

The Keys to the Future Oil and Gas Production Facility: The Colorado Story

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With growing concern about climate change, the need for a diversified energy portfolio for energy security and the expectation for an energy transition away from fossil fuels to non-carbon energy solutions, such as renewables, all signals suggest that the energy transition has already begun. States like Colorado has been rewriting regulations to include stricter rules on oil and gas production. While the energy industry is transitioning due to market forces, public policies, and technological advances, fossil fuels are not yet out of the picture for the total energy supply of the future.

From our research about the DJ Basin in northeast Colorado, along with the success, or failure, of drilling and production permits since 2019, we have identified the following seven facilities design and

public engagement principals as key elements for the future oil and natural gas production facilities for the DJ Basin, and maybe even as a guide for other North American onshore shale basins. The increasing regulations may start in Colorado but will most likely be adopted in some form in other producing states. New Mexico has already begun a review of their environment regulations and could follow the Colorado example. These are our thoughts and we are responsible for them, but we have validated them with experienced subject matter experts from major operators involved in these major capital decisions.

While no two drilling and production permits are exactly the same, these concepts can and should be broadly applied as much as practical. They are more of a toolkit than a template. They are best focused on new permits and facilities, but the challenge of operating legacy operations will still be a part of the operator's responsibility, especially as many of these older vertical wells, or first-generation horizontal well pads, are critical to hold leases for future development.

Factors such as geology, economics, proximity to infrastructure (both pipelines and grid power), leasehold configuration, proximity to residential and commercial properties (remember the 2,000-foot standoff consideration) will all influence the design of the next generation of oil and natural gas production facilities. Operators may also have to factor in the impact of community expectations for "unquantifiable and perceived risk" factors in their designs.

This is more than just a conversation internal to the company based on costs versus production value analysis (like ROI- return on investment or ROCE- return on capital employed) but one that involved community and regulatory requirements. It may take deeper pockets, a longer strategy planning time horizon and an ESG investment perspective from the top of the corporate hierarchy, but this is the new evaluation equation that is evolving. But these seven design principles will help, even if an operator only holds these solutions in a "toolbox" and applies them to specific opportunities.

1) **A large consolidated and compact leasehold**, preferably away from urban or fast growing suburban residential areas. The focus of our work is future facilities design near urban and suburban environments but the safest way to minimize difficulties is to avoid them in the first place. In the DJ basin that favors the rural areas of Weld County where the bulk of the production comes from anyway. This approach is summarized in the phrase: "*avoidance, miniaturization and mitigation.*" According to one of our expert interviews: "*If an application is rural and not in a sensitive wildlife receptor habitat the permit will be fairly easy to apply for and receive.*" Case in point two of the first permits approved after SB-181 were both smaller rural applications in eastern Colorado."

The Front Range of northern Colorado is a popular and growing area. Colorado's population grew by nearly 15 percent between 2010 and 2020, according to U.S. Census Bureau data, so suburban sprawl is inevitable. Metro Denver now the fifth least affordable housing market in the United States.

If you don't have a single large land owner, like Kerr McGee has with Bronco CAP, then work with your land department to trade and acquire leases to develop a lease hold like Chevron has at Mustang where they can access an eight square mile lease from a single 7.5-acre production pad, with as many as 28-32 horizontal wells. Chevron has two drilling rigs that are capable of drilling 100 wells per year taking only 3-5 days to drill each well. Two and a half mile laterals are now the norm. In some cases, the growth of residential properties will come to the oil patch, not the other way around. The rest of

these best design principles will help the operator both when the facility is first commissioned and later when future development may get closer.

2) **Electrification:** Using electricity as power to reduce emissions: Where possible, invest in infrastructure to power compression engines and drilling rigs using electricity from the power grid. Xcel is the largest public utility in the DJ Basin but there are several regional cooperatives that may provide other options. When an operator can use grid electricity to power a rig, they eliminate 100 percent of nitrous oxides and other ozone precursor emissions from rig operations in summer months and approximately 75 percent in colder months, when operations require the use of boilers for heat. In the Mustang area, Chevron has drilled 56 wells using utility electric power since 2019.

While access to public grid power is not always possible or affordable, electrification solutions should be evaluated. The drivers for electrification are reduced costs, higher reliability, higher returns and environmental sustainability. Where feasible, electrification can lead to more efficient unmanned operations, automation and condition-based maintenance and prognostic health monitoring of critical equipment.

It isn't just greenhouse gases that are a concern. On December 16, 2019, the U.S. Environmental Protection Agency (EPA) announced a final rule to reclassify the Denver Metro/North Front Range ozone nonattainment area from Moderate to Serious nonattainment under the Clean Air Act. The area covered embraces all of Adams, Arapahoe, Boulder, Denver, Douglas, and Jefferson counties as well as the southern portions of Larimer and Weld counties.

3) **Tankless facilities** reduce emissions and surface footprint: Many operators are committed to using tankless production facilities, which reduce emissions and surface footprint. The industry's newest facilities enable them to eliminate more than 90 percent of greenhouse gas emissions compared to older facility designs. In the Mustang CDP area for Chevron, it now takes only about 7.5 surface acres to deliver the same production volume that previously required 400 surface acres — reducing their surface footprint by more than 95 percent. In addition, they have eliminated more than 152 million miles of truck traffic and associated emissions by transporting oil and natural gas from their Mustang CDP by pipeline instead of trucks. They have gone from 95% of product carried off lease by truck to 95% of oil, natural gas and produced water carried off lease by pipeline. In many communities truck travel is named as their number one concern.

However, tankless is not the only option. Smaller operators like Bayswater have successfully developed sites with tanks that are designed not to vent. Bayswater was the first operator to receive a permit under the new 2019 rules. Sealed tanks, reprocessing of gas that comes out of the storage tanks back into the processing stream are also successful techniques that meet or exceed state requirements.

There is huge potential for emissions reductions with these newer centralized facilities. Occidental has also been championing these kinds of facilities even before the 2019 change in state regulations. These should be the models for development elsewhere. Occidental and Chevron are starting to transfer their DJ Basin lessons learned to their larger operations in the Permian Basin.

Large operators have a distinct advantage in this realm. They have capital and longer-term plans that allow this upfront spending / planning to design bigger centralized facilities. Smaller operators will need to find ways to partner with larger operators to simply tie into these bigger systems. With the

Title V permit requirements and pending severe ozone non-attainment status any pad larger than ~4 wells will have difficulty operating under Title V thresholds. The complexity and expense of operating under Title V will become very onerous for these smaller operators to manage.

4) **Operations control center:** The impact of automation is another key design element. Operations Control Centers are the nerve center for production operations across northern Colorado. It allows automated oil and natural gas facilities to be monitored and controlled remotely, in real time, 24 hours a day, seven days a week. For Chevron currently, more than 90 percent of their operations in Colorado are automated and monitored.

Technologies as IIoT (Industrial Internet of Things), wearables, and digital twin can strengthen an oil and gas company regardless of the circumstances but the foundation rests with traditional SCADA instrumentation and control systems. Reliable, secure and robust field to office communications networks are now as critical as pipelines. Now, the industry doesn't need a crisis to understand that remote technology is here to stay. Its value covers two aspects:

- a. Improved people management and working conditions for employees
- b. Improved awareness and decision-making for managers and domain experts

But greater automation brings about the concern of cybersecurity. The good news is that field operations, control centers and headquarters are getting better connected with near real time data transparency and the capability of applying new advanced analytical techniques to develop better prediction models and gain new insights into operations. The not-so-good-news is that the connectivity brings with it the vulnerability of hackers gaining access to these networks. Process control systems are not invulnerable to hacking and malware. These networks bring a lot of potential value but they must be reliable and secure.

5) **Long Horizon planning phase with predictable and efficient permitting process:** The concept of a comprehensive development plan (CDP) or a comprehensive area plan (CAP) for a large area allows a longer-term planning horizon for operators to innovate and redesign production facilities and to allocate the capital for infrastructure investment like pipelines and electrical power. However, this assumes some predictability in the permitting process. Operators can't commit to multi-year capital investment unless they are certain that permits will be granted when it comes time to drill and complete wells. The longer planning phase allows the opportunity to engage with community (implied consent process) and with regulators. The permitting phase should be efficient and consistent based on best practices and innovative design that come out of the planning phase.

6) **Environmental Monitoring and proactively address abandoned well inventory:** Chevron and other operators like Civitas have committed to proactively address abandoned well inventory with modern plugging and reclaiming standards, regardless of the historical ownership of the abandoned well. Chevron has 17 rigs running for P&A work and properly abandoned up to 600 legacy wells per year (at \$60k per well for a budget of \$50m annually) at its Mustang property near Greeley. COGA have estimated that between 2015 and present, the industry has actually plugged and reclaimed more wells than it has drilled. **Wellbore Integrity Rules** negotiated between operators, service contractors and the state also ensure that wells in the future will be less likely to become environmental problems.

There is only one direction for regulations, and that is they will get tougher. So, operators must be proactive and get ahead of the curve even if that means more investment in early phases. Environmental monitoring of air and water quality not only keeps up with new regulations but provides the operators with data to identify, locate and mitigate fugitive emissions and to quantify emissions for regulators. Working with a data-driven understanding will help with better design solutions. Whatever solutions an operator chooses to deploy, environmental monitoring combined with SCADA process automation and field maintenance practices will significantly transform the environmental impact of next generation oil and natural gas production facilities. Operators can also work with third party certification schemes to have an extra set of eyes on the impact of their operations and possibly turn their investments into a market return with Responsible Gas.

7) **Engage with all Stakeholders, not just your production engineers:** Operators have to figure a way to engage with the local and state expectations (community hotlines and website with more transparent reporting of emissions, etc.). With newer facility designs and public influence at the “front-end” of the regulations ruling process rather than being order-takes at the “back-end.” O&G operators can build effective partnerships with all stakeholders but it takes some effort. One example of this collaboration was the February 2021 rule making on pneumatics controllers. An effort between operators, service companies and NGOs over several months led to a successful hearing on a new ruling that everyone could buy- into from a starting proposal that wasn’t workable.

Summary: the Colorado Story

Applying these practices will require staff commitment (and a lot of meetings) and the willingness to share best operational practices with regulatory staff. The last several years were the era of the drilling and completions engineers developing ways to contact more tight reservoir rock through horizontal drilling and more intense completion practices. Now it is the turn of the facilities engineers to create acceptable “minimum” surface designs.

Collaboration within the industry is a must. The role of trade groups can serve as a way to moderate internal criticism about some leading operators “raising the bar” to make it harder for others to get leases. Traditional approach of priority of subsurface mineral rights (sue the county or landowners to gain access if they opposed development) won’t get a company to where they need to go. A company needs to prepare for a long negotiation (a change from the 90 days to get a permit to well over a year) and have the mindset that the result won’t end up in court. Start first with satisfying local demands and end up keeping ahead of new regulations not worrying about the cost of compliance.

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