Case Study

PREDICTING NATURAL GAS WELL FREEZING

FOR A TOP FIVE OIL AND GAS COMPANY

Elder Research developed risk models that predicted well freezes with 70% accuracy, enabling targeted well intervention to reduce freeze remediation cost and recover gas production that would have been lost or deferred.

INDUSTRY

» Oil and Gas

BUSINESS NEED

» To predict when natural gas wells were at risk for freezing and when wells were likely to need a downhole pump installed

SOLUTION

» Developed Downhole Freeze and Plunger Pump risk models that provided actionable predictions of which wells would freeze and projected the impact of timely intervention

BENEFIT

» Predictive analytics was successful at predicting downhole freeze events and the need for plunger installation 70% of the time

» Prioritized well intervention resources and reduced freeze remediation costs

The Challenge

Natural gas wells have a propensity to "freeze" (or "shut-in" due to hydrate obstruction), especially during harsh winter months, losing or deferring gas production and incurring intervention costs to disperse the obstruction and/or install a downhole pump. Predicting when each natural gas well is at risk for freezing and when it is likely to need a downhole pump installed is a challenging problem, but knowing the risks in advance enables effective prevention. The client engaged Elder Research to discover and communicate actionable insights about well production and propensity to freeze (or experience pump failure) based on well design, environmental conditions, well interventions, and other data gathered by the client. The goal was to optimize intervention resources to achieve the greatest benefit.

The Solution

Over a terabyte of operational (instrumental) well data was harnessed to identify and predict well freeze events on about 1,700 wells. The data was mostly from wellhead and separator tanks and included temperatures, pressures, tank levels, and flow rates. Also, operational reports of freezes were provided, and records of well design, well environment, and production history played predictive roles in the models. The data was large, diverse, noisy, often erroneous, and incomplete so many rules were developed and applied to clean the data and impute estimated values when data feeds were down or unreliable. The data were effectively normalized for predictive modeling and a subset of wells were identified for modeling purposes that had

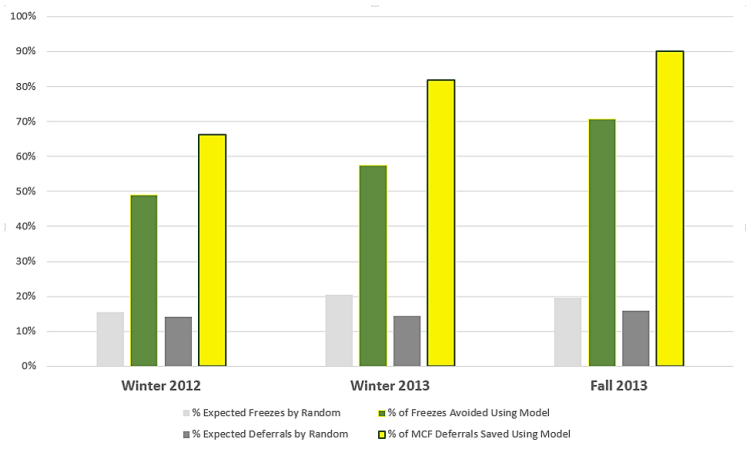

Figure 1. Freeze Model performance compared to random decisions

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sufficiently complete data for the time period of the study. With input from the client on how engineers and operators understand and articulate well condition and capacity, the data was aggregated in ways that were relevant to gas well operation. Key ratios that affect the well's propensity to freeze within the next three months were calculated.

Elder Research modeled well freezing and the need for plunger pump installation to predict the impact of interventions on production volume. We were able to predict well freezing several times better than any previous efforts given the available data. SAS Enterprise Miner was employed to model the well outcome (production volume or propensity to freeze) based on predictive factors such as environment, well design, and interventions. Several modern modeling algorithms — including decision trees, neural networks, regression, and ensembles of multiple techniques — were applied, tuned, and evaluated.

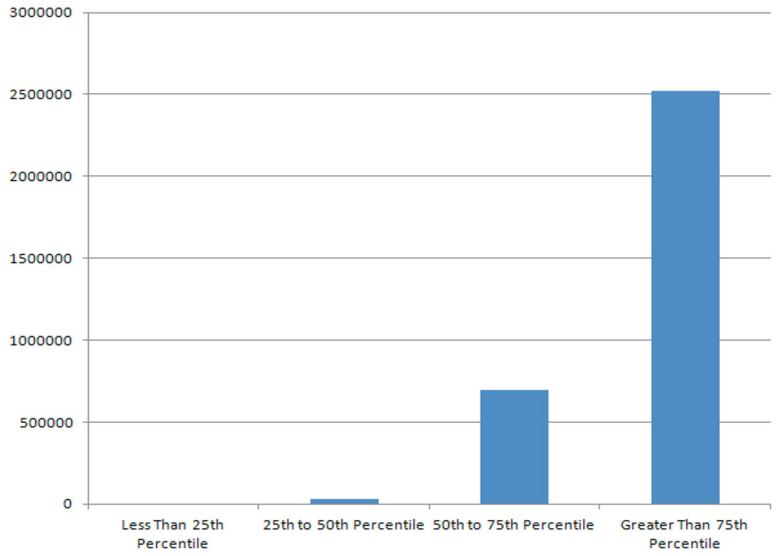

Figure 2. Total gas production deferrals (MSCF, or million standard cubic feet) versus recommended time to plunger installation date. The recommended time after start of well production is before the 50th percentile date. This demonstrates the benefit of knowing when pump installation and activation should to be completed. The required information is available within one month of start of production.

During the model building process, the insights about predictive relationships were reviewed periodically with client subject matter experts. The models were cross-validated using several independent samples of the observations that were not used for building the model. Once the structure of a model was validated, tested, and finalized, it was tuned using all available observations, including those from the validation and testing samples. The team applied the predictive models for well interventions to all wells with adequate data available and predicted which wells would improve production if an effective intervention were made. Elder Research designed custom data visualizations to illustrate important relationships and how cross-validation validated the models on historical data. Both models were thoroughly vetted by the client using a blind validation process.

Results

Actionable insights about well production and freeze propensity were discovered. The Plunger Pump model produced useful and flexible predictions for optimizing the timing of plunger pump installation and was projected to reduce production deferrals by 15-20%. Testing of the Downhole Freeze model revealed that it had a 70% success rate. Its insight helped the client prioritize well interventions and optimize intervention resources to reduce freeze remediation costs. It was projected to save 600,000 MSCF (million standard cubic feet) in deferred gas volume annually.

About Elder Research

Elder Research is a recognized leader in the science, practice, and technology of advanced analytics. We have helped government agencies and Fortune Global 500® companies solve real-world problems across diverse industries. Our areas of expertise include data science, text mining, data visualization, scientific software engineering, and technical teaching. With experience in diverse projects and algorithms, advanced validation techniques, and innovative model combination methods (ensembles), Elder Research can maximize project success to ensure a continued return on analytics investment.

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