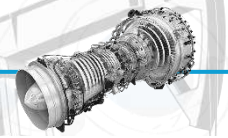
C3 AI Reliability

e-dea — eni digital energy analytics

Advanced Analytics Solution

Smart Maintenance *Fouling*

Solution that predicts the remaining useful life (RUL) for a filter or a heat exchanger in terms of remaining days until the equipment needs cleaning maintenance.



Equipment

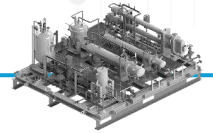
Smart Maintenance *Critical Machineries*

Anomaly detection application for industrial assets with a focus on rotating machineries. PHOEniX is designed to provide a forward-looking predictive maintenance capability

Sub-System

BHC3.ai Reliability

Allows to promptly detect anomaly and problems concerning processes, sensors or static equipment by exploiting the history of operation.



Process

Energy Management

e-dea™

e-dea™ is a predictive tool based on machine learning technics that allows to highlight anomalies in unit/equipment energy consumption anticipating plant energy intensity index increase.

Plant

Benefits

Improve Asset Reliability — Early detecting dangerous or not normal operating conditions

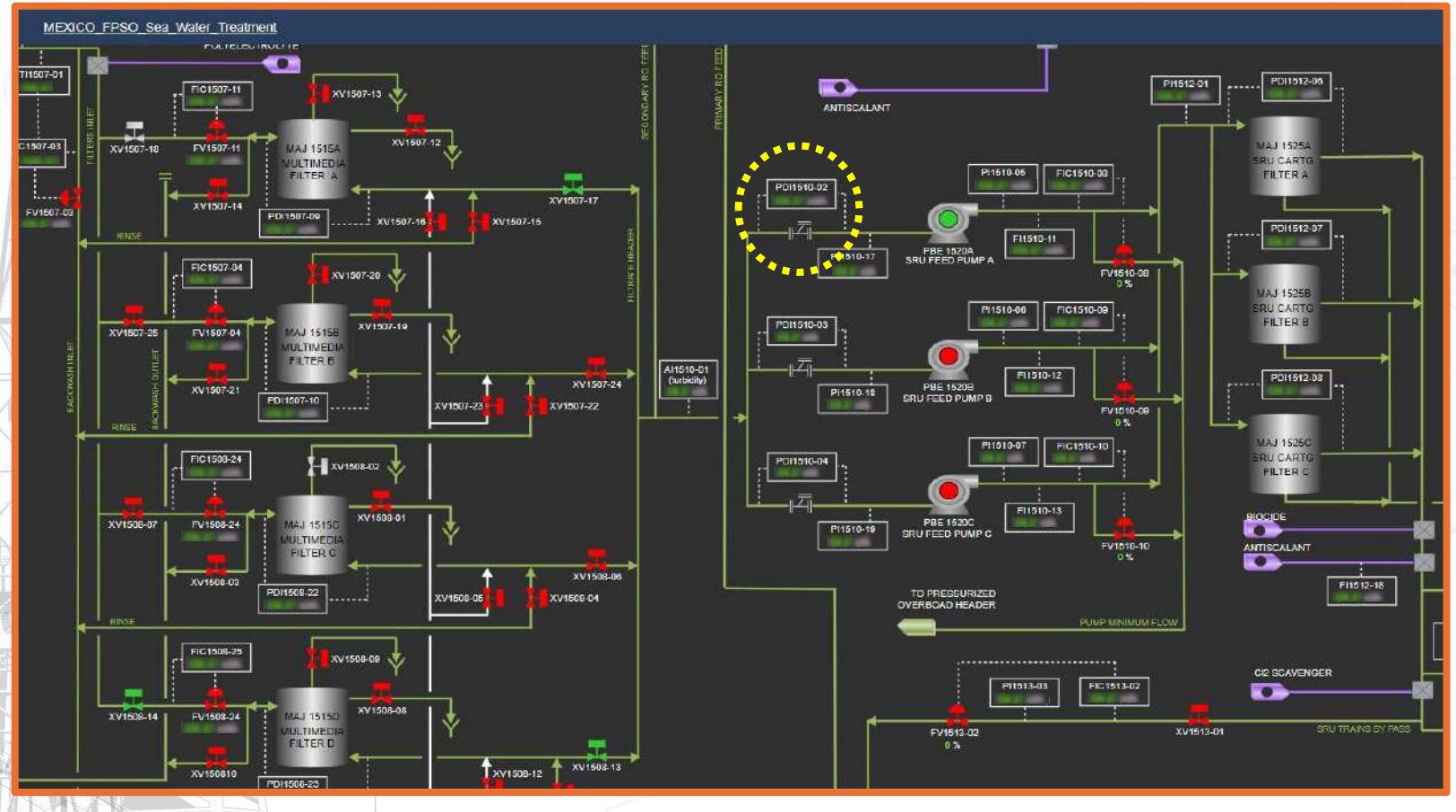
Reduce OPEX — Less expensive Preventive Maintenance vs Corrective Maintenance

Energy Intensity — thanks to the use of specific tools and reduction of unplanned SD

BHC3.ai Reliability –

EPSO Sea Water Treatment, SRU Feed Pump A

Real Case



Criticality of the process

SWT treats almost **50%** of the injected water that supports continuously Eni Mexico production.

BHC3.ai Reliability –

EPSO Sea Water Treatment, SRU Feed Pump A

Real Case

Real Suction Strainer DP

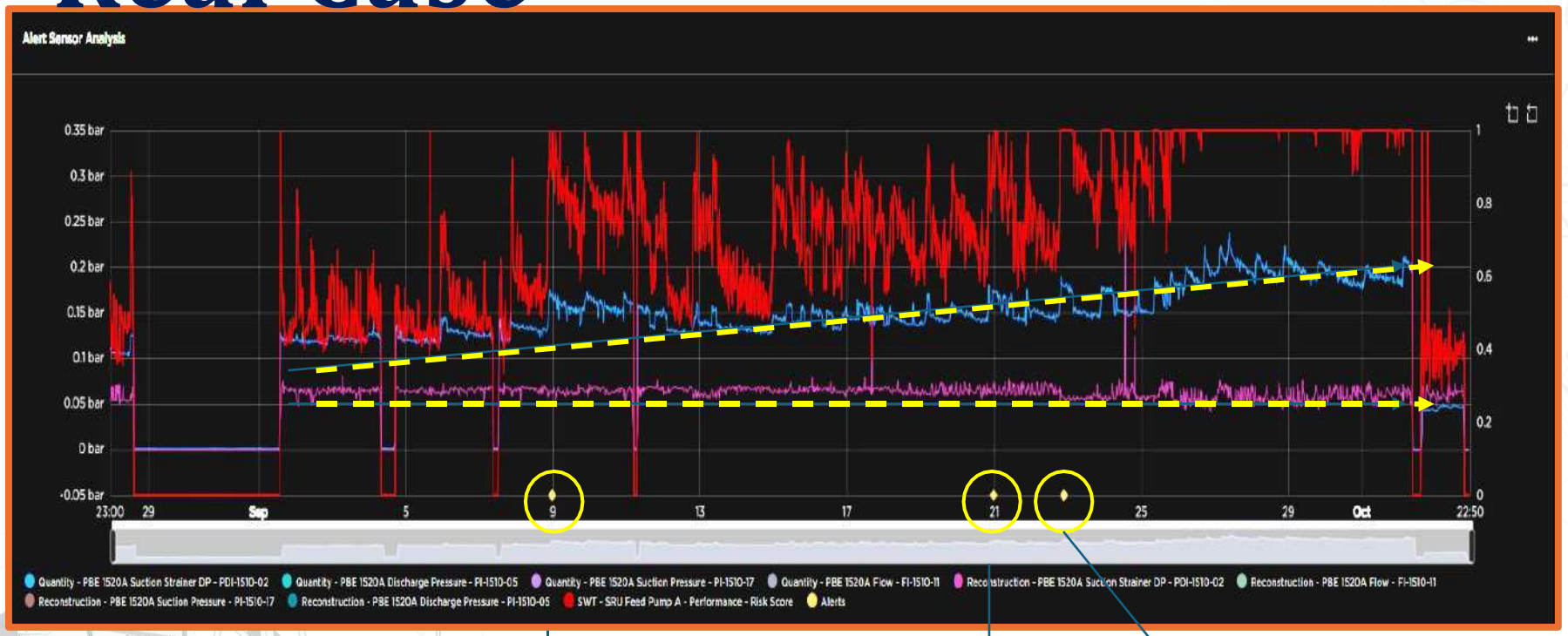
Reconstructed Suction Strainer DP

Reliability Risk Score

BHC3.ai Reliability –

EPSO Sea Water Treatment, SRU Feed Pump A

Real Case



Alert generated by AI Model

Alert generated by AI Model

Alert generated by AI Model

Event

Delta pressure across suction strainer ***increasing*** continuously along the days.

3 alerts generated

BHC3.ai Reliability – Real Case

FPSO Sea Water Treatment, SRU Feed Pump A

Alert generated by AI Model

Alert generated by AI Model

Alert generated by AI Model

Cleaning of the Filter

Event

Delta pressure across suction strainer ***increasing*** continuously along the days.

3 alerts generated

Tracking

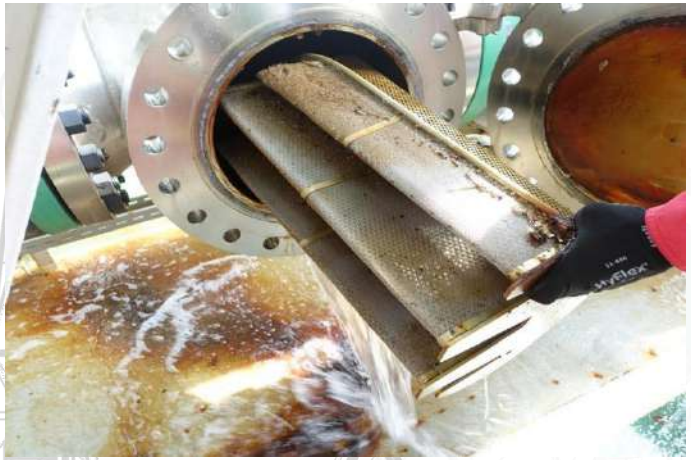
Eni FPSO Maintenance Superintendent activated the O&M contractor in order to perform strainer cleaning

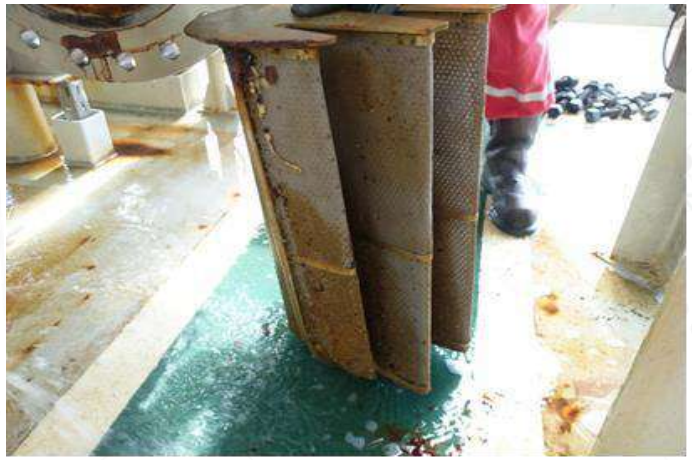
Even if the ***maintenance plan*** foresees a periodic suction strainer cleaning, the plant was ***operated in not optimal conditions for 3 weeks***

BHC3.ai Reliability –

EPSO Sea Water Treatment, SRU Feed Pump A

Real Case





Avoid operations in not optimal conditions

Early detection of dangerous conditions

Increase of asset availability and reliability


Colegio de Ingenieros
Petroleros de México, A.C.
CONGRESO
Jóvenes Ingenieros
del FUTURO
2da. Edición
CIPM
Thank You,Gracias