REDUCING CARBON FOOTPRINT BY DEPLOYING HIGH-PERFORMANCE ELECTRIC SUBMERSIBLE PUMPS AND ENABLING REAL-TIME DIGITAL OPTIMIZATION

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ABSTRACT

This case study presents a comprehensive evaluation of how the integration of advanced electric submersible pump (ESP) technologies, efficient gas handling devices, high-efficiency induction motors, and continuous real-time digital surveillance can drive both operational efficiency and sustainability in upstream oil production. The focus is on 22 wells operated by SOGC, Inc. in the Williston Basin, USA, between June 2024 and May 2025. The primary objective of this study is to illustrate how these technological advancements, combined with proactive remote operations, can minimize downtime, extend ESP run life, and significantly reduce the carbon footprint associated with oilfield operations.

The methodology involved a comparative analysis of production data and downtime before and after the digital service center assumed full control of remote interventions for the operator. The study meticulously tracked ESP performance indicators, such as mean time to failure (MTTF), average run life, and uptime, to assess the impact of digitalization and proactive interventions. Environmental impact was quantified by translating operational improvements into tons of Co_2e emissions reductions, directly linked to the prevention of field trips and workovers. The analysis also considered the broader implications of these operational changes on safety and labor efficiency, including the reduction of nonessential field visits and the prevention of potential ESP failures.

INTRODUCTION

Climate change has implications for both human and natural systems and could lead to significant impacts on resource availability, economic activity and human wellbeing. According to the United Nations, to prevent the most catastrophic impacts of climate change, the global rise in temperature must be limited to only 1.5 °C.

In response, international, regional, national and local initiatives are being developed and implemented by public and private sectors to mitigate greenhouse gas (GHG) concentrations in the Earth's atmosphere as well as to facilitate adaptation to climate change. To get back in balance, it is required not only to decarbonize as fast as possible, but also to remove gigatons of carbon from the atmosphere.

The carbon footprint of a product (PCF) is the "sum of greenhouse gas (GHG) emissions and greenhouse gas (GHG) removals in a product system, expressed in tons of Co$_2$ equivalents and based on a life cycle assessment using the single impact category of climate change." (ISO, 14067:2018)

The GHG emissions are categorized into three scopes. Scope 1 are an operator's emissions from hydrocarbon fuel use; Scope 2 emissions are assigned to operators using electricity (and other forms of energy) generated by third-party combustion of hydrocarbon fuels, e.g. and electric utility business. Scope 3 emissions are all other emissions indirectly associated with an operator's business, including the emissions from third-party business activity upstream and downstream of an operator. (Europump, 2024)

Among all artificial lift systems, electric submersible pumps (ESPs) have the highest greenhouse gas (GHG) emission profile (Useche et al., 2022). The carbon footprint of an ESP is driven primarily by its electrical power consumption, which is largely driven by motor efficiency and the type of power source (grid-supplied electricity versus on-site generation).

For SLB, the ESP provider, ESP-related emissions are classified under Scope 3, Category 11 (Use of sold products). For the operators (owners of the pumps), the ESP emissions are classified under Scope 2 (generation of acquired and consumed electricity, steam, heat, or cooling).

Remote operations introduce a meaningful pathway for emissions reduction by significantly decreasing the need for personnel to travel to well sites for routine or specialized activities. By enabling real-time monitoring, diagnostics, and control from centralized locations, these technologies reduce the frequency of field visits that would otherwise require vehicle or helicopter trips, both of which contribute substantially to operational carbon footprints. The underlying assumption is that each avoided trip directly translates into lower fuel consumption and associated greenhouse gas emissions, while also improving safety and operational efficiency. As remote capabilities expand, the cumulative impact of reduced travel is expected to support broader corporate decarbonization goals and contribute to more sustainable field operations.

METHODOLOGY

Field measurements were taken as junction-box kVA, translated to kWh at the variable speed drive (VSD) output with an efficiency of the VSD (η_VSD) = 97%, Power Factor (PF) being the ratio of real power (kW) used by the system compared to the total power supplied (KVA), and an efficiency of the Transformer (η_Xfmr) = 98.6%, then converted to TCO$_2$e using an emission factor (EF) = 417.312 gCO$_2$/kWh (or 920 lb Co$_2$/MWh), according to the EPA, GHG emission factors hub (2025); the uptime for emissions normalization was 80% unless otherwise noted. The translation is as follows:

$$\text{Energy [kWh]}=\text{kVA}\times\text{PF}\times\eta\text{VSD}\times\eta\text{Xfmrx time [hr]}$$

The calculation of GHG emissions from an ESP system is derived by converting the electrical energy consumed (kWh) into its equivalent carbon footprint using a standardized emission factor (EF). The term Energy [kWh] represents the total electrical load required to operate the ESP across the evaluation period, while EF [g Co_2e/kWh] quantifies the carbon intensity of the power grid supplying that energy. Multiplying these yields the total grams of TCo_2-equivalent associated with ESP operation. The final term, 10^{-6} [TCo_2e/g CoO_2e], performs a unit conversion from grams to metric tons.

$$\text{GHG emissions [T Co}_2\text{e] = Energy [kWh] x EF [g Co}_2\text{e/ kWh] x } 10^{-6}\text{ [TCo}_2\text{e /g Co}_2\text{e]}$$

Legacy ESP motors were compared against high-efficiency, two-pole induction motors (HE-IMs) on identical production targets and near-identical well configuration per profile. Real-time digital optimization was enabled (frequency/torque control; pump-off, gas-lock, and intake-pressure stability rules) to minimize ramp/restart losses and cycling.

ASSUMPTIONS AND NOTES FOR THE CASE STUDY

- Energy → Emissions: All reductions are expressed in TCO_2e/year and are derived from actual operating data translated from kVA (power) → kWh (energy) → TCO_2e (emissions unit of measurements) using stated conversion factors/efficiencies; results reflect measured electrical performance, not nameplate.
- System boundary: Auxiliary loads (e.g., surface heaters/separators) are outside the ESP boundary unless explicitly tied to ESP duty.
- Data hygiene: Where power factor (PF) was unavailable, VSD-output kW from field logs was linked and checked, ensuring that kVA comparisons do not bias the result.

CASE STUDY

High-efficiency induction motors (HE-IM) incorporate an optimized electromagnetic design that minimizes both copper and core losses, resulting in a measurable reduction in electrical demand during operation (Escobar et al., 2021). Compared with previous-generation ESP motors, these designs deliver at least 3.5% improvement in electrical efficiency, directly reducing the energy required per unit of lift. This improvement translates into a tangible reduction in emissions, depending on whether the electricity is supplied from on-site generation or the grid (Reda™ Maximus Eon™ extended-life, install-ready ESP motor, SLB, 2026). By lowering the fundamental energy intensity of the

ESP system, high-efficiency motors serve as a practical, low-disruption lever for decarbonizing artificial lift operations.

In addition, efficient gas-handling devices are engineered to deliver more effective energy transfer than conventional centrifugal stages, particularly under high gas-volume-fraction (GVF) conditions. By mitigating gas-locking and maintaining stable hydraulic performance, these devices enable the ESP system to process significantly higher percentages of free gas without operational interruptions. This enhanced gas-management capability supports smoother, more reliable operation in gassy wells and ultimately contributes to increased, more consistent production from the reservoir (Multiphase gas handling system, SLB, 2026).

Well Profile 1 — Low Flow (420–800 BPD)

This low-rate case has three production pump sections plus two tapered sections, a gas handling device upstream of tandem gas separators, a single four-chamber protector, and a high-efficiency two-pole induction motor set at 9,500 ft in 7-in., 32 lbm/ft production casing with 2.875-in. tubing. The fluid and reservoir properties are shown in **Table 1**.

Table 1 – Reservoir and fluid properties – Well Profile 1

Reservoir Temperature	255°F
Water SG	1.20
Oil API	41°API (~0.82 SG at 60°F)
Gas SG	0.89
WC	82%
GOR	3,716 scf/stb
GLR	668 scf/stb

Two operating points were evaluated on equal liquid targets ~420 BPD and ~800 BPD, holding pump intake pressure above the bubble-point envelope via VSD control to suppress gas-interference excursions. The HE-IM reduced junction-box apparent power materially, which, after power factor (PF) and efficiency normalization, that yielded 3.7% for the high potential production stage evaluation where the estimated production is allocated at 800 BPD and 3.5% for the low potential production stage evaluation where the estimated production is allocated at 420 BPD, getting as a result a reduction in TCO_2e/year, respectively; the cohort mean is 3.6% in average of the two well profiles. Mechanistically, gains derive from lower copper/core losses, improved slip efficiency, and fewer high-amperage transients during ramp-and-hold sequences, compressing kWh/BBL without eroding drawdown. **Figure 1** shows for both types of motor under the same well profile, operating parameters for final emissions analysis. As previously mentioned, high-end sets at 800 BPD, and low-end is at 420 BPD. Results stated a reduction in emissions at 3.7% and 3.5%, respectively.

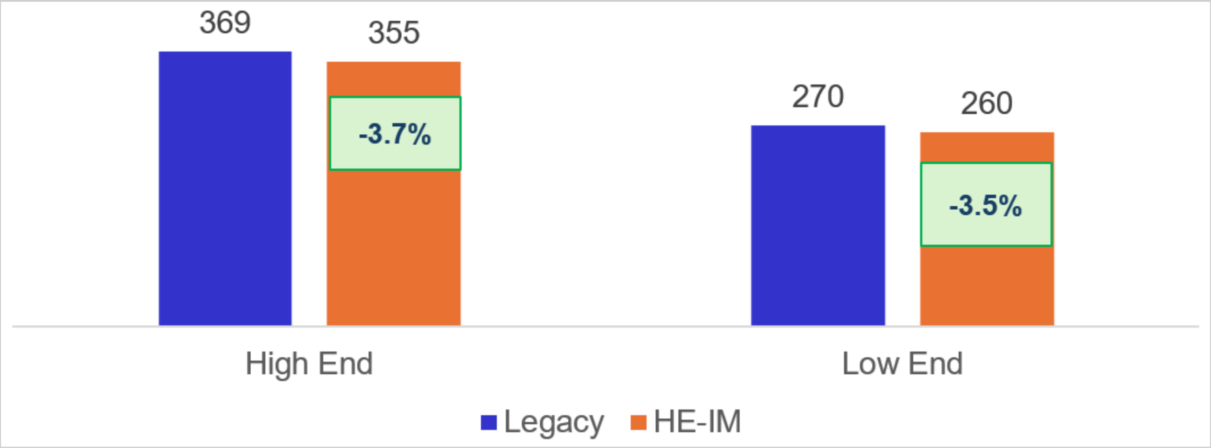


Figure 1 – Well Profile 1 – Case Comparison (TCo₂e/year).

Well Profile 2 — Low-Mid Flow (800–1100 BPD)

The low-mid profile has the same ESP configuration (three pump sections + two charge pumps, gas handling device + tandem separators, four-chamber protector, HE-IM) with the pump set at 9,700 ft in 7-in., 32 lbm/ft casing and 2.875-in. tubing. The fluid and reservoir properties are shown in **Table 2**.

Table 2 – Reservoir and fluid properties – Well Profile 2

Reservoir Temperature	255°F
Water SG	1.20
Oil API	41°API (~0.82 SG at 60°F)
Gas SG	0.89
WC	71%
GOR	1,722 scf/stb
GLR	500 scf/stb

Under increasing dynamic head and rising produced-water fraction, legacy motors trend into a steeper loss curve and poorer power factor (PF), whereas the HE-IM keeps the operating point inside its efficiency plateau across 50–60 Hz. On matched production targets at ~800, normalized energy analyses show 4.2% of energy consumption reduction, while for the high potential production stage evaluation where the estimated production is allocated at 1,100 BPD and 4.9% of energy consumption reduction for the low potential production stage evaluation where the estimated production is allocated at 800 BPD, getting as a result a reduction in TCO_2e, for a profile average of 4.6%. Digital optimization contributed by damping pump-off/slug cycles, maintaining intake-pressure stability, and minimizing inrush-heavy restarts, all of which shorten the “entropy tail” (non-productive energy consumption, kWh) common in water-rising wells. **Figure 2** shows both types of motors under the same well profile, operating parameters for final emissions analysis. As previously mentioned, high end set at 1,100 BPD and the low-end is at 800 BPD. Results stated a reduction in emissions at 4.2% and 4.9%, respectively.

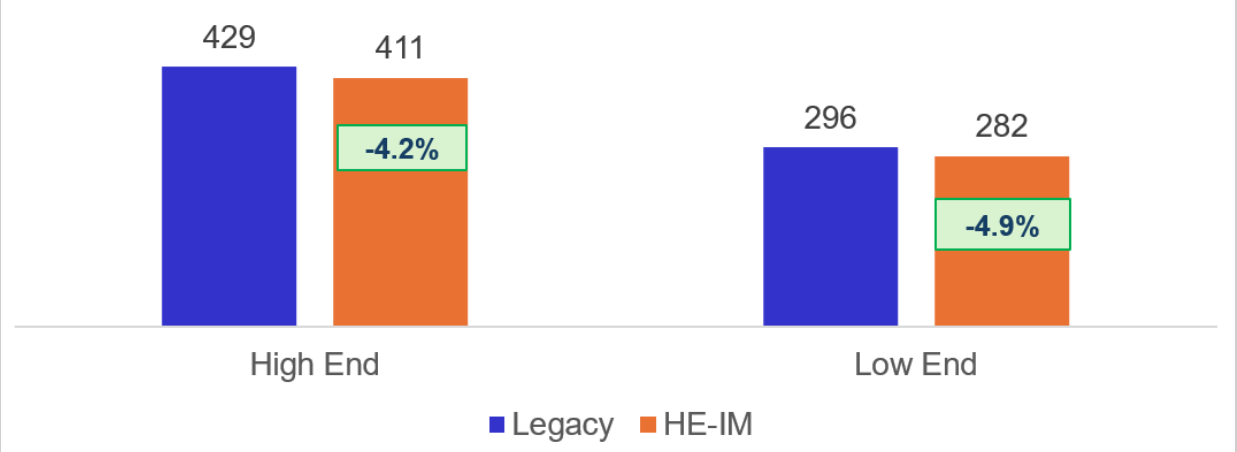


Figure 2 – Well Profile 2 – Case Comparison (TCo$_2$e/year).

Well Profile 3 — Mid-High Flow (1,400–1,700 BPD)

This ESP configuration comprises three production pumps plus one charge pump, a gas handling device, tandem gas separators, a single four-chamber protector, and an HE two-pole motor landed at 10,300 ft in 7-in., 32 lbm/ft casing and 2.875-in. tubing. The fluid and reservoir properties are shown in **Table 3**.

Table 3 – Reservoir and fluid properties – Well Profile 3

Reservoir Temperature	250°F
Water SG	1.20
Oil API	41°API (~0.82 SG at 60°F)
Gas SG	0.89
WC	60%
GOR	1,652 scf/stb
GLR	661 scf/stb

This well profile has a higher-rate, gassy-liquid regime where total dynamic head and gas management co-control energy intensity. At ~1,400 and ~1,700 BPD, HE-IMs reduced annualized emissions by 3.9% for the high potential production stage evaluation where the estimated production is allocated at 1,700 BPD and reduced annualized emissions by 4.2% for the low potential production stage evaluation where the estimated rate is allocated at 1,400 BPD, getting as a result a reduction in TCO_2e for a profile average of 4.1%, respectively. The improvement is consistent with reduced rotor/stator I^2R under high torque loading, better PF at operating slip, and more stable motor cooling, while the control layer muted intake-pressure oscillations (a frequent trigger of gas-lock recovery cycles that waste energy, kWh). **Figure 3** shows both motor types under the same well profile, with operating parameters used for final emissions analysis. As previously mentioned, high end set at 1700 BPD, and the low-end is at 1,100 BPD. Results stated a reduction in emissions at 3.9% and 4.2%, respectively.

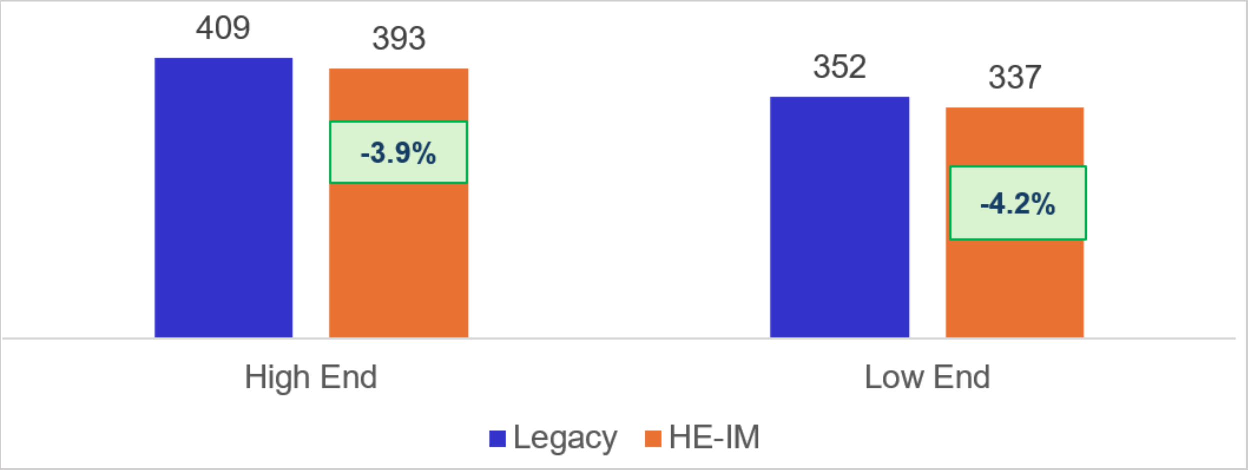


Figure 3 – Well Profile 3 – Case Comparison (TCo_2e/year).

Well Profile 4 — High Flow (2,200–2,750 BPD)

The high-rate ESP string comprises three pumps plus one charge pump, gas handling device + tandem separators, four-chamber protector, HE two-pole motor at 10,300 ft in 7-in., 32 lbm/ft casing and 2.875-in. tubing. The fluid and reservoir properties are shown in **Table 3.**

Table 3 – Reservoir and fluid properties – Well Profile 3

Reservoir Temperature	250°F
Water SG	1.20
Oil API	41°API (~0.82 SG at 60°F)
Gas SG	0.89
WC	64%
GOR	1,477 scf/stb
GLR	532 scf/stb

At elevated HP set points, the HE-IM advantage widens through lower core loss and improved PF at high load, while VSD ramp governance suppresses restart surges that dominate non-productive energy (kWh) in legacy systems. On matched targets of ~2,200 and ~2,750 BPD, the normalized analysis shows 8.1% of energy consumption reduction for the high potential production stage evaluation where the estimated production is allocated at 2,750 BPD and 13.7% of energy consumption reduction for the low potential production stage evaluation where the estimated rate is allocated at 2,200 BPD, getting as a result a reduction in Emissions (TCO$_2$e) for a profile average of 10.9%, respectively, the largest relative abatement among the studied cohorts. This reflects both thermodynamic efficiency at high torque and operational stability that maintains submergence and intake pressure within a narrow band. **Figure 4** shows both types of motor under the same well profile, operating parameters for final emissions analysis. As previously mentioned, high end set at 2,750 BPD and low end at 2,200 BPD. Results stated a reduction in emissions at 8.1% and 13.7%, respectively.

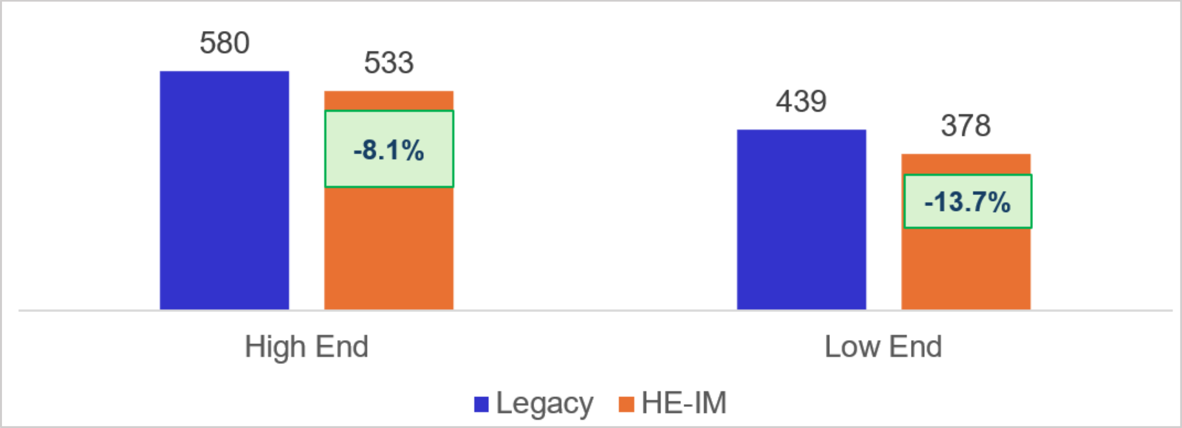


Figure 4 – Well Profile 4 – Case Comparison (TCo$_2$e/year).

Reliability Improvement – Average Run Life

Figure 5 shows that high-efficiency induction motors (HE-IM) deliver a clear uplift in ESP run life, averaging 249 days compared with 225 days for legacy motors. This improvement reflects design enhancements that reduce thermal stress, improve rotor–stator alignment, and stabilize motor loading under variable reservoir conditions. Combined with digital monitoring and predictive analytics, HE-IM systems enable earlier detection of degradation patterns, minimizing unplanned shutdowns. The result is a more reliable ESP fleet, longer operating cycles, and a measurable reduction in intervention frequency and lifecycle cost.

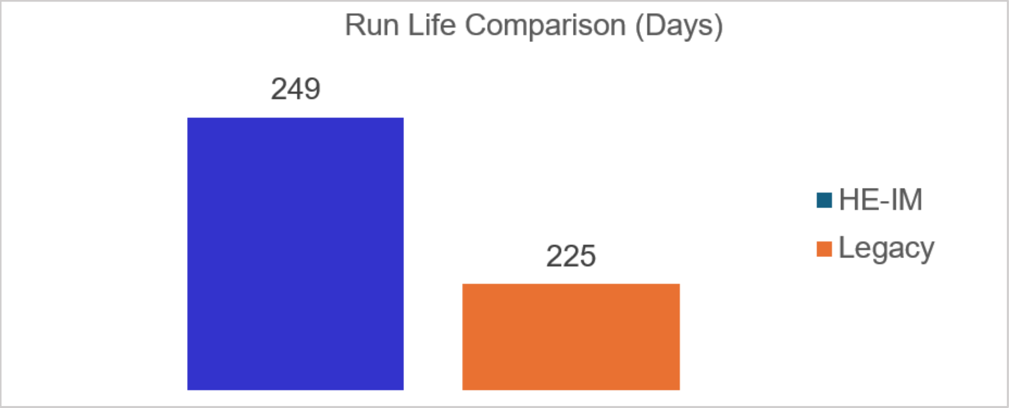


Figure 5 – Average Run Life Improvement

Figure 6 shows the Kaplan–Meier survival analysis (Bailey, 2006), which clearly demonstrates that high-efficiency induction motors (HE-IM) deliver a consistently higher probability of survival than legacy motors across all evaluated time frames at 90, 180, 270, and 360 days. At 90 days, HE-IM units exhibit a ~96% survival rate versus ~91% for legacy, indicating a 5-point advantage early in the run. This gap widens significantly by 180 days, where HE-IM maintains ~79% survival while legacy drops to ~64%, representing a 15-point differential driven by reduced thermal loading and improved winding integrity. By 270 days, HE-IM continues outperforming with ~56% survival compared to ~49% for legacy, reflecting superior resistance to mechanical wear and harmonic stress. At 360 days, the divergence is most pronounced: HE-IM motors retain ~34% survival while legacy falls to ~22%, a 12-point improvement. Overall, the survival curve indicates HE-IM motors degrade more slowly, benefiting from enhanced reliability design and digital monitoring that reduces failure acceleration and extends ESP operational life.

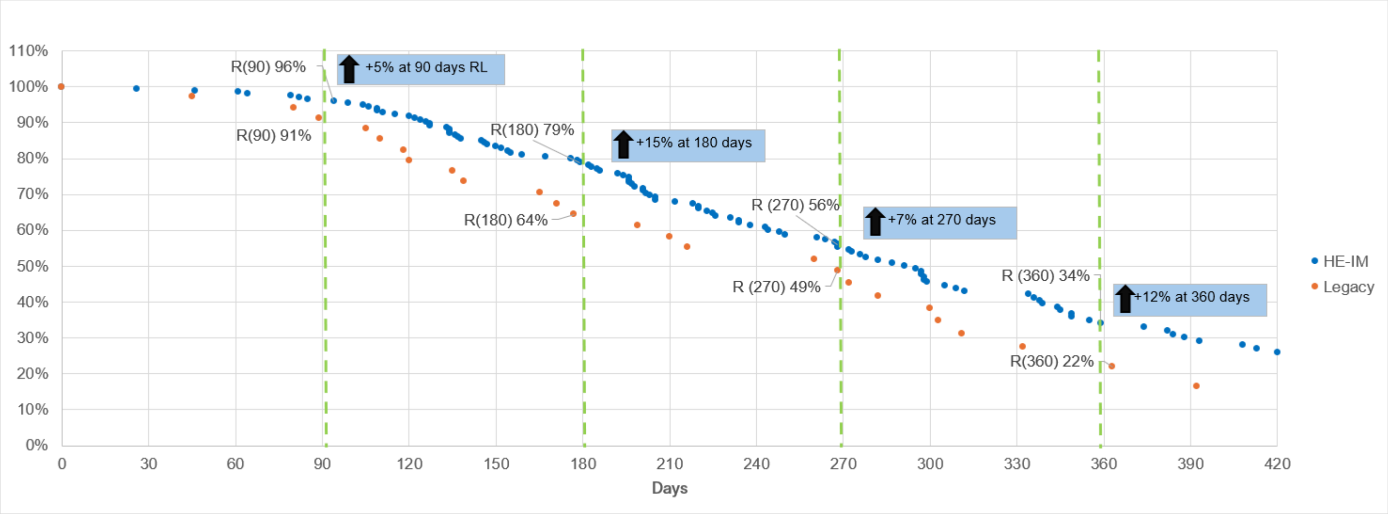


Figure 6 – ESP Survivability Chart (HE-IM vs Legacy)

REMOTE REAL-TIME MONITORING AND OPTIMIZATION

Artificial lift surveillance and remote monitoring are key enablers of modern oil and gas operations, providing real-time visibility and control over systems such as ESPs. By integrating sensor data, advanced analytics, and cloud-based platforms, operators can monitor equipment performance remotely, identify emerging issues, and implement predictive maintenance strategies, reducing the need for on-site interventions.

The capabilities of the real-time monitoring and surveillance digital center deliver continuous digital surveillance and automated optimization of ESP operating parameters. This real-time oversight supports more stable operation, helps reduce operational expenditures, enhances production performance, and contributes to environmental and sustainability goals by minimizing unnecessary field visits and preventing avoidable equipment failures.

Out of the 22 wells selected in the Bakken field operated by SOGC, a detailed assessment was conducted to evaluate the operational significance of remote interventions. This review identified three cases where remote actions were particularly critical in preventing equipment failures and mitigating production losses. The three critical interventions are summarized below:

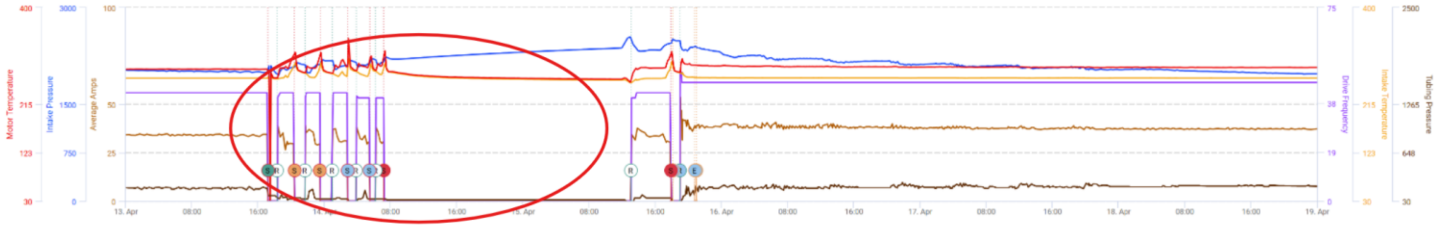
Case 01 - Insufficient Lift

The ESP was operating at a low frequency of 42 Hz while exhibiting a high pump intake pressure (PIP) of 2,337 psi. As the PIP continued to rise, the well experienced a loss of production, with tubing pressure dropping to 69 psi. The unit subsequently underwent multiple shutdowns caused by increasing motor and intake temperatures (Tm and Ti), a result of inadequate motor cooling. If unaddressed, these conditions could have led to a motor overheating event and potential ESP failure.

In response, the real-time monitoring and surveillance digital center team initiated a revised startup procedure. By applying a controlled speed ramp and gradually increasing the running frequency, the ESP was able to regain load progressively while minimizing the risk of repeated motor overheating caused by insufficient cooling.

Following this intervention, the ESP showed improved operational stability, evidenced by effective reservoir drawdown. Tubing pressure increased significantly to 234 psi, indicating a successful resolution of the issue and setting the stage for measurable improvements in production performance.

Figure 7 illustrates the number of ESP shutdown events occurring in one day period. During this interval, continuous operation of the unit did not exceed two hours. Following remote intervention executed by the real-time digital operations team, the ESP achieved a stable runtime exceeding four consecutive days without any interruptions or the need for on-site personnel involvement.



Before remote operations

After remote operations

Figure 7 – Case 01 – Insufficient Lift

Case 02 - Pump Off

The ESP was operating with a low PIP (171 psi) and showed significant fluctuations in motor amperage, indicating intermittent gas ingestion. These unstable conditions led to multiple shutdowns triggered by pump-off events, which were associated with low/reduced reservoir recovery and weak inflow capability.

The real-time monitoring and surveillance digital center team remotely adjusted the ESP control settings by switching the unit to Motor Amp Feedback (MAF) mode. They then optimized the target amperage to provide a more stable operating point, enabling longer uptime and a smoother drawdown while minimizing the likelihood of recurring pump-off events. **Figure 8** shows the impact of real-time operations on extending the uptime of the unit from one hour to more than two months.

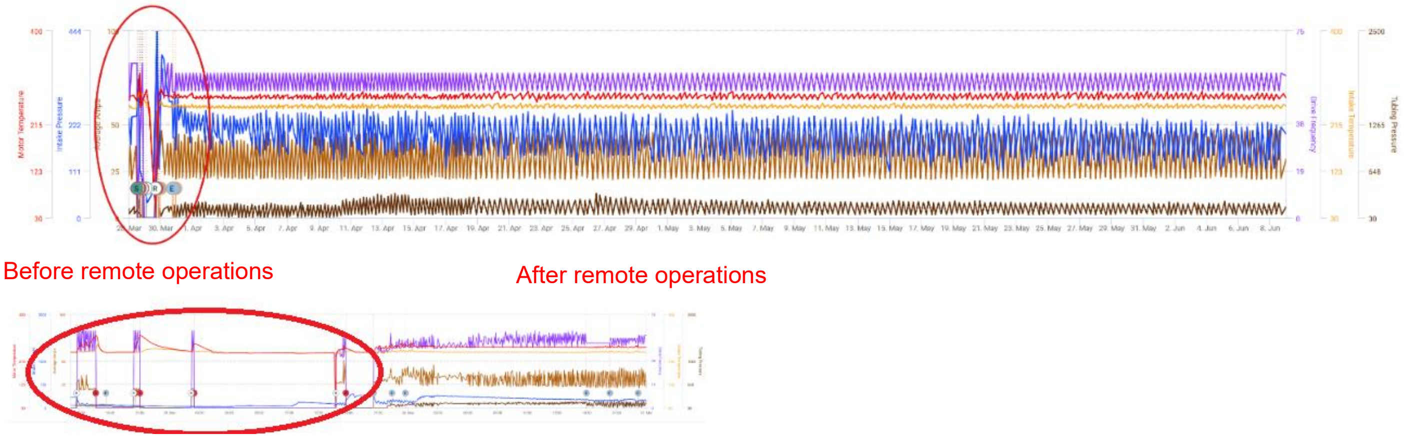


Figure 8 – Case 02 – Pump Off

Case 03 - Gas Interference

In this case, the ESP exhibited fluctuations in motor amperage, indicating the possible presence of gas within the pump. These conditions can accelerate early-stage pump degradation and may progress into a gas-lock event if not addressed, affecting both operational continuity and equipment integrity.

To mitigate this risk, the real-time monitoring and surveillance digital center team adjusted the unit's operating parameters by switching the ESP to MAF mode and increasing the feedback setpoint. This configuration provided a more stable operating load, improved drawdown efficiency, and enhanced overall operational stability, reducing the likelihood of gas lock and supporting more consistent well performance. **Figure 9** demonstrates how remote operations enhanced unit stability by achieving more consistent amperage levels and effectively managing gas interference.

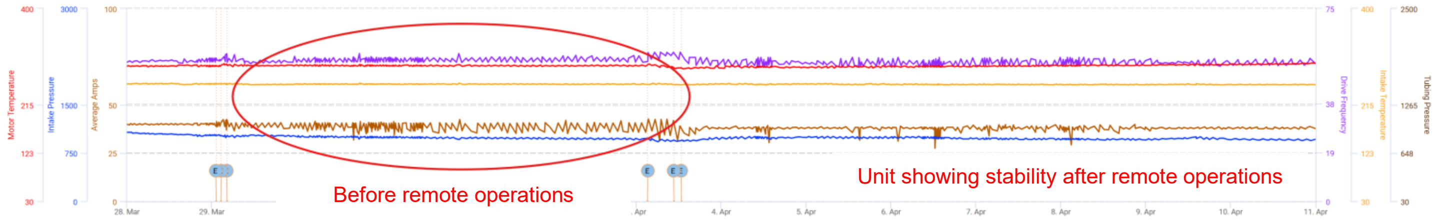


Figure 9 – Case 03 – Gas Interference

REAL-TIME MONITORING AND SURVEILLANCE DIGITAL CENTER SAVINGS CALCULATION

Assumptions and Notes

Based on the three cases presented above, the assumptions in **Table 4** were defined to support a consistent and accurate evaluation of the emissions reductions associated with remote operations.

Table 4 – Assumptions for evaluation of the Emission Reduction

Transport Method	Vehicle
Transport Details	Light Pickup-4 Doors Diesel Fuel
Base GPS / Distance Option	Distance
Measurement System	Imperial (mile)
Total Car Distance	Miles round-trip
Total Car Travel Hours	Roundtrip
Car Distance	Miles one way
Average Car Speed	mph
Rig Lead Time	4 Days

Total Miles Saved Miles

Each remote intervention eliminates the need for an on-site visit, directly translating into saved vehicle travel. This metric reflects the total miles avoided through remote operations. Fuel-related savings are calculated using an assumed fuel price of $2.70 per gallon and a vehicle efficiency of 20 miles per gallon (mpg), saving a total of 11,322 miles.

GHG Reduction

The GHG reduction is quantified as 5.7 mtCo$_2$e attributable to the decrease in vehicle emissions resulting from the miles avoided through remote operations. Based on the area fuel price, the vehicle's efficiency, and the total miles, the estimated savings amount to 1,528 USD.

Workover-associated mobilization activities reduction

Execution of three remote interventions eliminated the need for conventional workover mobilization, which typically requires daily travel to the well site. Under standard practice, each intervention would have required four days of field activity, with one round trip per day by vehicle to support the workover crew and associated equipment. By completing these activities remotely, operations avoided 12 site-visit days in total (3 interventions × 4 days). This avoidance directly reduced fuel consumption and the corresponding greenhouse gas emissions that would have been generated by those daily trips.

Remote operations reduced emissions by eliminating daily field mobilization and also delivered meaningful cost savings for the client. Although the real-time monitoring and surveillance digital center provided continuous support across the full population of monitored wells, only ~10% required critical interventions that directly avoided workover activity; this fraction was therefore used as the basis for estimating workover-related savings. The resulting value components included avoided workover execution costs, reduced field and workover labor hours (valued at the applicable labor rate), and minimized deferred-production losses enabled by timely remote action. After accounting for the service cost of the digital center, the net outcome demonstrates that remote operations provide both environmental and financial benefits to the operator.

Results

The results of the calculation made for the remote operations executed from the real-time monitoring and surveillance digital center are shown in **Table 5:**

Table 5 – Results for evaluation of the Emission Reduction

Item	Value	Conversion Note
Total Saved Miles	11322 miles	2.7 $ per gallon - 20 MPG Car*
GHG Reduction	5.7 $mtCo_2e$	10.21 kg Co2e per gallon*

* Source: EPA (2025), GHG Emission Factors Hub
https://www.epa.gov/climateleadership/ghg-emission-factors-hub

The implementation of remote operations through the Real Time Digital Center has demonstrated a positive impact on carbon emission reduction. The real-time monitoring and surveillance digital center reduced GHG emissions by 5.7 metric tons, primarily driven by 11,322 miles avoided through remote monitoring and intervention. Reducing the number of field visits decreases fuel consumption and lowers the carbon footprint associated with conventional field operations.

By minimizing the need for on-site interventions and improving operational efficiency, remote monitoring and surveillance contribute to both cost savings and reduced environmental impact. These results highlight the value of technology-driven solutions to address both economic and environmental challenges in industry.

CONCLUSIONS

For this study, a field-wide evaluation of 841 Bakken wells was conducted to quantify the carbon-intensity benefits achieved by upgrading legacy induction motors to high-efficiency induction motors (HE-IM) in conjunction with real-time optimization. The analysis segmented the population into four distinct production-rate cohorts representing typical basin variability: 243 low flow wells, 207 low-mid flow wells, 168 mid-high flow wells, and 223 high flow wells, where comparable parameters were equally auditable (bottomhole temperature, target production rates, gas production rates, equipment setting depth). For each cohort, paired comparisons were performed between wells operating with legacy motor systems and those equipped with HE-IM technology, ensuring a statistically balanced assessment of energy performance across differing horsepower loads and drawdown regimes.

Deployment of high-efficiency induction motors (HE-IM) combined with real-time optimization consistently drives TCo_2e reductions across all Bakken production cohorts without compromising drawdown or production targets. Cohort-level analysis shows average emissions abatement of 3.6%, 4.6%, 4.1%, and 10.9% across increasing flow-rate groups, with the highest-rate wells delivering the largest absolute impact due to greater horsepower demand and extended run-life exposure. At the field scale, implementation of high-performance ESPs demonstrates that motor-system upgrades represent a practical, low-disruption decarbonization lever in mature unconventional assets. Because emissions are calculated from actual kWh consumption rather than nameplate assumptions, results remain robust under operational variability and are readily transferable to other basins by adjusting the grid emission factor.

Results from the study demonstrate a substantial improvement in ESP performance and a marked reduction in environmental impact. The adoption of high-performance ESPs and digital operations led to a mean time to failure of 248 days, a significant increase in average run life from 110 days (with standard ESPs) to over 204 days, and ESP uptime consistently exceeding 90%. Real-time surveillance and remote interventions played a critical role in achieving these outcomes by enabling early identification of critical events and minimizing downtime. The adoption of advanced ESP technology and digital operations led to a reduction in carbon footprint by 5% per well per year (approximately 202 TCo_2e), achieved through reduced field trips, fewer workovers, and remote interventions that saved over 18,000 km (over 11,322 miles) in driving, reducing emissions by about 5 TCo_2e. Three critical remote interventions prevented ESP failures, eliminating additional workover jobs and further reducing emissions by almost 1 TCO_2e, for a total reduction of approximately 6 TCo_2e.

This case study offers novel, real-world data on the environmental and operational benefits of enhancing ESP survivability and leveraging digital solutions, an area not previously addressed in the existing literature. By minimizing production loss and nonessential field trips, the operator not only improved operational efficiency but also made a positive impact on the environment. The findings provide actionable insights for practicing engineers seeking to improve both operational and environmental performance in oilfield operations. This work demonstrates that the strategic deployment of advanced ESP technology, combined with digital optimization and proactive remote management, can serve as a model for sustainable practices in the oil and gas industry.

REFERENCES

Bailey, W. J., Weir, I. S., Couët, B et al. 2006. Survival Analysis: The Statistically Rigorous Method for Analyzing Electrical Submersible Pump System Performance. SPE Prod & Oper 21: 492–504. SPE-96722-PA. https://doi.org/10.2118/96722-PA.

EPA (2025), GHG Emission Factors Hub https://www.epa.gov/climateleadership/ghg-emission-factors-hub (accessed 12 February 2026).

Escobar, K., Radov, M., Vasilache, C. 2021. Defining a New Era for Induction Motors. Paper presented at the SPE Gulf Coast Section Electric Submersible Pumps Symposium, The Woodlands, Texas, United States, October. SPE-204511-MS. https://doi.org/10.2118/204511-MS

Europump, 2024. Use Phase GHG Emissions from Pump Units. (accessed 20 February 2026).

Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification (ISO 14067:2018)

SLB. 2026. Multiphase gas handling system. https://www.slb.com/products-and-services/innovating-in-oil-and-gas/completions/artificial-lift/electrical-submersible-pumps/reda-esp-pump-system/esp-gas-devices/mgh-multiphase-gas-handling-system (accessed 23 February 2026).

SLB. 2026. Reda Maximus Eon motor. https://www.slb.com/products-and-services/innovating-in-oil-and-gas/completions/artificial-lift/electrical-submersible-pumps/reda-esp-pump-system/motors/reda-maximus-eon-esp-motor (accessed 23 February 2026).

Useche, C., Montes, E., Guerrero, C. 2022. Evaluation of the carbon footprint produced by conventional artificial Lift systems in a Colombian field. Journal of Petroleum Science and Engineering. Volume 208, Part E, https://doi.org/10.1016/j.petrol.2021.108865.

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