NextWave Production Rejuvenation Solution
Maximize value from existing shale wells
A steep decline curve in production performance typically occurs over a three-year (or shorter) period in unconventional wells. The result is an estimated recovery of only 10% or less of available reserves.

At that point, you may choose to accept suboptimal production rates, drill more wells to try and meet production targets, or blindly restimulate existing wells.

None of these options represent an effective or efficient approach for managing, or increasing your return on investment, but this has been business as usual—until now.

Now, there is another option—one that uses a science- and fact-based methodology to help maximize value from your wells that still have more production to offer.
In this scenario, by restoring connections to previously stimulated intervals and tapping into zones that were missed in the initial stimulation three years prior, a properly planned well rejuvenation would reestablish initial production levels and significantly increase total recovery.
To most service companies with fracturing fleets, every well is a potential refrac candidate. While there is a lot of focus and activity around refracturing, not every well benefits equally from this approach. It is important to build your efforts on a process that leverages science and facts, and to understand the reasons behind poor well performance.

The Baker Hughes NextWave rejuvenation solution uses reservoir and production data to identify the wells that have the highest potential to be restored to, and to even exceed, initial production levels in order to boost ultimate recovery—ensuring that financial resources are allocated to the wells with the highest probability of success.

First, analyze overall field production data. Then, examine each well for a variety of factors, including:

- Productivity
- Decline curve
- Original completion and stimulation program

**Step 1: Select the best rejuvenation candidates**

well rejuvenation

the process of restoring production in existing wells through efforts that can include wellbore cleanup, installation of artificial lift and or restimulation.
The NextWave candidate selection suite helps Baker Hughes experts rapidly access and examine both proprietary and public well data. By combining the selection suite with a rigorous workflow, it is possible to quickly:

- Determine individual well performance
- Identify which wells were placed in the “sweet spot”
- Spot relevant patterns, including the effectiveness of different completion and production practices on well performance

The NextWave candidate selection suite includes information from more than 4 million wells across all of the major unconventional basins in North America, making it the industry’s most comprehensive tool for analyzing production data. Close review of these wells through the NextWave suite’s Discovery™ tool has revealed thousands of wells that were understimulated in their first fracturing treatment. These wells present a unique opportunity to quickly and cost-effectively restore production without drilling new wells.

Review field production data

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Selecting the best candidates for rejuvenation is not as simple as identifying the underperforming wells. In fact, the best performers in a field often represent the best candidates. And, for underperforming wells, it is important to understand the reasons behind the poor production. The proprietary NextWave workflow ensures that every well’s background and production history is fully understood and contextualized before any recommendations are provided.

Our holistic approach includes a rigorous interpretation of large data sets through nonlinear multivariate statistical analysis that provides extremely valuable information on production drivers and local correlations.

Along with the reservoir and production data, the determination of the time throughout the life of the well when rejuvenation is required, as well as the evaluation of the economic benefits, will be the primary factors in the candidate selection process.
Rank wells based on economic potential

After thoroughly analyzing field data and examining the individual wells, Baker Hughes experts estimate the rejuvenation potential of each well using key reservoir and well parameters. Wells are then ranked, with the best candidates receiving the highest scores in the most categories. This ensures that you can maximize your rejuvenation investment by targeting the wells with the greatest potential and avoiding the wells with limited prospects.
Once the best candidates have been identified, each well requires additional analysis to understand the production contribution from the existing fracture stages, along with a comprehensive review of the initial completion and the wellbore’s condition.

These efforts can include:
- Examining the original completion and stimulation
- Conducting a thorough wellbore cleanup
- Verifying the integrity of the casing and cement
- Creating a diagnostic profile of existing fractures
- Gathering additional formation evaluation data if needed

Step 2: Diagnose the production framework and potential of each well
Review original completion and stimulation design
During this phase, the Baker Hughes team works closely with you to review the parameters of the well’s original completion and fracture treatment. Those data are examined, along with available formation and production logs, to better understand each stage’s contribution to the well’s overall production and to also determine if any additional logging is required to gain the necessary insight. If additional data needs are identified, the cost and risk of obtaining the data will be weighed against the benefits. The well review will also identify any restrictions associated with the initial completion, such as casing size, that could limit your rejuvenation options. In many cases, cuttings from the time the well was drilled can be analyzed to establish formation mineralogy, total organic carbon, and rock brittleness.
Confirm technical feasibility and well integrity

Conducting a thorough well cleanout prior to developing your rejuvenation plan is critical. Often, these cleanouts can temporarily boost production, and some have even been effective at achieving the desired recovery levels without requiring any additional rejuvenation efforts.

Immediately following the cleanout process, Baker Hughes evaluates the burst and collapse strength of the casing and confirms the well’s mechanical integrity. Collecting this data helps determine the most effective isolation method if well restimulation is needed to improve production.

Baker Hughes offers a comprehensive portfolio of wellbore cleanup and displacement services to effectively clean your well and remove all debris prior to any rejuvenation efforts. The Baker Hughes integrated offering known as the X-Treme Clean™ wellbore cleanup and displacement solution enables you to significantly reduce cost and risk by using Baker Hughes tools and chemicals that are tailored to your requirements.

The Baker Hughes EasyReach™ service combines thorough planning and advanced technologies to significantly increase the lateral reach of coiled tubing (CT) compared to conventional solutions—helping make successful CT applications in lateral lengths greater than 12,000 feet routine.

Note: Sample analysis of 2-in. coiled tubing in 5½-in. horizontal well. Ability to transfer 500 lbf available weight on bit for each condition is listed above.
Evaluate reservoir quality and producing intervals

Estimations of the remaining reserves and the current reservoir conditions are extremely important aspects of the candidate selection process. Baker Hughes can effectively evaluate and identify the optimal stimulation zones and characterize flow from existing fracs—helping identify any high-potential zones that were left untreated or understimulated.

Injectivity and drawdown tests can be performed to help understand pore pressures and fracture networks, and to identify optimal treatment parameters. Other key measurements, such as deep shear wave, can help refine reservoir models by identifying geological features including faults and natural fractures that do not intersect the borehole.

The review of information may also include petrophysical analysis of legacy rock cuttings in the field. This qualitative and quantitative nondestructive analysis provides vital information on textural, micro-fabric, and elemental and mineralogy, and allows our experts to further refine the well profile by tying the cuttings analysis to a specific well interval or stage.

Mineral map with individual mineral grains identified by color (26 micron)

BSE image of cuttings particles (1 micron)

Combining production logs with reprocessed seismic data and cuttings analysis helps identify the best intervals for restimulation.
You may find, based on the well examination, that the cleanup process itself improved production, or that one of Baker Hughes advanced electrical submersible pumps ( ESPs) is the best option for restoring the well to desired production levels. However, because the production benefits from a well cleanup are often fleeting, and not every well is an ESP candidate, combining these efforts with refracturing is often the best solution for higher, sustained production.

When refracturing is necessary, the production profile data from existing stages provides additional near-wellbore understanding that can be used to further refine the existing reservoir model. This gives our experts the insight they need to design the most effective rejuvenation program and forecast each program’s expected results. The rejuvenation options will be carefully evaluated and selected based on our sound engineering practices and available production results.

This process ensures that you can effectively manage costs by limiting your reinvestments to viable refrac candidate wells that can be rejuvenated—at a fraction of the cost of new wells—not just once, but multiple times.
The pros and cons of each restimulation method are considered, and the production forecast is aligned with the efficiencies achieved by each intervention technique.

Unlike conventional solid particulate diverter systems, the Baker Hughes REAL Divert™ Complete system incorporates specially engineered, strong, ultra-lightweight proppant, along with the dissolvable particulates, to ensure that all pathways remain fully open for hydrocarbon flow once the diverter dissolves—eliminating the risk of a near-wellbore “choke” that could limit production rates.

Baker Hughes also offers a variety of advanced frac fluid systems engineered to optimize production efficiently and effectively, including a new suite of frac fluids specifically engineered for reliable application using recycled production water.

If downhole scale or asphaltene deposition was a contributing factor to the original well’s rapid decline curve, the restimulation treatment can incorporate patented Baker Hughes Sorb™ solid scale inhibitors. Sorb particles are placed into the reservoir, along with the proppant, and inhibition chemicals are released into the produced fluids over extended periods of time, providing enhanced flow assurance—increasing production and reducing the likelihood of future interventions.
Model and select the optimal rejuvenation program

Sometimes, the right artificial lift technology is the key to restoring production from unconventional oil plays. The Baker Hughes ProductionWave™ FLEXible production solution combines a purpose-built artificial lift system with experts in system performance optimization to help operators increase production rates, (in some cases, by more than 40%) while lowering operating expenses and reducing health, safety, and environmental risks in comparison with rod-lift operations. A ProductionWave solution also includes flexible commercial models to fit your unique business requirements.

If additional reservoir stimulation is needed, Baker Hughes experts build on reservoir analysis by using proprietary data from thousands of professionally engineered stimulation treatments to design the most effective fracture or acid stimulation program customized to achieve your technical, environmental, and production goals. Refracturing program objectives often include:

- Restimulating underperforming intervals
- Stimulating previously untreated zones to increase reservoir contact
- Reestablishing connectivity to the wellbore through preexisting fractures

The optimized program is built using a process that weighs the technical feasibility and risk against the cost of intervention. A variety of remedial, completion, and fracturing techniques can be employed to drive the restimulation treatment to the desired sections of the reservoir. These technical alternatives include:

- Fluid diversion
- Mechanical isolation:
  - Expandable liners
  - Cement squeezes
  - Slim ball drop multistage completion systems
- Chemical remediation
- Coiled tubing interventions with packers or straddle tools.
Perform reservoir, geomechanics, and fracture modeling

Baker Hughes JewelSuite™ subsurface modeling and geomechanics software improves understanding of unconventional plays. By showing all relevant aspects of the reservoir as integrated 3D models and combining them with advanced geomechanical models, our experts refine your fracturing program based on the most comprehensive reservoir data set available.

Then, by inputting the frac fluid system, proppant selection, and the proposed pumping schedule, our experts can model both fracture geometry and conductivity by using our MFrac™ suite software. It is also important to consider how the well will be put back on production after the treatment. Proper flowback management is crucial in order to ensure optimal flow rates and to achieve desired production.

During the fracture modeling stage, Baker Hughes can create a stage-focused fracture mechanics model, which can then be combined with the microseismic data to optimize the re-frac treatment schedule in real time.

Review and revise economic analysis

In the final step before initiating a rejuvenation treatment in the field, our experts employ JewelSuite software and a variety of production forecasting tools to perform sensitivity analysis to refine the job design based on net present value or the predicted effectiveness of the refracturing treatment.

The result is a fully optimized treatment designed in a manner that maximizes your ultimate recovery—and your ROI.
Step 4: Execute the plan

Efficient and effective field execution is the final, but crucial step in your rejuvenation process. Baker Hughes has a full arsenal of completion and stimulation technologies and services to help prepare any well for refracturing, to close off existing stages that are not part of the refrac design, and to isolate the desired frac stages to effectively restimulate the well.

A second, but equally important, part of executing the field program is managing wellsite operations. Baker Hughes assigns a dedicated wellsite coordinator and project manager who are responsible for overseeing the project, resulting in better execution efficiency and improved overall communications.

Finally, it is critical to review the complete rejuvenation program, along with the field results, in order to update any and all planning processes and forecasting models.
Design a detailed operational plan
Before executing in the field, every step of the operational plan is documented and reviewed to ensure safe, reliable, and on-schedule operations. In essence, Baker Hughes experts document each and every well operation on paper before initiating any wellsite activities.

Manage all wellsite activities
Each project receives a dedicated wellsite coordinator and project manager who are accountable for flawless job execution. The wellsite coordinator is responsible for effective communication across all disciplines to ensure alignment of goals and objectives while avoiding any unnecessary delays or downtime. The project manager provides a single point of contact for all communications between you and the Baker Hughes team executing the job.
Monitor and collect data on treatment effectiveness

During the refracturing process, monitoring fracture propagation is important to ensure the success of the job. Real-time microseismic monitoring on a refrac operation can significantly enhance both stimulation treatment efficiency and ultimate recovery. This real-time monitoring can quickly confirm zone restimulation and map new fractures. When you receive immediate feedback on diverter behavior, you can better control the frac in real time. The combination of microseismic and real-time pressure monitoring during the treatment improves fracture geometry estimation and overall stimulation effectiveness.

This live data, combined with post-refrac analysis, is crucial to refine and enrich the reservoir models for the next refracturing operation. It also takes a multi-well approach to identify the most effective rejuvenation treatments, and to help further drive efficiency, reliability, and improved ultimate recovery.

At the wellsite, the effectiveness of restimulation treatments is often assessed through microseismic measurements—allowing one to optimize stage placement, better assess fracture geometry and orientation of the fracture network, and determine the changes in subsurface stress distribution due to reservoir depletion. Microseismic data from previous or offset wells can be used to enhance future program design. Baker Hughes can also monitor the effectiveness of any flow assurance treatment, including extended chemical treatment programs with our unique Sorb family of scale and asphaltene inhibitors. SENTRYNET™ intelligent injection technologies and monitoring services can be leveraged to further enhance production, and to confirm customized chemical programs perform as planned to enhance flow, improve ESP performance, and help you meet your production goals.

As part of a NextWave solution, we also track post-treatment well production. Verifying actual production against the projected results ensures rapid adoption of successful rejuvenation practices based on improved reservoir models—further driving ROI on future rejuvenation projects.
Capture even greater value with flexible commercial models

We know that each unconventional shale play operator has different business drivers. That’s why we offer commercial models that increase economic value to you by aligning our success with the success of your well. We offer these flexible models (such as direct contracting of all services, execution-based risk, and production-based risk), because we strongly believe in our ability to cost-effectively rejuvenate your wells for maximum recovery.

Partner with Baker Hughes and let us help you accomplish your production objectives.

Contact your local Baker Hughes representative or visit BakerHughes.com/NextWave to learn more about how our NextWave solution can help you extract more value out of your existing shale wells.