AADE
AMERICAN ASSOCIATION of DRILLING ENGINEERS
HOUSTON CHAPTER

HALLIBURTON

All Electric Benefits from CAPEX to OPEX

AADE IETG/FMG : May 2021

Alan McLauchlan

Principal Product Champion – All Electric

Advanced Completions

All Electric Progression

2021 Corvette Stingray

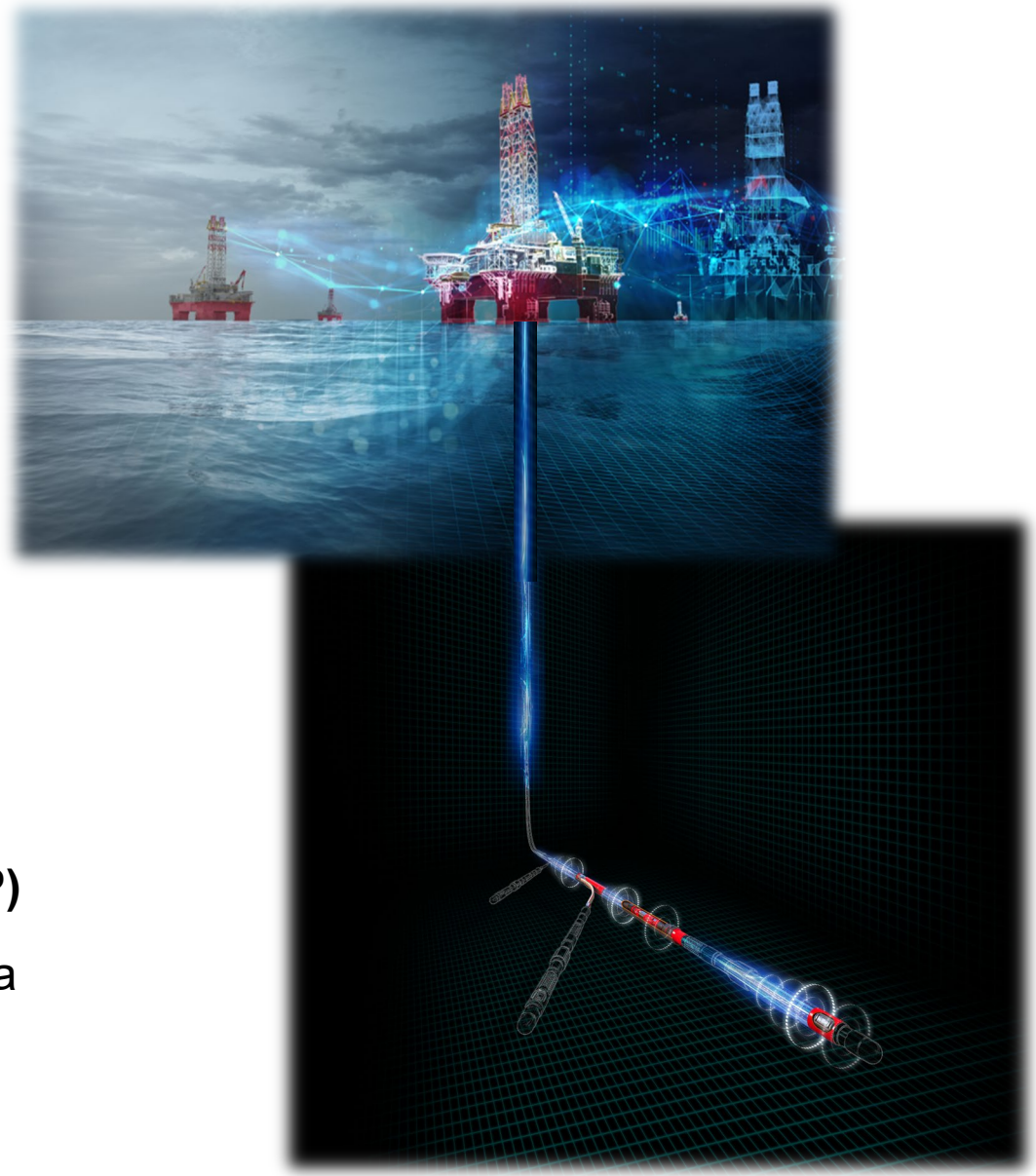
Horsepower: 495
Speed: 194 mph
0-60: 2.9s
¼” mile: 11.2s

2021 Tesla Model S Plaid+

Horsepower: 1100+
Speed: 200 mph
0-60: <1.99s
¼ mile: <9.0s

Voice of the Customer

- “All systems should become electric and automated.” **(Total, N.Sea)**
- “Electrical actuation is Equinor’s base case for control of Advanced Subsea Processing.” **(Equinor)**
- “Increased standardization and electrification of our subsea systems.” **(Chevron, AP)**
- “Everything will be electric and we will eliminate hydraulics.” **(Woodside, AP)**
- “Move to electric controls.” **(BP, N.Sea)**
- “Expect all electric and automated technology.” **(Petronas, AP)**
- “Longer tiebacks, greater use of electrical systems and subsea processing” **(Chevron, Africa)**



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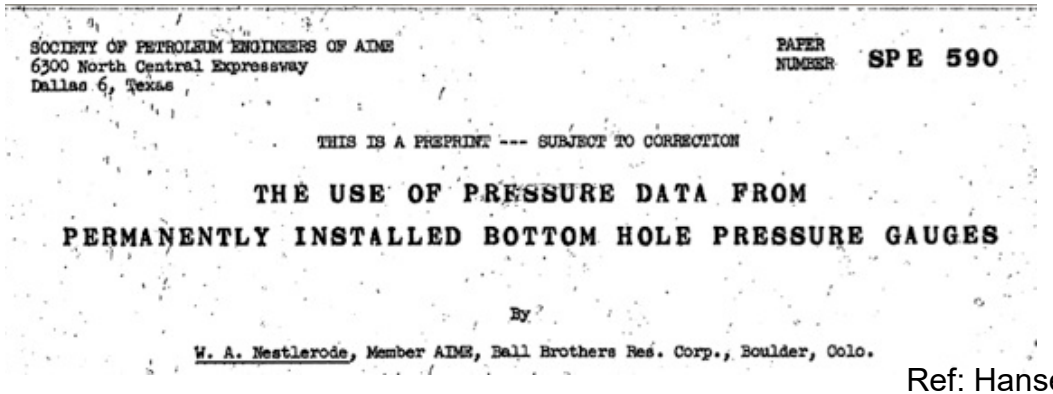
All Electric is Not New

- 1962: First publicized use of a gauge: SPE paper # 590
- 1977: Petrobras installs gauge in subsea well in Campos basin
- 1986: 1st Quartz gauge installation
- 1995: 1st multi-drop system deployed
- 2000's: High temperature Printed Circuit Boards
- 2009: Introduction of Hybrid Electronics
- 2018: Introduction of Application Specific Integrated Circuits (ASIC)



SOCIETY OF PETROLEUM ENGINEERS OF AIME
6300 North Central Expressway
Dallas 6, Texas

PAPER NUMBER SPE 590

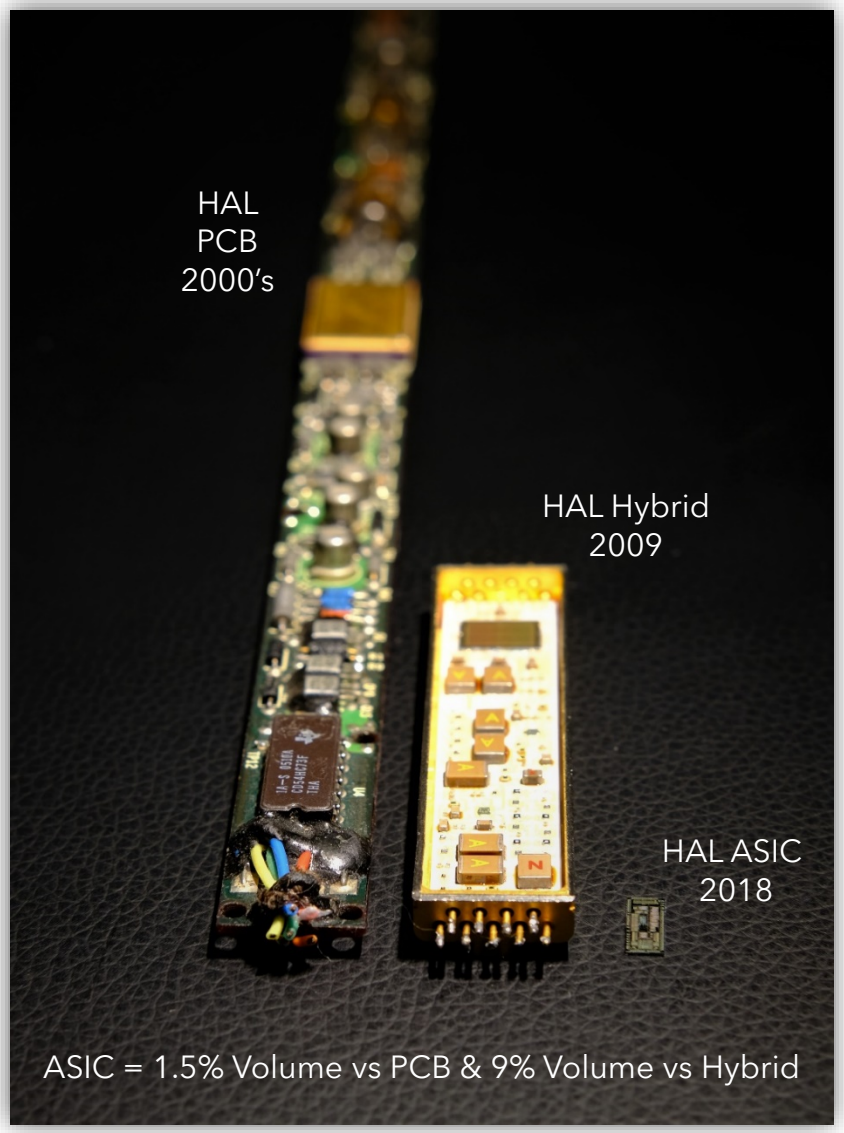
THIS IS A PREPRINT --- SUBJECT TO CORRECTION

THE USE OF PRESSURE DATA FROM
PERMANENTLY INSTALLED BOTTOM HOLE PRESSURE GAUGES

By

W. A. Nestlerode, Member AIME, Ball Brothers Res. Corp., Boulder, Colo.

Ref: Hansenenergy.biz



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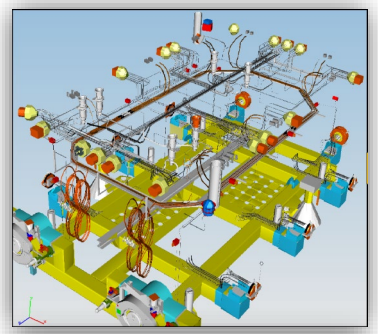
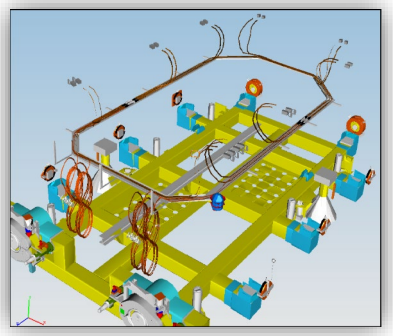
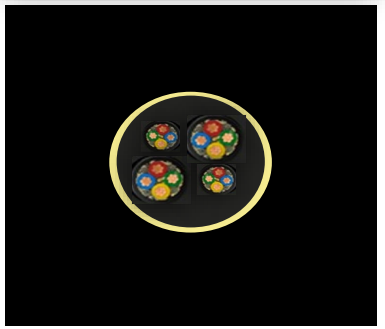
Industry Drive to All Electric - CAPEX

- Eliminate Hydraulics:
  - Reduced hydraulic footprint needed for HPU's etc
  - Smaller platforms – increased potential for unmanned platforms
  - Smaller umbilical
  - Less complex tree systems
  - Enables longer step outs to reach satellite fields
  - Reduced time to first oil

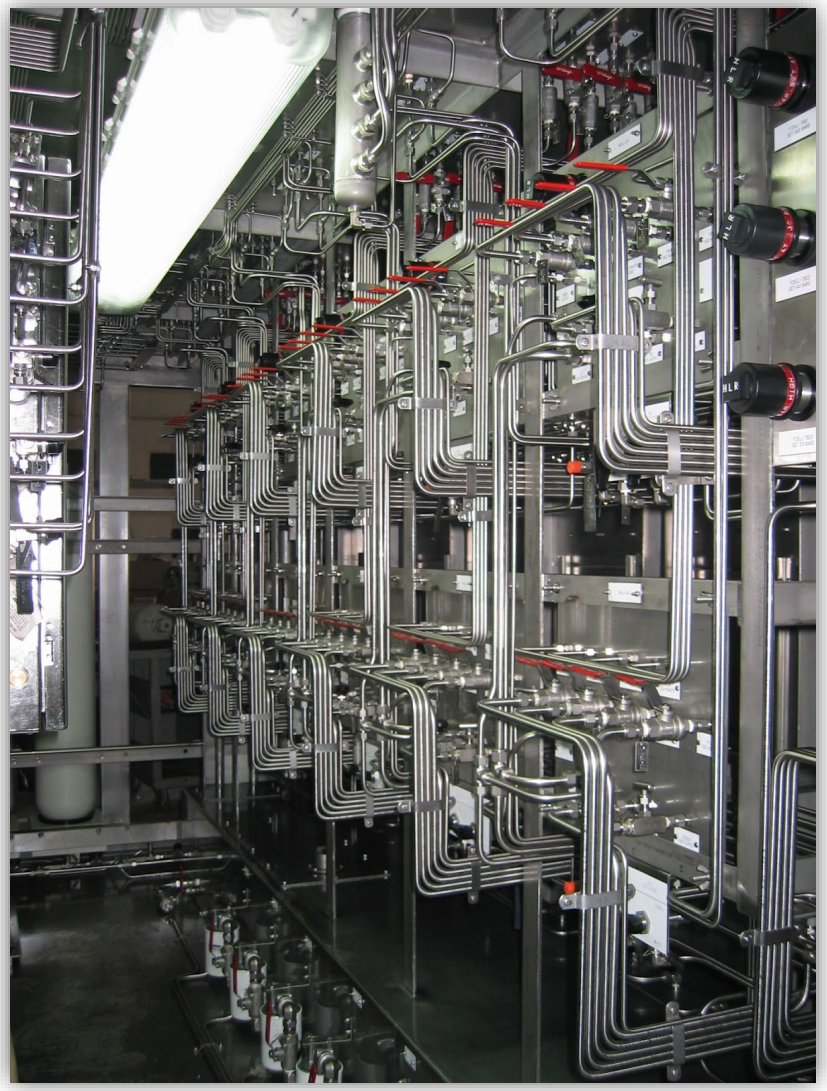






Industry Drive to All Electric - OPEX

- OPEX reduction from:
  - Reduced maintenance – no hydraulics, less moving parts
  - Reduced personnel needs on location
  - Advanced health monitoring gives insights into tool performance
  - Faster response times for shut down and startup
  - All adds up to less production downtime, potential for increased recovery



HSE Benefits

- HSE
  - Reduce high pressure line of fire / personnel interaction
  - Zero discharge
  - Reduced carbon footprint

Halliburton All Electric Philosophy

- Leverage almost 25 years of intelligent well history
- Based on field-proven hydraulic designs
- No reduction in performance versus hydraulic systems
- Advanced health monitoring
- Compatible with existing subsea trees

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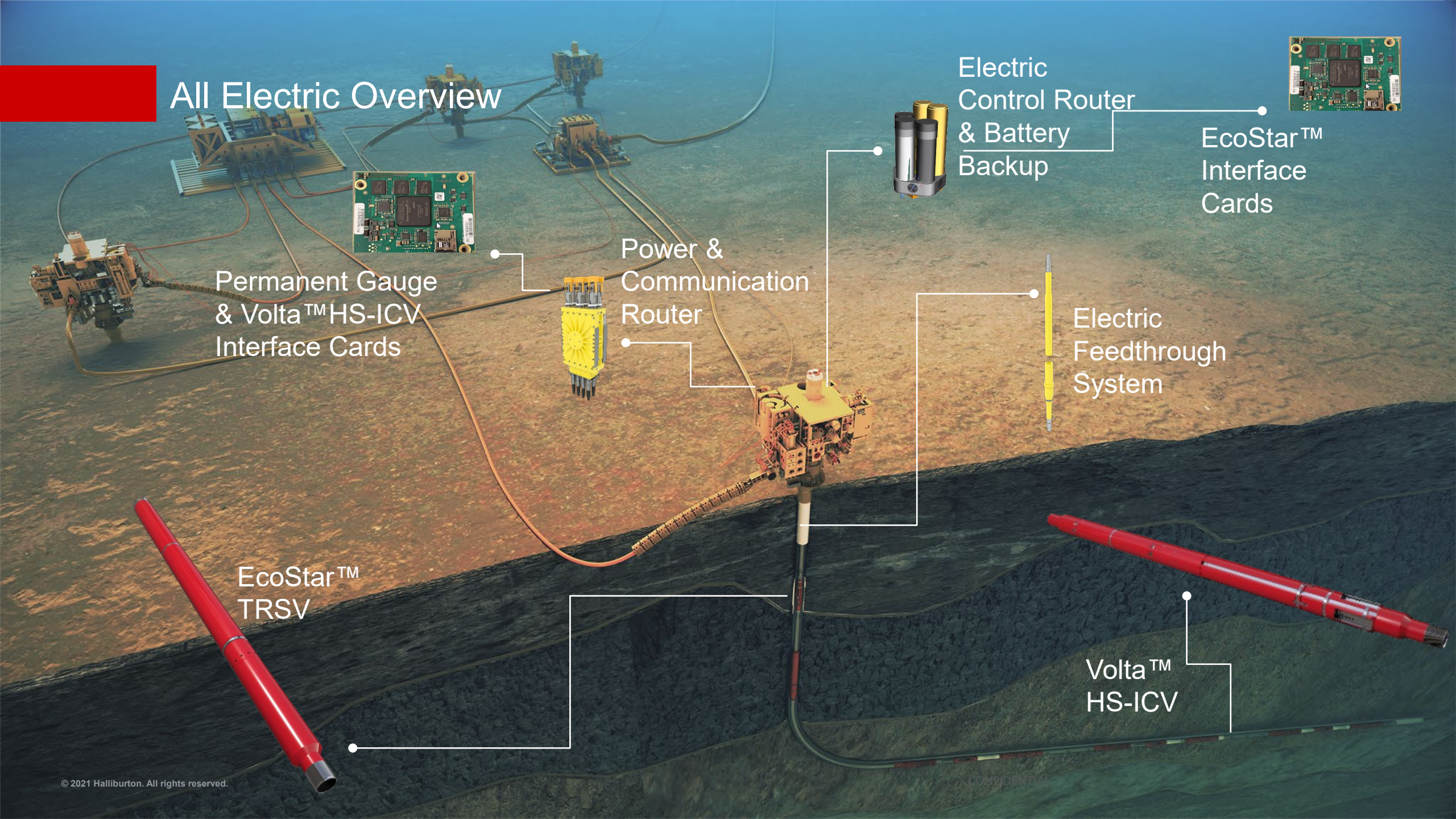
All Electric Overview



EcoStar™ TRSV Features

- World's First Electric safety valve
- All electro-mechanical actuation
- Integrated sensors for onboard diagnostics
- Mechanical failsafe closed – independent of external power source
- Fully independent and redundant actuation and control systems
- Sensing and reporting of valve position
- Functionality not impacted by changes in tubing pressure
- Operating procedure TVD insensitive - within valve operating envelope

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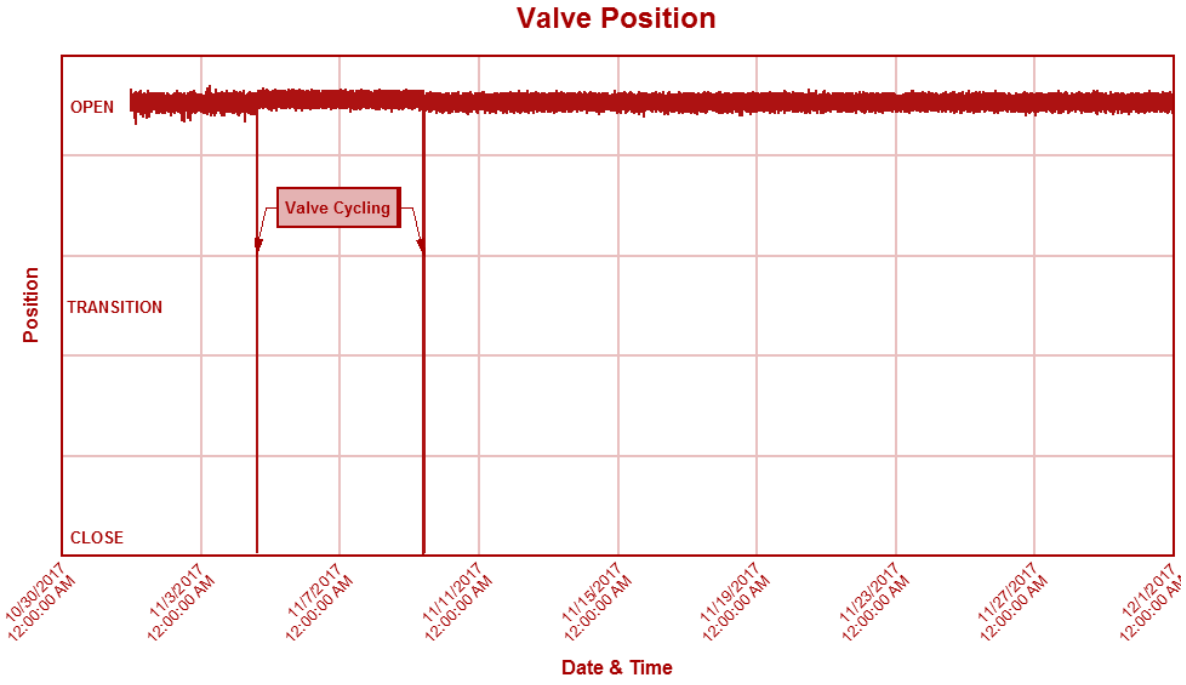
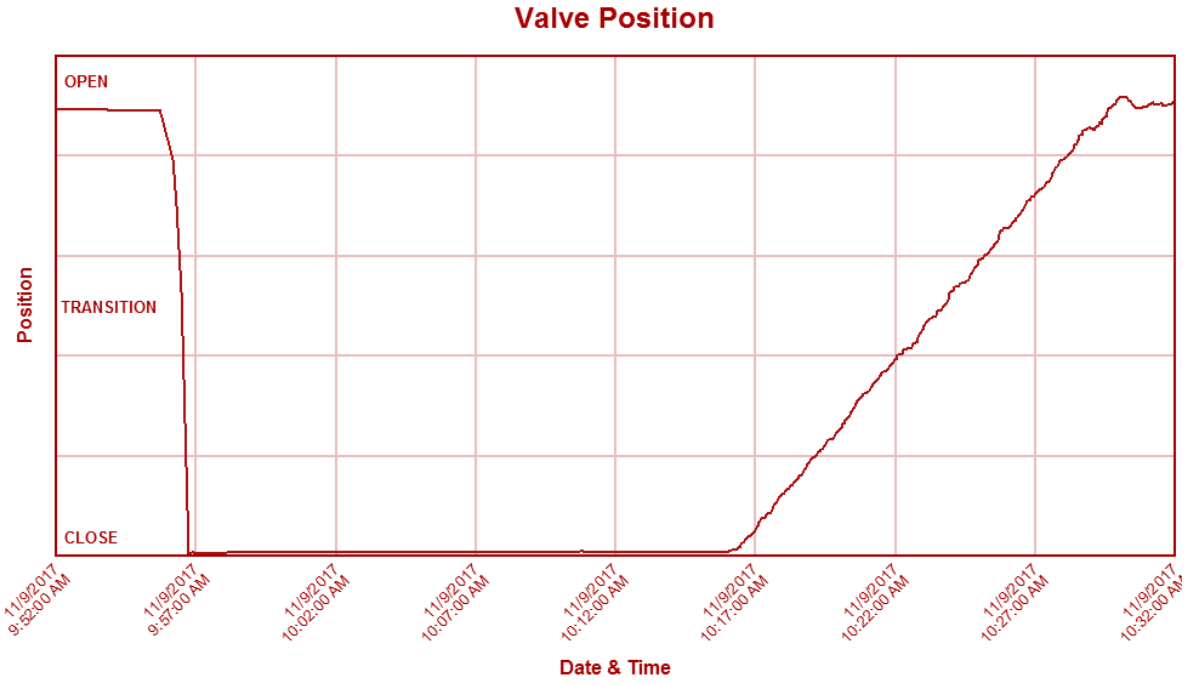
EcoStar™ TRSV Position Sensing

- EcoStar™ Valve Positioning
  - Digital footprint of valve opening
  - Identify onset of scale build up
  - Determine operating strategy to optimize performance and longevity





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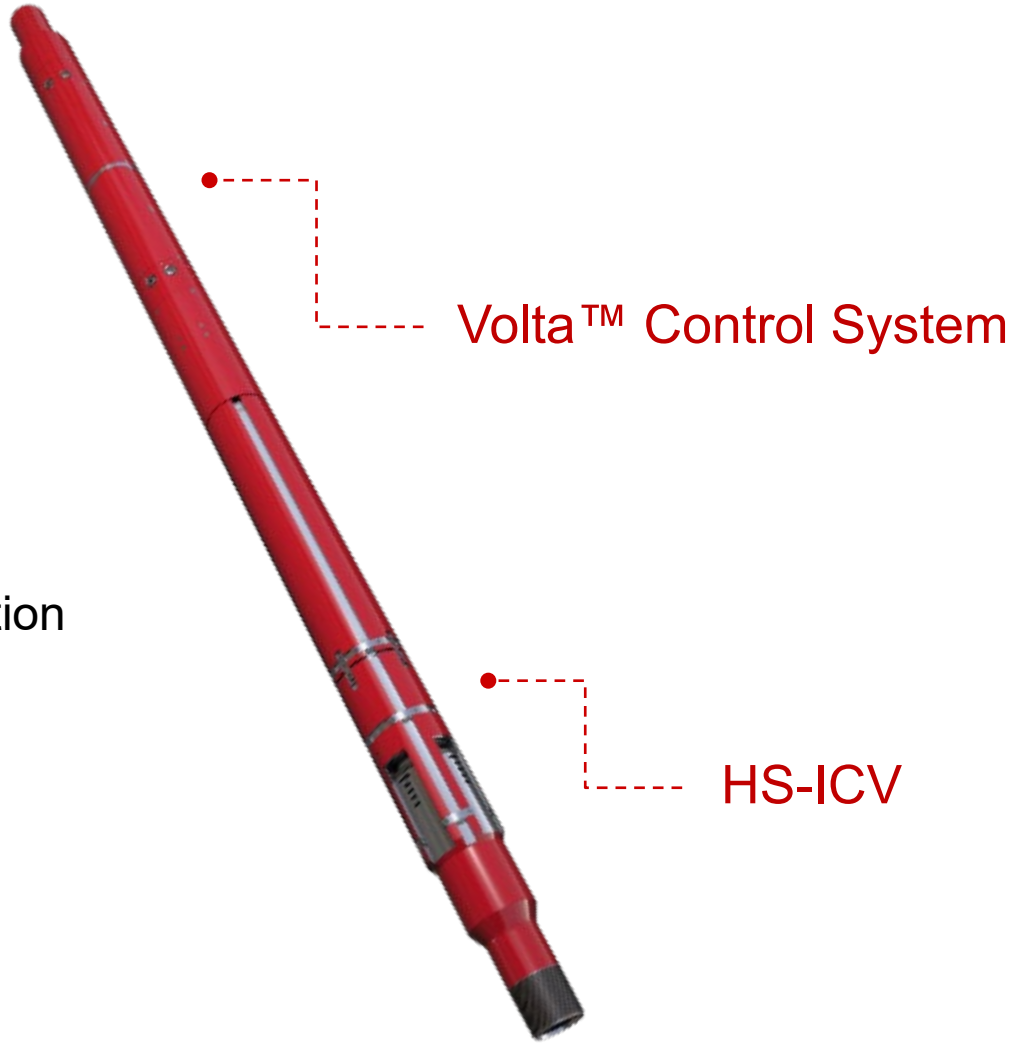
SmartWell® Volta™ HS-ICV Reservoir Management System

System Overview

- Built on HS-ICV field proven system
- Provides full bi-directional choking control of the reservoir
- Integrated system
- Single line operation
- Full redundancy capability
- Health management and well monitoring integration
- Long term reliability
- Flow rate equivalent to Hydraulic HS-ICV



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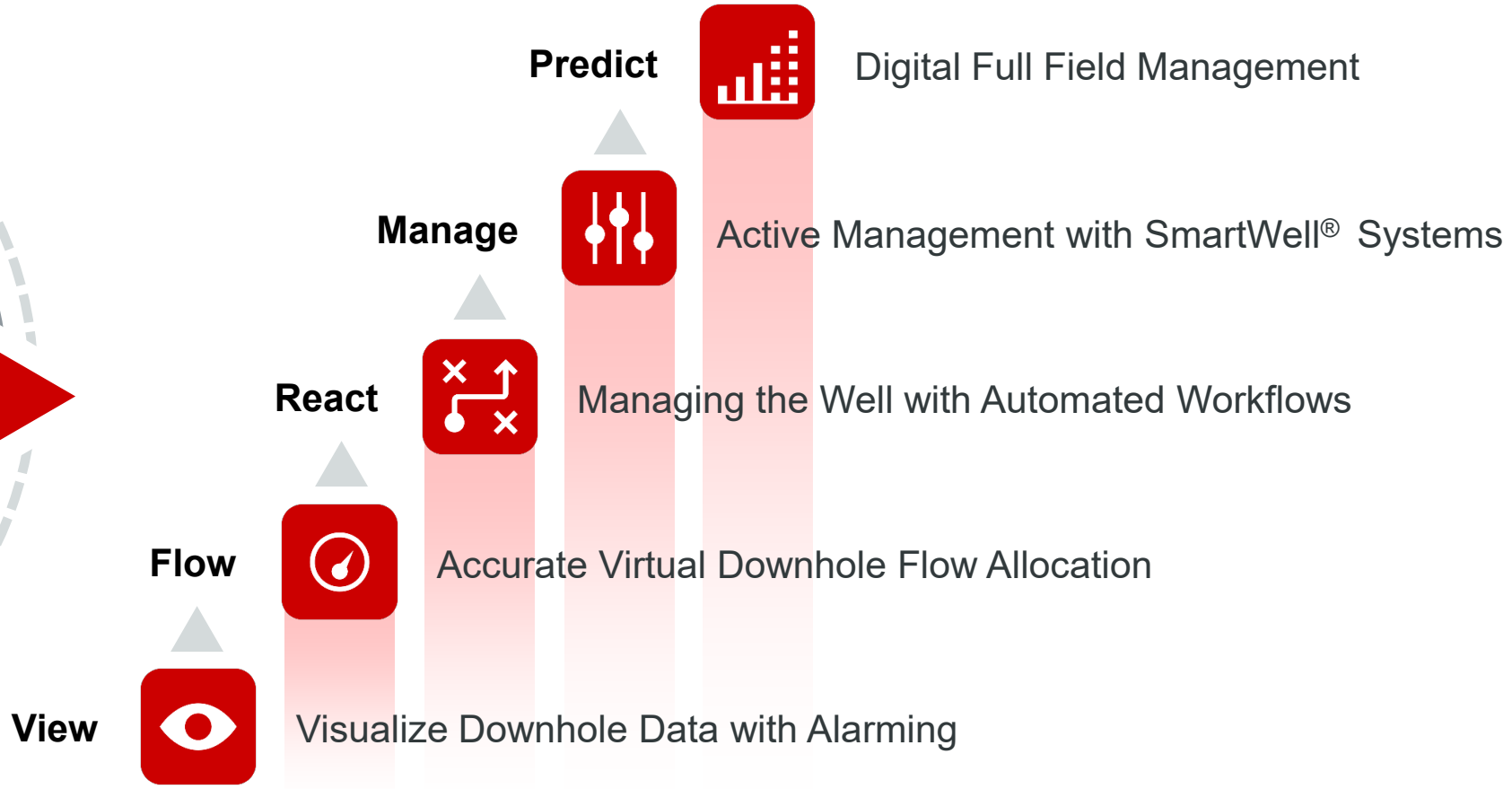
eCompletions™ Clariti™

Clariti™

Reservoir Management

Designed to offer more insight and control with each application.



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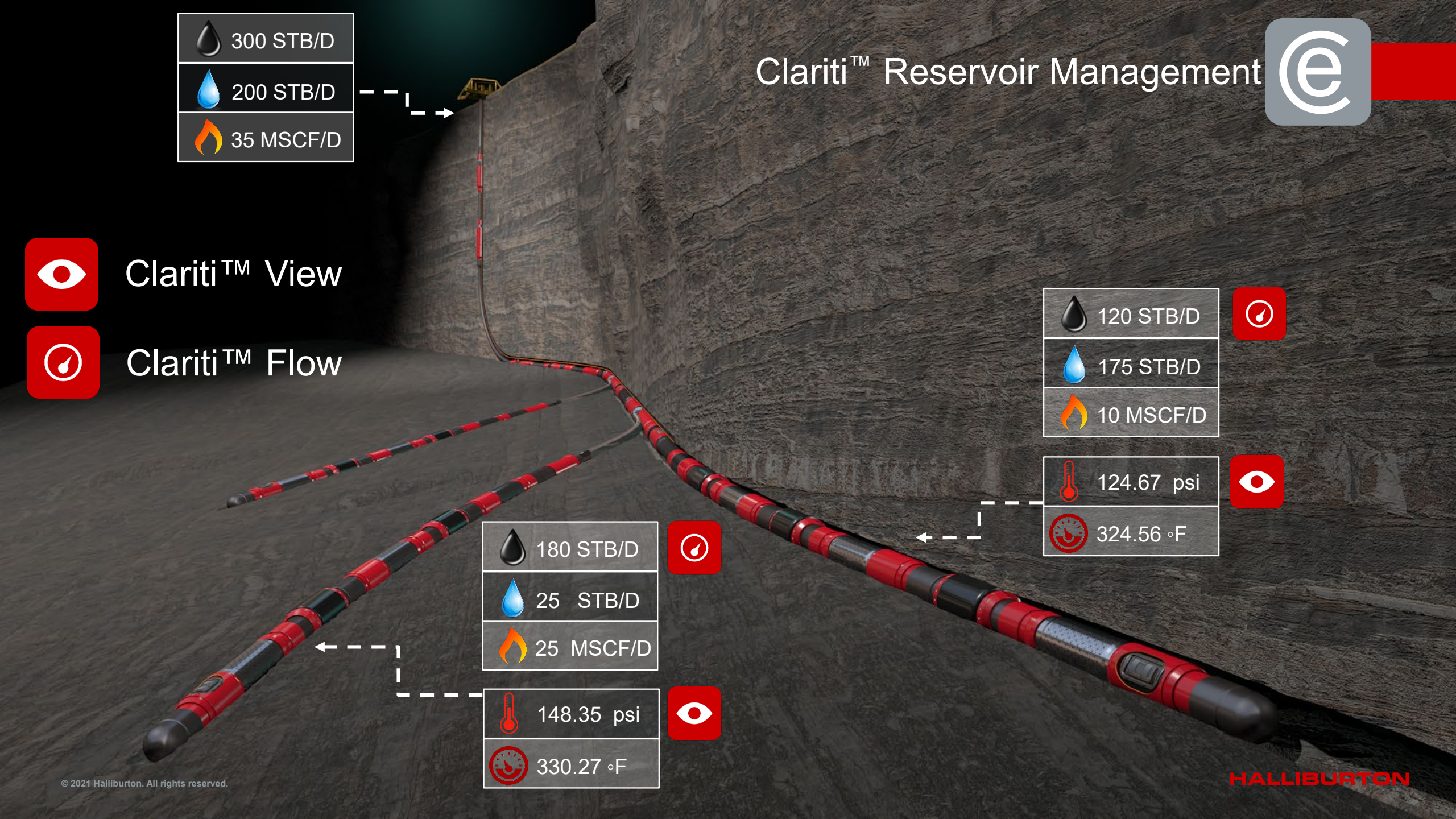

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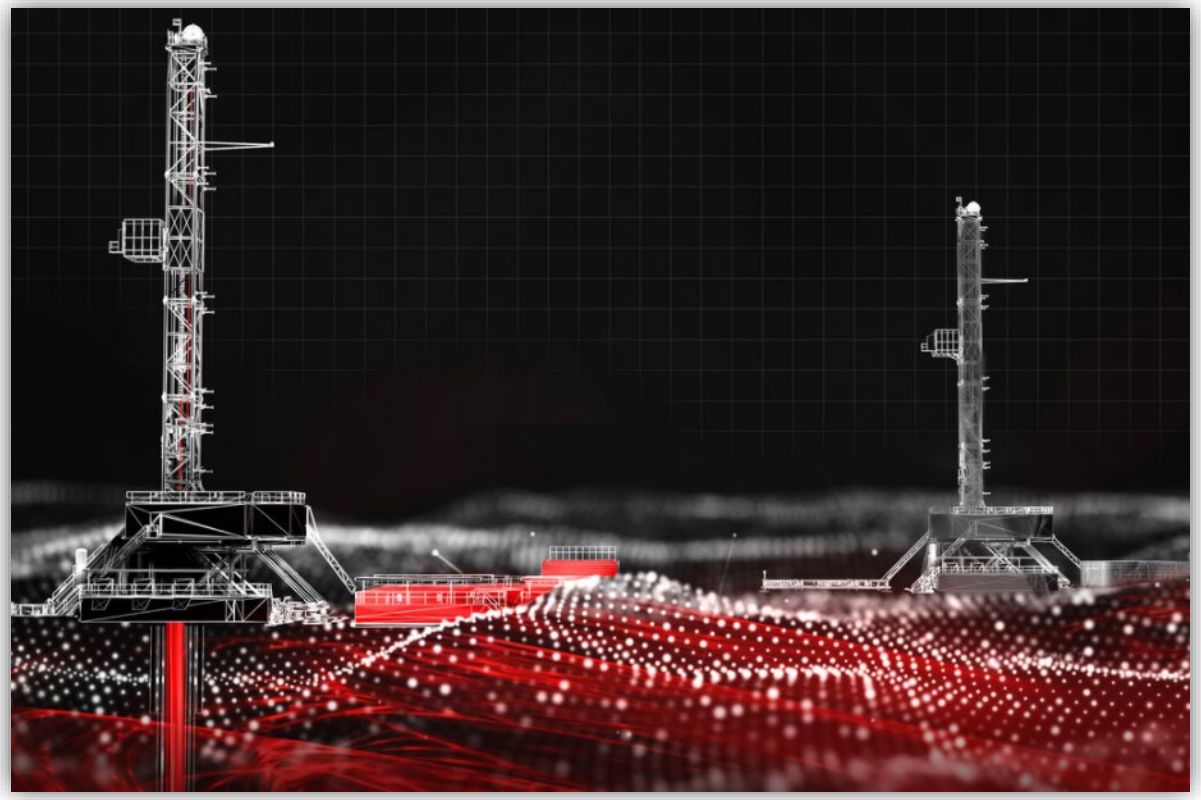
Conclusions

- All Electric systems can provide significant cost savings on CAPEX, OPEX and HSE
- All Electric enables HSE initiatives such as reduced carbon footprint to be realized
- All Electric enables enhanced monitoring and feedback from the reservoir and installed downhole equipment
- Halliburton's Clariti™ Reservoir Management System leverages the All Electric benefits to enable production optimization, improved operational efficiency, and increased ultimate recovery.



THANK YOU