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Invisible threads: Rethinking subsurface intelligence for a lower impact

Muhammad Ahsan [1,*] and Rizwan Khan [2]

[1] *Baker Hughes, Sustainability and Energy Transition, Houston, United States of America.*
[2] *Baker Hughes, Drilling Services, Houston, United States of America.*

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Abstract

As the energy industry accelerates toward decarbonization, the opportunity to reduce environmental impact lies beneath the surface literally. Subsurface operations, especially those involving drilling, are major contributors to emissions during the life of a well. This paper explores how an integrated, digitally enabled drilling approach where drilling services, drill bits, and drilling fluids are combined as a unified intelligence system can transform performance and sustainability outcomes. Using insights rooted in Baker Hughes' approach, we analyze how invisible threads of data and integration reduce emissions intensity while enhancing operational precision.

Keywords: Low Impact; Drilling Services; Sustainability; Digital Integration

1. Introduction

Drilling remains a critical yet energy-intensive phase in hydrocarbon development. Historically optimized for speed and cost, today's drilling operations must also meet new expectations of carbon efficiency. While the individual domains of drilling services, bits, and fluids have seen performance improvements, the industry is only beginning to unlock the value of aligning them as one cohesive digital ecosystem. At Baker Hughes, we believe rethinking subsurface intelligence means connecting these domains each a pillar of well construction through data, integration, and automation to lower the environmental footprint of drilling.

2. Discussion

2.1. The Case for Integration

Each drilling component services, bits, fluids hold data and behaviors that influence the others. When designed and executed in isolation, this interplay is often missed, leading to suboptimal performance, non-productive time (NPT), and higher emissions per foot drilled. Integration, on the other hand, leverages real-time subsurface intelligence across these domains to refine decisions at every stage: from trajectory planning to rate of penetration, hydraulics management, and hole cleaning.

2.2. Digital-Driven Precision

Digitally enabled workflows allow predictive modeling of formation behavior and dynamic updates during execution. This intelligence minimizes overdesign, reduces trips, and prevents fluid losses each a high-emission event in itself. For example, smarter planning reduces rig time, which directly correlates with lower diesel consumption and emissions. Simultaneously, precision drilling minimizes the need for rework or unnecessary sidetracks, reducing carbon and material waste.

* Corresponding author: Muhammad Ahsan.

2.3. Emissions Impact Through Optimization

By harmonizing data and design across drilling services, bits, and fluids, operators can shift from reactive to proactive decision-making. Real-time optimization leads to better drilling fluid formulations suited to downhole conditions, longer bit runs, and reduced vibration all reducing energy usage. Furthermore, the ability to measure and manage carbon performance while drilling enables transparent reporting and improvement over time.

2.4. A System View of Sustainability

Rather than treating each product or service as a standalone asset, viewing them as an integrated system redefines what sustainability in drilling can mean. Invisible threads of data, engineering logic, and human-machine collaboration create a virtuous cycle where every decision has a lower-impact outcome. Baker Hughes continues to drive this system-level thinking, enabling operators to reduce total emissions per well drilled without compromising performance or safety.

3. Conclusion

The future of lower-impact drilling lies in rethinking how subsurface intelligence is captured and applied. Integration of drilling services, drill bits, and drilling fluids into a digital and emissions-aware system allows operators to reduce their carbon footprint while maximizing drilling efficiency. At Baker Hughes, we believe the invisible threads of digital drilling woven through data, design, and execution form the fabric of a more sustainable energy future. As we work toward net-zero ambitions, leveraging these integrated capabilities is not just a competitive advantage; it is a responsibility.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest. It has been presented at Offshore Technology Conference (OTC) 2025.

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