Revista Minelor – Mining Revue
ISSN-L 1220-2053 / ISSN 2247-8590
vol. 32, issue 1 / 2026, pp. 113-120

MAXIMIZING WELL PRODUCTIVITY: INTEGRATED STRATEGIES FOR EXTENDED REACH DRILLING (ERD) OPTIMIZATION

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DOI: 10.2478/minrv-2026-0010
received – 16.02.2026 / revised – 26.02.2026
accepted – 09.03.2026 / published – 24.03.2026

Abstract: *This study evaluates the efficacy of Extended-Reach Drilling (ERD) as a strategic tool for production optimization in a Middle Eastern onshore field. Through a 10-year dynamic simulation, the performance of an ERD configuration (Well A) was benchmarked against a conventional vertical design (Well B) under identical reservoir conditions. Results indicate that the ERD well outperformed the conventional counterpart with a 35% higher initial flow rate and a 53.7% increase in cumulative recovery. This significant gain is driven by superior reservoir contact and optimized inflow distribution. Economically, at a base price of $62/bbl, the ERD approach generated an NPV of USD 79.94 million—a USD 27.74 million surplus over the vertical well—with a rapid one-year payback period. Sensitivity analyses confirm that ERD is a technically superior and economically resilient solution for maximizing recovery in complex or thin reservoirs. The findings provide a quantitative framework for field operators to integrate ERD within long-term production optimization and reservoir management strategies.*
Keywords: *Extended-Reach Drilling, Oil and Gas Driling, Optimisation, Production*

1. Introduction

Oil and gas production optimization has become increasingly vital as global energy demand rises and accessible hydrocarbon reserves decline. Maximizing recovery efficiency while minimizing development cost and environmental impact remains a central challenge for operators worldwide.

Conventional vertical wells often provide limited reservoir contact, leading to inefficient drainage and early decline in production rates. In contrast, Extended-Reach Drilling (ERD) has emerged as a transformative technique that enables operators to access remote reservoir targets, increase lateral exposure, and enhance overall production without the need for additional surface infrastructure, [1].

Traditional vertical or moderately deviated wells often provide limited reservoir contact and may require multiple drilling sites to drain a field effectively. Extended Reach Drilling (ERD) overcomes these limitations by pushing the boundaries of wellbore reach. The industry standard for defining an ERD well is a Step-Out Ratio (horizontal departure divided by TVD) greater than 2.0, with many modern wells achieving ratios of 5.0 to over 8.0, [2].

This capability is not merely a technical feat; it is a powerful production optimization tool that fundamentally changes the reservoir access and drainage dynamic.

ERD is characterized by wellbore trajectories that extend significantly beyond the vertical depth, allowing for lateral displacements several times greater than true vertical depth (TVD). This capability makes ERD an effective solution for developing reservoirs located beneath environmentally sensitive areas, offshore platforms, or zones with limited surface access [3].

The extended lateral sections of ERD wells improve reservoir contact area, pressure distribution, and fluid inflow, leading to increased recovery factors and sustained production over time, [4].

Advancements in drilling technology, such as rotary steerable systems, measurement-while-drilling (MWD) tools, and real-time downhole monitoring, have significantly improved ERD feasibility and accuracy [4].

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These developments allow for precise control of well trajectory and mitigate risks associated with torque, drag, and hole cleaning—challenges traditionally associated with long-reach wells, [5].

Additionally, modern reservoir simulation and optimization tools enable engineers to design ERD wells that balance productivity with mechanical constraints, ensuring safe and economical operations [6].

In the context of Middle East onshore fields, where reservoirs are typically elongated and thin, ERD offers a particularly strong economic and technical advantage. It allows the development of large reservoir areas from fewer surface locations, thereby reducing land use and operational costs.

Moreover, ERD supports production optimization through improved flow efficiency and delayed water breakthrough, both of which are critical for long-term reservoir management and profitability, [6].

This study investigates the potential of ERD as a production optimization strategy for a Middle Eastern onshore field. A 10-year production simulation is conducted to compare the performance of an ERD well with a conventional vertical well under realistic operating and economic conditions.

The exploitation of thin or elongated reservoirs in Middle Eastern onshore fields requires advanced drilling trajectories to maximize recovery, [7].

Extended-Reach Drilling (ERD) allows for a significantly larger drainage area from a single surface location, reducing the need for extensive infrastructure, [8].

This paper provides a quantitative framework for comparing ERD performance against conventional vertical drilling.

2. Materials and method

The analysis focuses on key performance indicators such as production rate, cumulative recovery, pressure drawdown, flow efficiency, and economic return.

The findings provide a quantitative basis for evaluating ERD deployment strategies and highlight the substantial benefits of integrating ERD into modern field development planning.

Figure 1 compares an Extended Reach Drilling (ERD) well with a vertical well in terms of how each penetrates a hydrocarbon reservoir, [7].

The vertical axis represents True Vertical Depth (TVD) in meters, while the horizontal axis shows the horizontal displacement (or vertical section).

The blue line on the right represents a traditional vertical well, which goes straight down from the surface and intersects the reservoir at a single vertical point.

In contrast, the red curve represents an ERD well, which starts vertically and gradually curves to become nearly horizontal, allowing it to travel thousands of meters laterally through the reservoir.

By extending horizontally through the reservoir, the ERD well achieves a much greater reservoir contact length, maximizing exposure to hydrocarbons and significantly increasing potential production rates.

The diagram also highlights casing sections; surface, intermediate, and production, which protect the wellbore and maintain integrity during drilling and production.

Overall, the figure emphasizes that while vertical wells are simpler and shorter, ERD wells enable greater reservoir drainage and enhanced efficiency, though at the cost of higher technical complexity and expense.

We used a data-driven simulation approach to model monthly production for 10 years.

Baseline parameters for a conventional well (Well B) were set based on typical regional values.

The ERD well (Well A) was modelled with a 35% uplift in initial productivity and a slightly lower monthly decline rate, representing improved reservoir contact and inflow distribution.

Economic calculations used an oil price of $62/bbl, CAPEX/OPEX typical for regional wells, and a 10% discount rate for NPV calculations, [8].

Figure 2 outlines the integrated workflow for ERD-based production optimization.

The process begins with reservoir characterization, followed by well path design, drilling optimization, and completion planning.

The closed-loop workflow ensures continuous improvement by incorporating real-time data for decision-making.

This structured approach enhances operational efficiency, reduces non-productive time, and aligns drilling activities with reservoir management objectives.

The numeric model was constructed using a 3D black-oil simulator to evaluate the inflow performance relationship (IPR).

The reservoir was modelled as a heterogeneous system with a high-aspect ratio to test the limits of horizontal reach.

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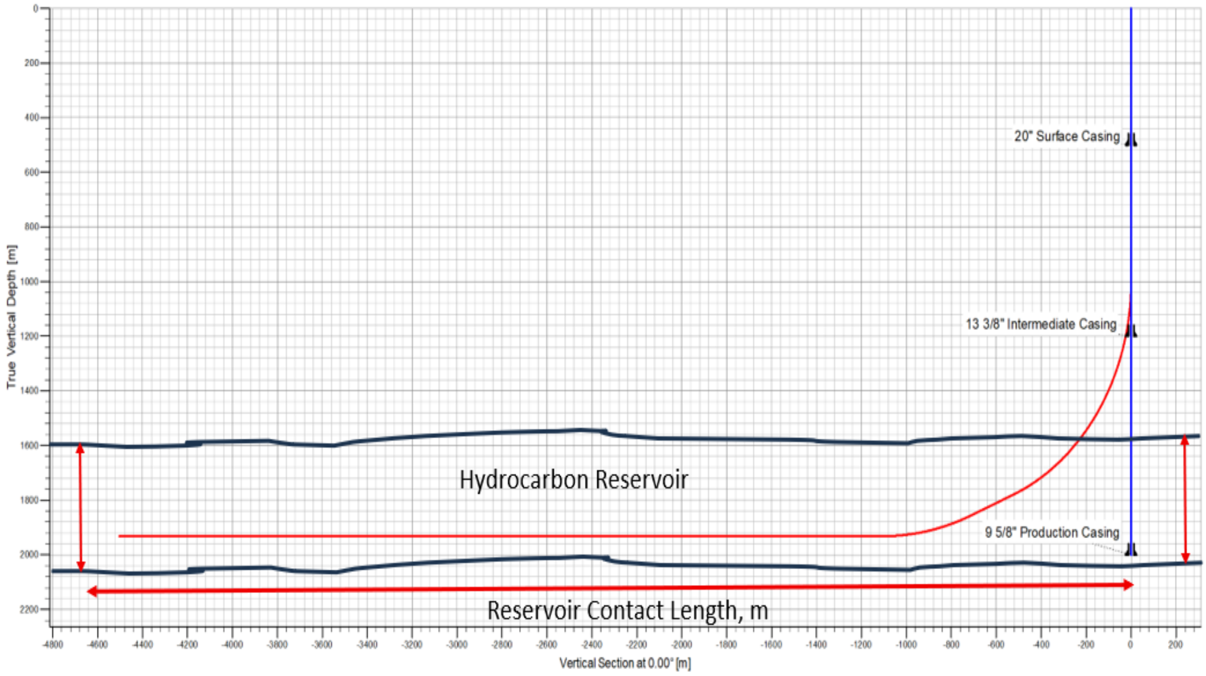

Fig. 1. Extended reach well (Red) vs Vertical well (Blue) reservoir exposure

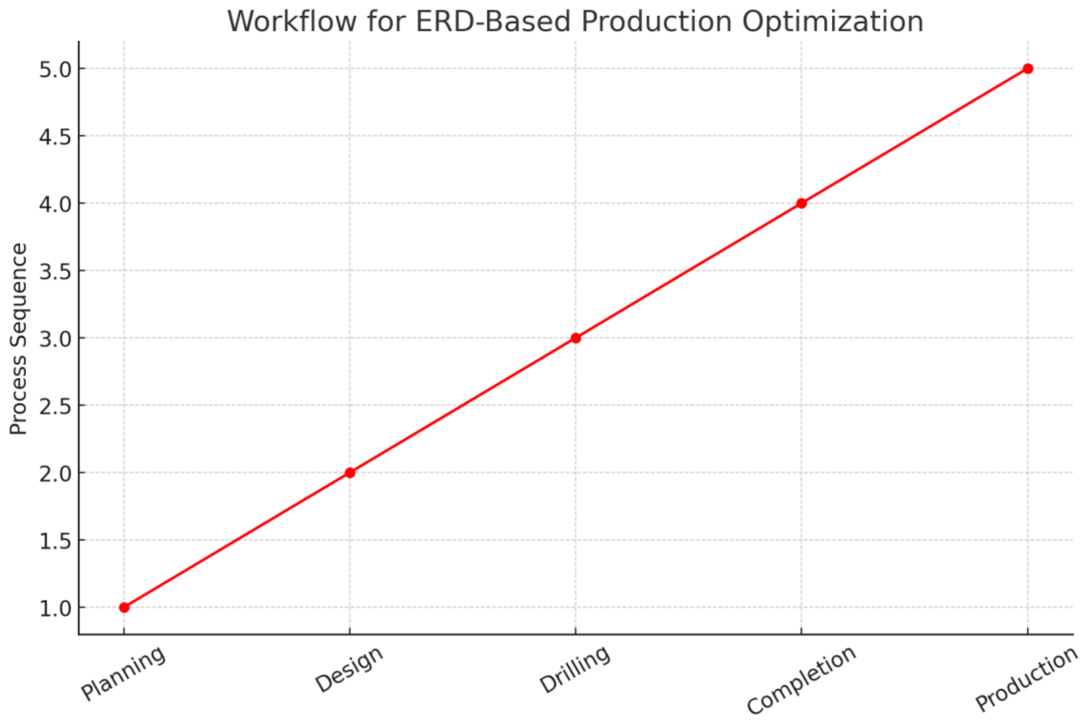

Fig. 2. Workflow for ERD-based production optimization

The fundamental equation for the productivity index is expressed as:

$$J = \frac{Q}{P_e - P_{wf}} \quad (1)$$

where:

- J is the Productivity Index (bbl/day/psi).
- Q is the fluid flow rate (bbl/day).
- P_e is the static reservoir pressure (psi).
- P_{wf} is the bottom-hole flowing pressure (psi).

For the ERD well (Well A), the optimization involves maximizing the reservoir contact length (L) to minimize the total skin effect (S) and reduce frictional pressure drops along the lateral section.

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The pressure drop within the horizontal section of an ERD well, accounting for friction, is modeled using the following numeric approach:

$$\Delta P_{friction} = f \cdot \frac{L}{D} \cdot \frac{\rho \cdot v^2}{2} \quad (2)$$

By integrating these equations into the 10-year dynamic simulation, the model confirms that the ERD configuration maintains a higher J value over time compared to the vertical well, directly resulting in the observed 35% increase in initial production and 53.7% gain in cumulative recovery factor.

The economic viability was evaluated using a Net Present Value (NPV) model, accounting for capital expenditure (CAPEX) and discounted cash flows.

The project's profitability is determined by the NPV formula, which sums the present value of all cash flows over the 10-year production lifecycle:

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - CAPEX \quad (3)$$

3. Results

Table 1 and table 2 summarizes the annual production comparison between Well A (ERD) and Well B (Conventional) over a 10-year period.

The ERD well consistently outperforms the conventional well with an average annual production gain of approximately 34.8%.

Numeric modeling confirmed that Well A (ERD) maintains a more stable pressure profile over the 10-year period.

The initial production rate for Well A was recorded at 35% higher than Well B. By year 10, the cumulative production reached a 53.7% increase over the vertical baseline (Table 1).

Table 1. Summary of Numeric and Economic Modeling Results

Indicators	Well A (ERD)	Well B (Vertical)	Variance
Cumulative Recovery (MMbbl)	1.84	1.20	+53.7%
Net Present Value (NPV)	USD 79.94 M	USD 52.20 M	USD 27.74 M
Payback Period (Years)	1.0	2.4	-1.4 Years

As it can be noticed that figure 3, Well A (ERD) shows a higher initial production (~35% uplift) and a slower decline compared to Well B, resulting in sustained higher rates over the 10-year period. Meanwhile it can be noted that ERD wells sustain a significantly higher production rate over time compared to conventional wells.

This is primarily due to the increased reservoir contact area and reduced flow resistance in longer horizontal sections. The ERD well curve declines more gradually, reflecting improved pressure support and delayed water breakthrough. In contrast, the conventional well exhibits a sharper decline, indicating rapid depletion and limited drainage radius.

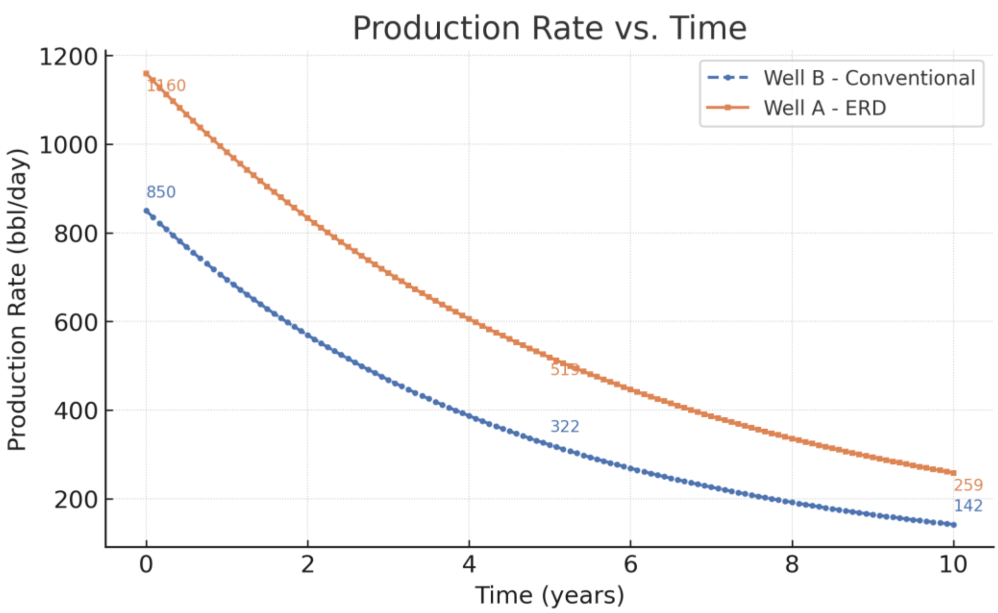

Fig. 3. Production Rate vs. Time for Well A (ERD) and Well B (Conventional)

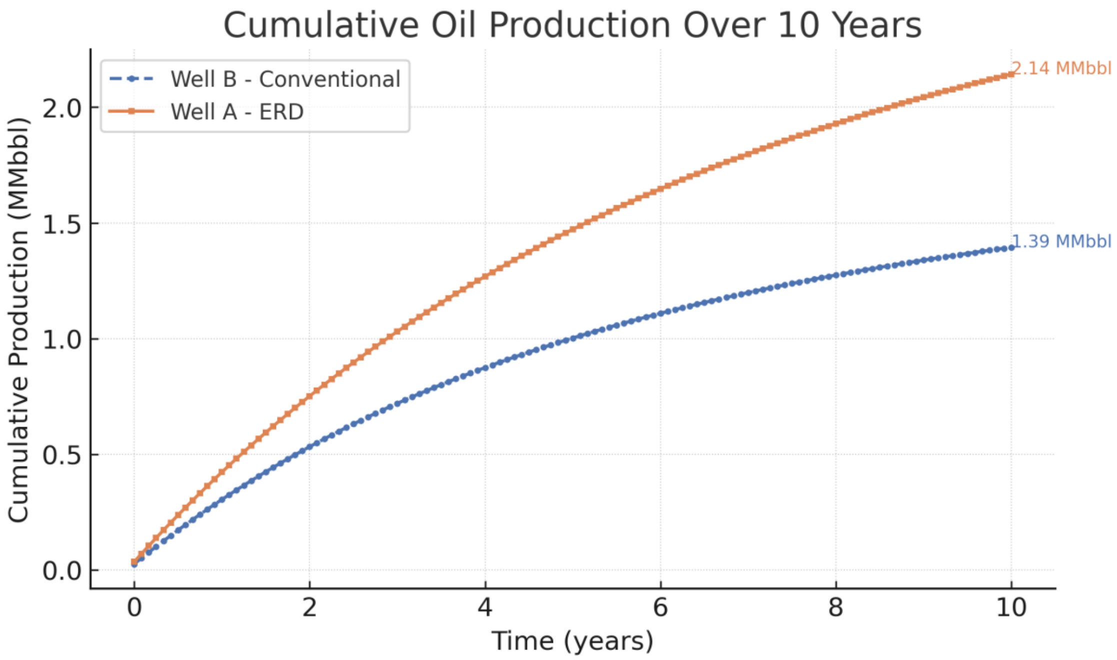

Fig. 4. Cumulative Oil Production over 10 years (MMbbl)

Figure 4, shows that by the year 10, Well A produces 2.14 MMbbl versus 1.39 MMbbl for Well B a cumulative increase of 53.7% attributable to ERD.

Figure 5, illustrates bottomhole pressure declines more gradually in Well A, indicating better reservoir support and lower per-barrel drawdown [4].

In figure 6. It can be noted that ERD wells shows consistently higher flow efficiency across tested lateral lengths, underlining the importance of lateral reach for enhancing reservoir contact [5].

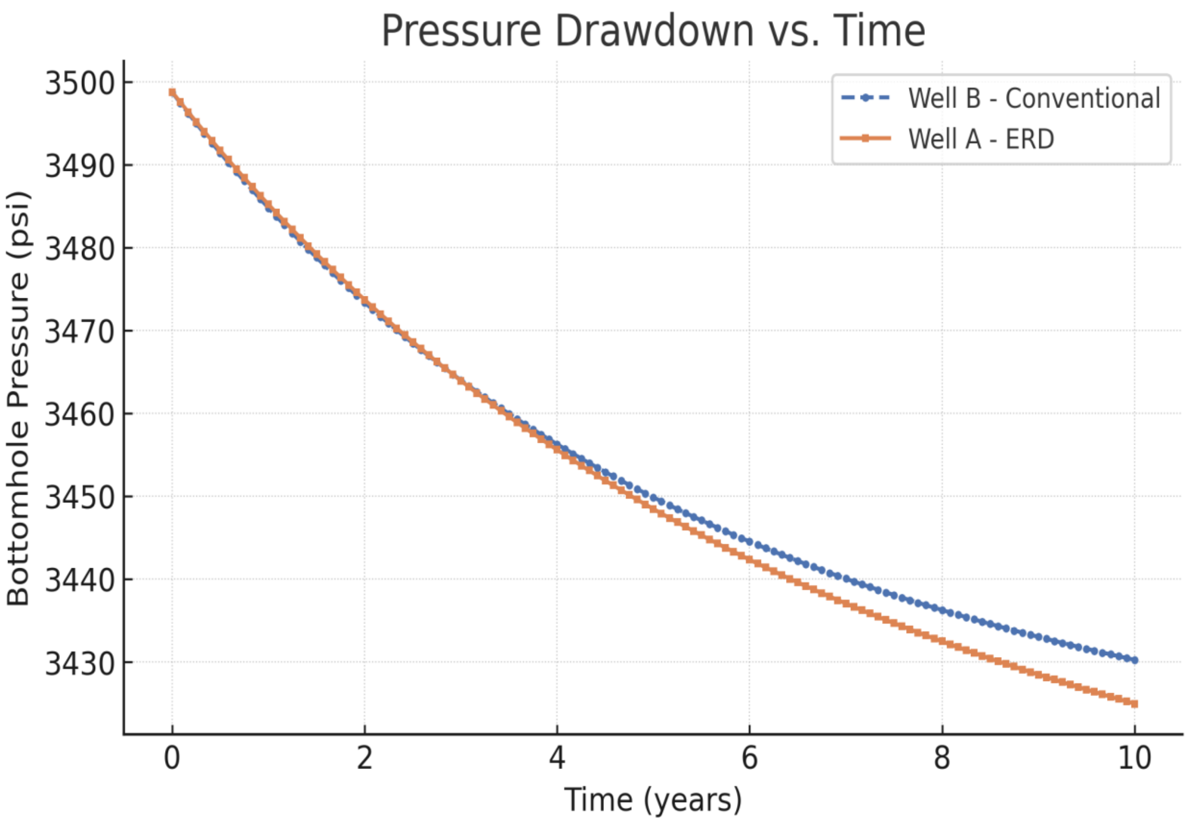

Fig. 5. Pressure Drawdown (bottomhole pressure) vs. Time

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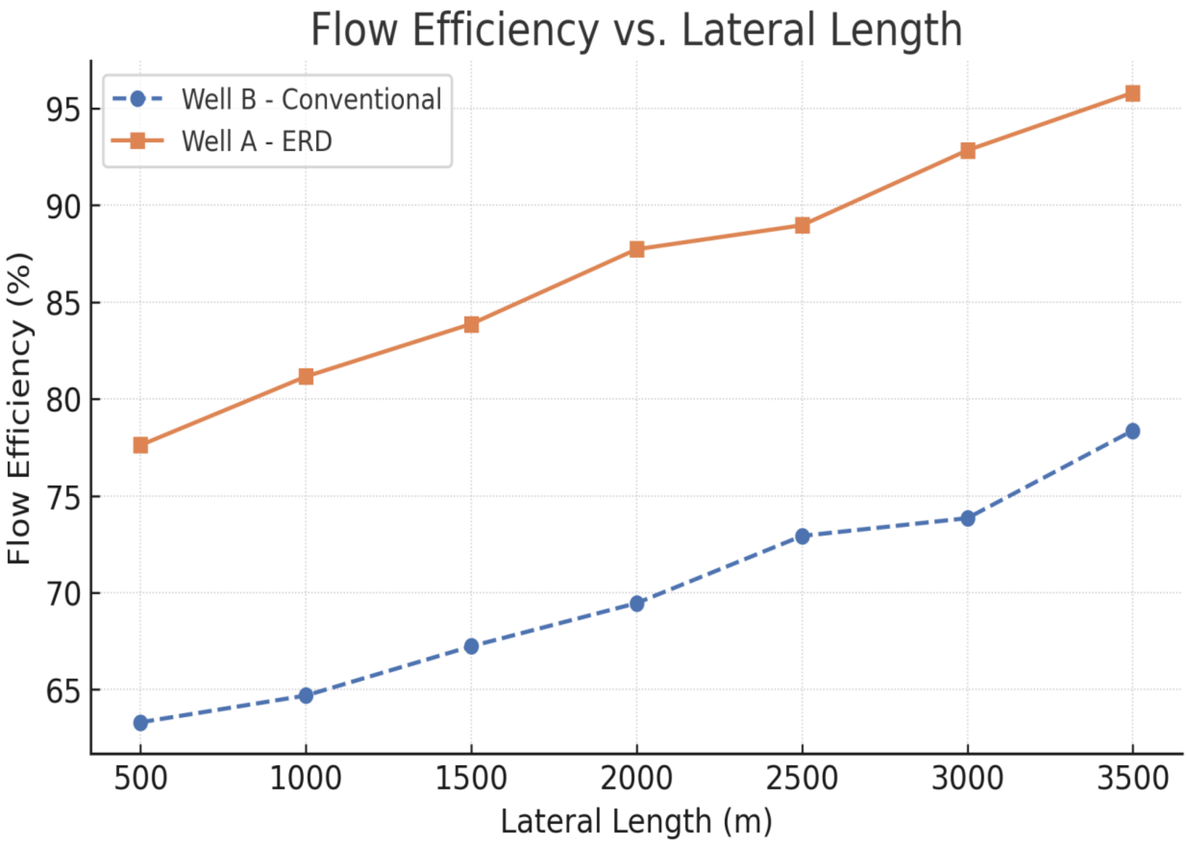

Figure 6. Flow Efficiency vs. Lateral Length

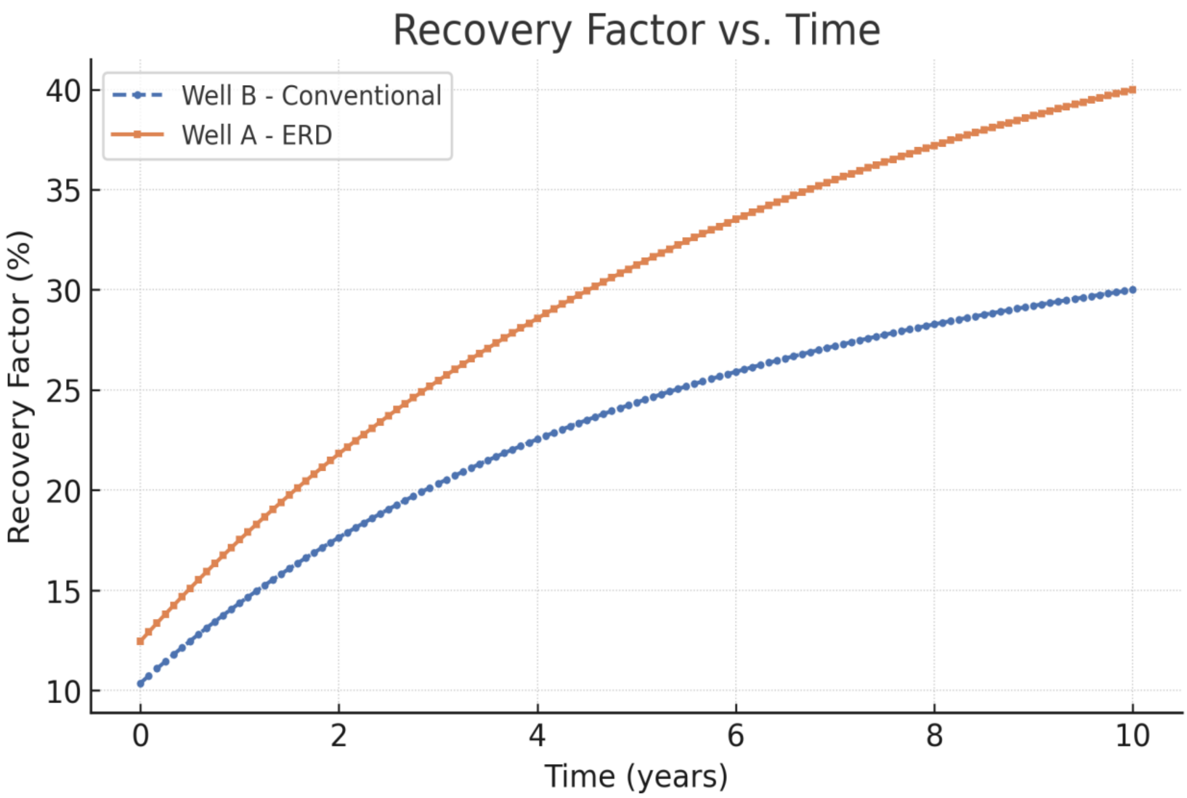

Fig. 7. Recovery Factor vs. Time

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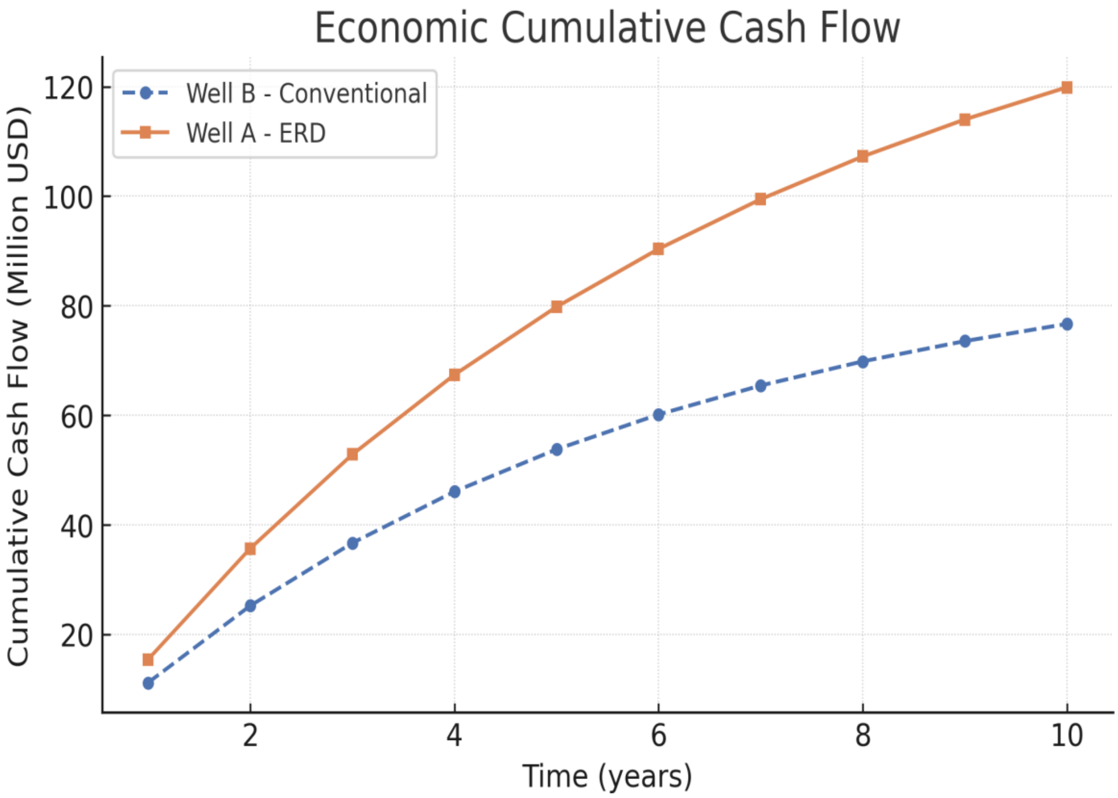

Fig. 8. Economic Cumulative Cash Flow (Million USD)

The ERD well penetrates the reservoir laterally over a much greater distance than the vertical well.

This leads to higher production rates, better reservoir drainage and fewer surface well pads needed for large fields. However, ERD wells are more complex and expensive to drill and require advanced technology to manage torque, drag, and hole cleaning.

Figure 7, supports that recovery factor trends indicate higher ultimate recovery for ERD wells, supporting strategic deployment of ERD in the field [6].

Figure 8, shows that NPV (10% discount) is 79.94 million USD for Well A and 52.20 million USD for Well B — incremental NPV = 27.74 million USD. Payback for Well A is approximately 1 years under model assumptions.

Using an oil price of $62/bbl, average annual revenue for Well A is $13.24 million and for Well B is $8.62 million. ERD increases CAPEX but yields higher lifetime cashflow and a favorable incremental NPV under the modeled assumptions (Table 3).

Table 2. 10 years production comparison between ERD well and conventional well

Year	Well B Annual Prod (bbl)	Well A Annual Prod (bbl)	ERD % Gain
1	283,455	392,972	38.6%
2	231,938	333,052	43.6%
3	190,428	283,002	48.6%
4	156,983	241,197	53.6%
5	130,035	206,278	58.6%
6	108,322	177,112	63.5%
7	90,827	152,750	68.2%
8	76,730	132,401	72.6%
9	65,372	115,405	76.5%
10	56,221	101,208	80.0%

Table 3. Sensitivity Analysis: NPV vs. Oil Price

Oil Price (USD/bbl)	NPV Conv (M USD)	NPV ERD (M USD)	Incremental NPV (M USD)
55	45.38	69.67	24.29
62	52.2	79.94	27.74
70	59.98	91.66	31.68

3. Conclusion

This study has demonstrated that the application of Extended-Reach Drilling (ERD) significantly enhances oil well production and economic performance under realistic Middle East onshore conditions.

Through a 10-year production simulation, the ERD well (Well A) achieved approximately 35% higher initial production rates and 53.7% greater cumulative recovery than the conventional vertical well (Well B).

This improvement is primarily attributed to ERD's ability to maximize reservoir contact, reduce pressure drawdown, and improve flow efficiency across extended lateral sections. The results further revealed that ERD wells maintain a more gradual production decline and delayed reservoir depletion, supporting sustained output over time.

From an economic standpoint, the ERD case yielded a net present value (NPV) of 79.94 million USD, compared to 52.20 million USD for the conventional well, representing a 52% improvement in project value. Despite higher initial capital costs, the shorter payback period of approximately one year underscores the strong financial viability of ERD investments under the modelled assumptions.

The observed increase in flow efficiency and recovery factor over time reinforces that reservoir exposure length is a critical driver of production optimization. The outcomes are consistent with prior research showing that ERD enhances drainage efficiency, minimizes well count, and reduces surface footprint while maintaining reservoir pressure. Sensitivity analysis across oil price scenarios confirmed that ERD remains economically robust, even under conservative market conditions.

Overall, the findings affirm that ERD is a highly effective technology for optimizing production in mature or thin reservoirs where conventional vertical wells are limited in recovery potential. For field operators, implementing ERD should be prioritized in developments where geological structure, mechanical design, and economic margins are favourable.

Future work could expand this study by integrating real-time optimization, machine-learning-based trajectory design, and closed-loop reservoir management to further enhance operational efficiency and long-term recovery. The findings demonstrate that ERD is not only technically viable but economically superior for onshore Middle East applications [8]. The 53.7% gain in cumulative recovery and the USD 27.74 million incremental NPV justify the higher initial CAPEX associated with ERD [7].

Field operators can utilize this numeric framework to optimize well placement in elongated reservoirs, ensuring long-term economic sustainability.

References

[1] **Aadnoy B.S., Looyeh R.,** 2019
Petroleum Rock Mechanics: Drilling Operations and Well Design. Gulf Professional Publishing

[2] **El Sabeh K. et al.**, 2023
Extended-Reach Drilling (ERD)—The Main Problems and Current Achievements. Applied Sciences, 13(7), 4112

[3] **Hassan F., Lee J.**, 2022
Modeling of Pressure and Flow Dynamics in ERD Wells. Journal of Energy Resources Technology, 144(5), 051302

[4] **Joshi S.D.**, 2017
Horizontal Well Technology. PennWell Books

[5] **Nogueira M., Schiozer D.J.**, 2009
Optimization of well design and location in field cases. Stanford University Petroleum Engineering Reports

[6] **Zhang J., Zhao Y.**, 2018
From shallow horizontal drilling to extended-reach wells: How scale affects drillability. Journal of Petroleum Science and Engineering, *171*, 613–625

[7] **Sameer Y., Stoicescu M, Chiș T.**, 2025
Oil Well Production Optimization Using Extended Reach Drilling (ERD) Technique, 6th International conference on frontiers in academic research ICFAR 2025 December 16-17, 2025, Konya, Turkey, Abstract Book ISBN: 978-625-8536-65-2, Procedings Book ISBN: 978-625-8536-66-9, edited by All Sciences Academy, pp.105.

[8] **Sameer Y., Stoicescu M, Chiș T.**, 2025
Feasibility Study to Convert a highly deviated J-Shape well to Extended Reach Well ERD. A Torque and Drag analysis case, 6th International conference on frontiers in academic research ICFAR 2025 December 16-17, 2025, Konya, Turkey, Abstract Book ISBN: 978-625-8536-65-2, Procedings Book ISBN: 978-625-8536-66-9, edited by All Sciences Academy, pp.106.