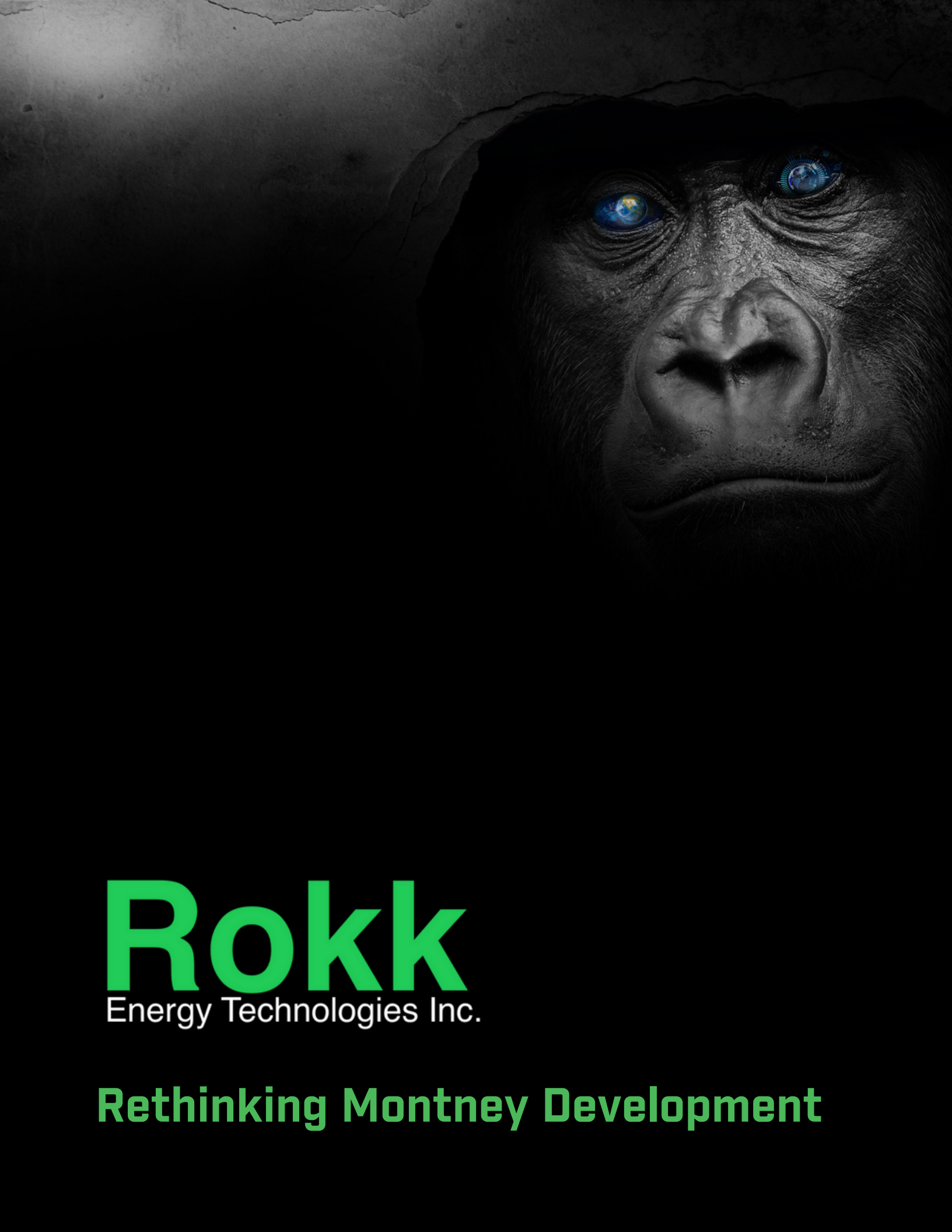




Rokk
Energy Technologies Inc.

Rethinking Montney Development

White Paper – Resource Development Series

Introduction

The Montney Formation is a significant geological formation located in Western Canada, primarily in the provinces of British Columbia and Alberta. The Montney Formation, known for its vast reserves of both natural gas and oil, is one of the largest unconventional hydrocarbon resources in Canada, containing significant quantities of oil, natural gas, and natural gas liquids (NGLs), making it a crucial area for oil and gas development. It is one of the primary producing reservoirs throughout western Canada and promises to be a dominant factor in the Canadian oil and gas industry for the foreseeable future.

Secondly, it is planned that it will be a key contributor to LNG export, such as those beginning shortly on the West Coast of Canada. Unlike other resource developments, such as heavy oil, the environmental impacts of natural gas tend to be viewed as less significant. **That being said, there remain challenges on the horizon.**

Take, for example, that **every shale-producing basin in the United States is seeing declining well productivity**, while they are increasing lateral length. Some consider it to be a double whammy. We expect increases in lateral length to proportionately increase both production and cumulative recovery of reserves in place; but that is often not the case. (Ng, S. (2025, May 6). U.S. shale production is likely to decline, warns major driller. The Wall Street Journal.) Although there may not be significant evidence of this to date in the Montney, it has been clearly evident in every shale basin all the way back to the Barnett Shale.

Technological Advances: The development of the Montney Formation has been facilitated by advancements in drilling and hydraulic fracturing technologies. Horizontal drilling combined with multi-stage fracing has made it economically viable to extract hydrocarbons from tight rock formations like the Montney. Through the development of Montney drilling and completions, there have been several major transitions, all of which have seen success in certain cases. However, to date, the most prominent method for fracturing tends to be plug-and-perf, particularly in the deeper and more prolific areas. In recent years, the primary changes to fracturing have been higher pump rates at higher pressures, higher sand concentrations in kilograms per meter of lateral, more water, and variations of perforating strategies.

In addition, variations in stage counts have generally increased, but appear now to have plateaued, and in some cases decreased. Coil, tubing, activated sleeves, and low-rate, single-point entry fracturing are prominent in some areas. This, however, **has certain limitations, especially in extended reach wells.** Ball drop systems using both open hole packers and cemented sleeves also maintains a loyal following including some of the largest producers in Canada who have fine-tuned the application with great success, but generally on shorter laterals. Lastly, are frac sleeves that are shifted open using a pump-down cartridge. These are often used in combination with other methods such as ball-drop or plug and perf.

All of these have proven useful in certain applications, but cost and commoditization seem to be a driving force along with ERD wells (long lateral wells). Each is worthy of discussion, but conclusions based upon research for this paper are:

1. Shorter lateral have higher recovery factors (URLs)
2. High pump rate fracs have gained preference in some areas
3. Coil tubing has gained acceptance where lower pump rates and tonnage are preferred
4. Recovery factors may be higher in dry gas
5. Shorter laterals offer more options for stimulation and fracturing
6. Shorter laterals offer more options for future utility (EOR, refrac)

Environmental Concerns: The development of the Montney Formation, like any oil and gas development, raises environmental concerns, including water usage, potential groundwater contamination, methane emissions, and habitat disruption. Regulatory bodies in Canada enforce stringent environmental regulations to mitigate these impacts. Surface footprints of large-scale pad development particularly with multiple benches of producing formation have become contentious, particularly in certain indigenous land access scenarios (Blueberry Tribe, for instance).

Another challenge from an environmental standpoint comes from the high intensity required for resource development in the Montney. For example, in many areas, there are significant reserves held in the Lower Montney, Middle Montney, and Upper Montney. In certain cases, operators have attempted to connect all three layers using massive hydraulic fracturing operations. In many cases, this has proven to be unsuccessful or less than optimal. Therefore, surface footprint becomes an issue. If an operator is using development for resources using six well or eight well pads, **this may ultimately result in 24 wells from surface to develop and effectively drain the three layers of the Montney.** This means that simply developing the Montney may require three separate eight well pads, consuming a considerable amount of surface lease area, as well as massive investment in well construction repeated 24 times. In addition, some other areas may have other stacked pay above or below the Montney leading to additional demand for surface impact.

Extended Reach Wells

Extended reach drilling (ERD) offers several benefits compared to conventional short laterals, vertical or moderately deviated wells. This has been the go-forward strategy for many objectives, such as **cost reduction and attempts to increase ultimate recovery for each well drilled.**

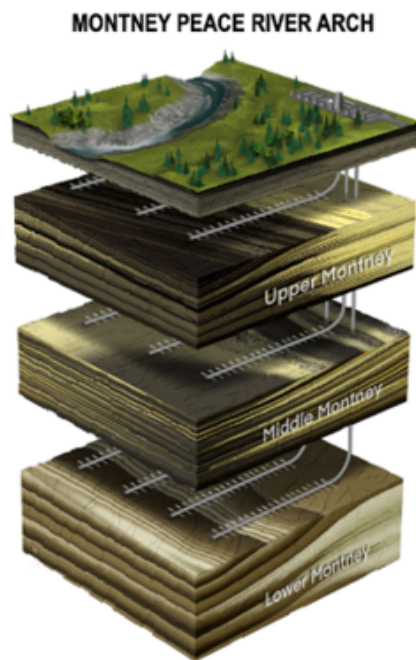


Figure SEQ Figure * ARABIC 1 – Example of Montney stacked pay common in many areas.

Reservoir Contact is typically the objective for ERD wells and enables access to a larger area of the reservoir from a single wellbore. By drilling horizontally over long distances, ERD maximizes reservoir contact and increases the potential for high-stage numbers, allowing for enhanced hydrocarbon recovery and improved production rates. ERD can be more cost-effective than drilling multiple vertical wells or using shorter horizontal wells to access the same reservoir volume. By reaching multiple zones, or large lateral expanse from a single wellbore, operators can reduce drilling, completion, and surface infrastructure costs, resulting in overall cost savings. ERD may allow operators to access distant reservoirs from centralized drilling locations. This reduces the need for additional well pads, access roads, and other infrastructure, leading to lower environmental impact and reduced surface disruption. **However, this comes at a cost.**

Well Productivity: ERD wells may exhibit higher productivity compared to either vertical wells or short horizontals due to increased reservoir contact and enhanced drainage efficiency. By accessing more of the reservoir's productive

zones, ERD wells can deliver higher initial production rates and sustained flow rates over the life of the well. However, this is where things begin to fall apart. For example, if you drill a 1-mile lateral, and you know the production and the ultimate recovery for that well, then a 2-mile lateral should be double, particularly for ultimate recovery numbers. However, in most of the basins, it has been determined that a 2-mile lateral is not double, but instead is roughly 1.5 times the recovery of a 1-mile lateral. By drilling extended-reach wells, we are intentionally leaving **25% of recoverable reserves behind in the interest of reducing well costs.** This, while commonly drilling top tier (tier 1 or tier 2) acreage throughout the basin. **The question is, is there a better way?**

Loss of well utility

A challenge with extended reach wells is that the longer the well gets, the less likely that any work over activity can occur due to equipment limitations, and high costs for entering long laterals. Working within the 1st mile of lateral is relatively cost-effective, but as you go to a 2+ mile (3200M) lateral, this begins to change. In certain cases, such as well clean outs, frac-hits, refracturing, or enhanced oil recovery (EOR), which may be future-oriented, you will likely lose utility and opt for more cost-effective methods.

Casing and Cementing Challenges

Running casing and cementing in ERD wells can be challenging due to the extended horizontal sections and complex well trajectories. Ensuring proper casing centralization, zonal isolation, and cement placement becomes critical to maintain well integrity and prevent fluid migration or gas leakage. In many of today's designs, **there are new concerns that are emerging**. For example, Montney operators have abandoned running intermediate casing strings which **provide a clean, uncontaminated cement** being circulated across hydrocarbon, bearing formations, that generally has been very successful in preventing casing vent leaks. However, the move to extended reached laterals with a **single casing string from surface** to TD now compromises the cement integrity and **increasingly is leading to casing vent leaks** at a time when the industry is promising to reduce methane emission. Thus, the **trends for the Canadian industry toward cheaper, well construction, may be leading to unintended consequences** that would prove unfortunate both for individual companies, as well as for the industry in general.

As fracture treatments have moved toward higher intensity and stage counts, the importance of effective zonal isolation has become increasingly important. We are now seeing stage counts in excess of 100 stages for coil tubing and plug-and-perf, commonly reaching 60 stages. With stage spacing becoming tighter, it has become more common to **have fracs converge, resulting in no stimulation of some sections and overstimulation in others**. The results are at minimum bypassed pay, resulting in lost production, and in many cases can create overstimulation that leads to "frac hits" or unwanted high (water) loads, potentially resulting in excess water production.

A study of a 60-stage cemented well showed that when measured, 67% of frac stages were in communication with previous stages. As the fracture treatments for this 60-stage job were executed, 18 of the 60 stages showed convergence with other stages during the entire fracture treatments. (Daneshy, Ali A., et al. 2019. "Horizontal Well Frac-Driven Interactions: Types, Consequences, and Damage Mitigation." *Journal of Petroleum Technology*, May 31, 2019.) Thus, more than 25% of the stages were ineffective and perhaps could lead to other operational issues. Also, 28% of the well's ultimate recovery will likely be lost as this rock is not fractured. Problems with cement jobs and horizontal wells are not uncommon, but extended reach and longer laterals will show a higher intensity for failure due to poor cementing practices or to excess lateral length in general.

Pad-Free™ Drilling – Options for Montney

Description

Pad-Free Drilling is a system designed for creating multilateral wells tailored for sale and unconventional resource development. It is also specifically designed to provide excellent zonal isolation and efficient multi-stage fracturing operations.

Introduction to the technology – Pad-Free Drilling

Rokk Energy Technologies Inc. have spent two years developing a system to create multilateral wells, using their Pad-Free drilling and completion systems. The fundamental basis for the development of the Pad-Free system is so that operators can replace drilling pads with a significantly lower footprint, be designed to recover equivalent reserves to standard length laterals, and increase ultimate recoveries over ERD wells. The development of Pad-Free was done explicitly with the Montney and other unconventional resource development in mind.

Impact – 27 million metric tonnes of CO2

This system can be a blueprint for resource development that is both cost-effective and has a much lower environmental impact. Based upon government estimates and moderate adoption of the technologies, the system, if commercialized, can save more than 27 million metric tons of CO2 equivalent emissions while reducing surface footprint, groundwater penetration, and methane emissions, both during well construction and during the life of the well. In addition, our calculations based upon both federal and Alberta government estimates for the **cost of development can be reduced by 60%**, meaning that the oil and gas resource development in major developing plays, such as the Montney and other formations, will continue to be a major player in the world energy market.

This assumes that drilling activity will remain relatively constant. It is estimated that for the 2024 drilling year, Canada will drill 6,400 new oil and gas wells. A significant number of these could be candidates for Pad-Free drilling systems. Rokk's Pad-Free Systems will also move the entire industry toward net zero by reducing methane and carbon emissions by approximately 70% simply by applying this technology. In addition, our reservoir studies indicate that oil and gas recovery per 1000M of lateral drilled will increase significantly.

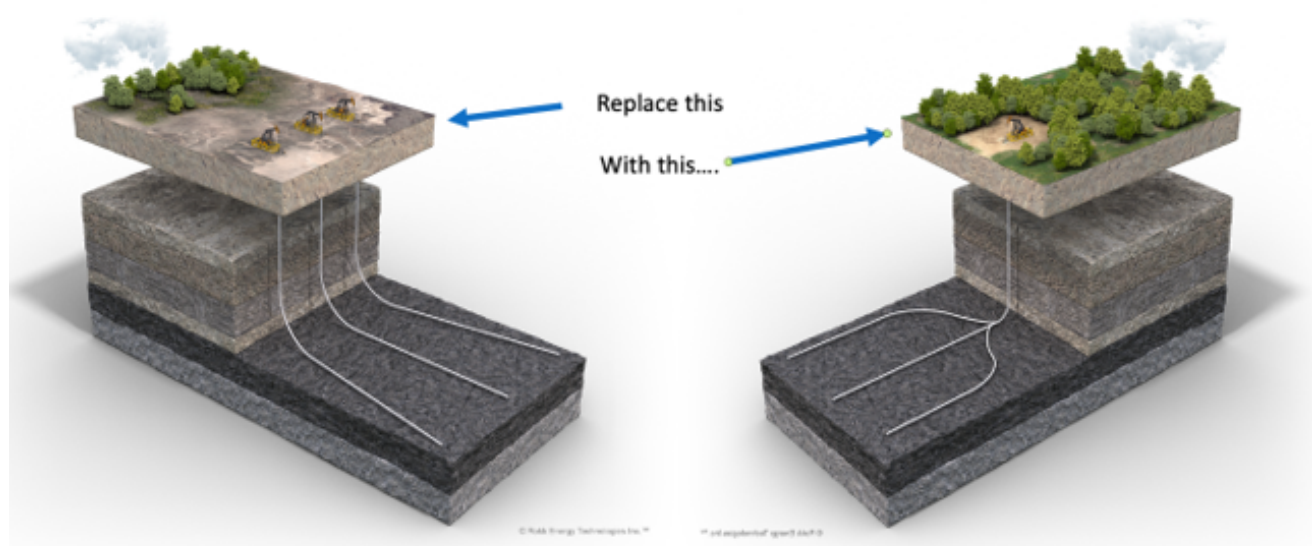


Figure 2 - The initial innovations for Pad-Free drilling greatly reduce the environmental impact of oil and gas development.

As an example, the Upper Montney contains significant reserves of oil and gas, but the financial viability is less attractive in some drilling areas. In fact, in our discussions with a number of operators, it has been stated, "We would love to develop the upper Montney, but it won't financially support grass-roots wells from the surface." The important thing is that all of the infrastructure, from pipelines to wellheads to gas plants, already exists in most of these producing areas. Secondly, over 70% of reserves are commonly depleted or drawn from an existing well within the first 24 months. Pad-Free technology would allow an operator to recover remaining reserves from the existing drilled lateral **while accessing secondary formations such as the Upper Montney** or others (shown below).

Strategies for Montney Development

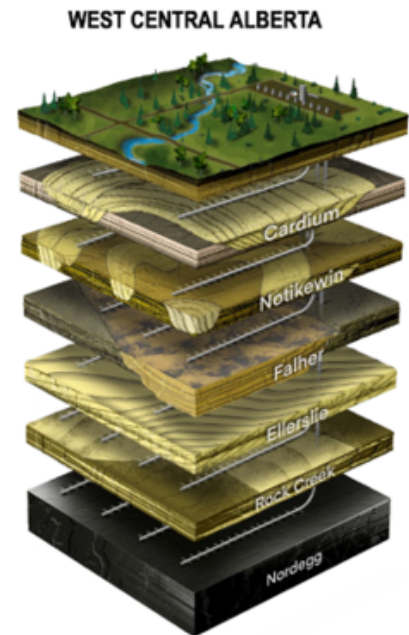
Incorporating Pad-Free into development plans can significantly change the approach to both current and future development within the entire basin. Multiple strategies could be applied with this technology to reduce cost while improving ultimate recoveries and reducing environmental impact. This is one of the few technologies that will actually reduce costs and provide an economic incentive.

Strategy one – stacked pay development

Throughout the basin, there is ample opportunity for utilizing staged development to develop stacked pay in a much more cost-effective fashion. Currently, each horizontal development requires a well drilled from surface. Since nearly 70% of the well construction cost is incurred by drilling and casing operations to get to the formation, it would make sense not to re-incur this for every lateral that is drilled.

How it works

It is typical to drill multiple wells into a single layer, such as the lower Montney. Many developments utilize 3 to 8 wells on a pad. From the surface, multiple closely spaced wells are drilled, but they enter the formation as independent, strategically spaced, parallel laterals in most cases. These are completed and put online to production. Then, when developing a second layer, the entire procedure will need to be repeated, **incurring all associated costs and doubling the surface impact.** Most reservoir development experiences relatively high decline rates, and so much of the well's lifetime production may be produced within 12 to 24 months, depending on the formation area. Over time, rapid decline continues to turn prolific wells into low-volume producers.



Pad-Free is specifically designed for Montney development in that it has a fully supported juncture and is fully compatible with most forms of multi-stage hydraulic fracturing. So an operator can develop as follows:

1. Set up the well pad
2. Install casing strings for Pad-Free with CEX couplings pre-installed
3. Drilling and complete wells in the lower Montney
4. Produce for 12 to 24 months
5. Rig up temporary plug for existing production
6. Rig up Pad-Free drilling systems and install in well
7. Cut casing window and drill lateral into middle Montney
8. Run completion as per design
9. Fracture stimulate as per design
10. Flow test as needed
11. Set up to produce both lower and upper formations
12. Produce for 12 to 24 months
13. Repeat, step 5 through 11 for the Upper Montney

Strategy 2 – Effective maximum reservoir exposure wells

While extended-reach drilling (ERD) wells have some economic benefits, it may be unwise to sacrifice recoverable reserves to reduce costs in the short term. It may soon become clear that burning through tier-1 acreage, two and three mile laterals is a poor business decision long-term. It is possible, however, with a Pad-Free drill to create maximum reservoir contact wells with much higher recovery factors. Currently, it is possible to construct wells that can get 3 to 4 miles (5000-6000M) of reservoir contact and possibly more. In addition, it may be possible to apply strategies one and two in tandem for full-field development.

Strategy 3 – Maximum utility wells

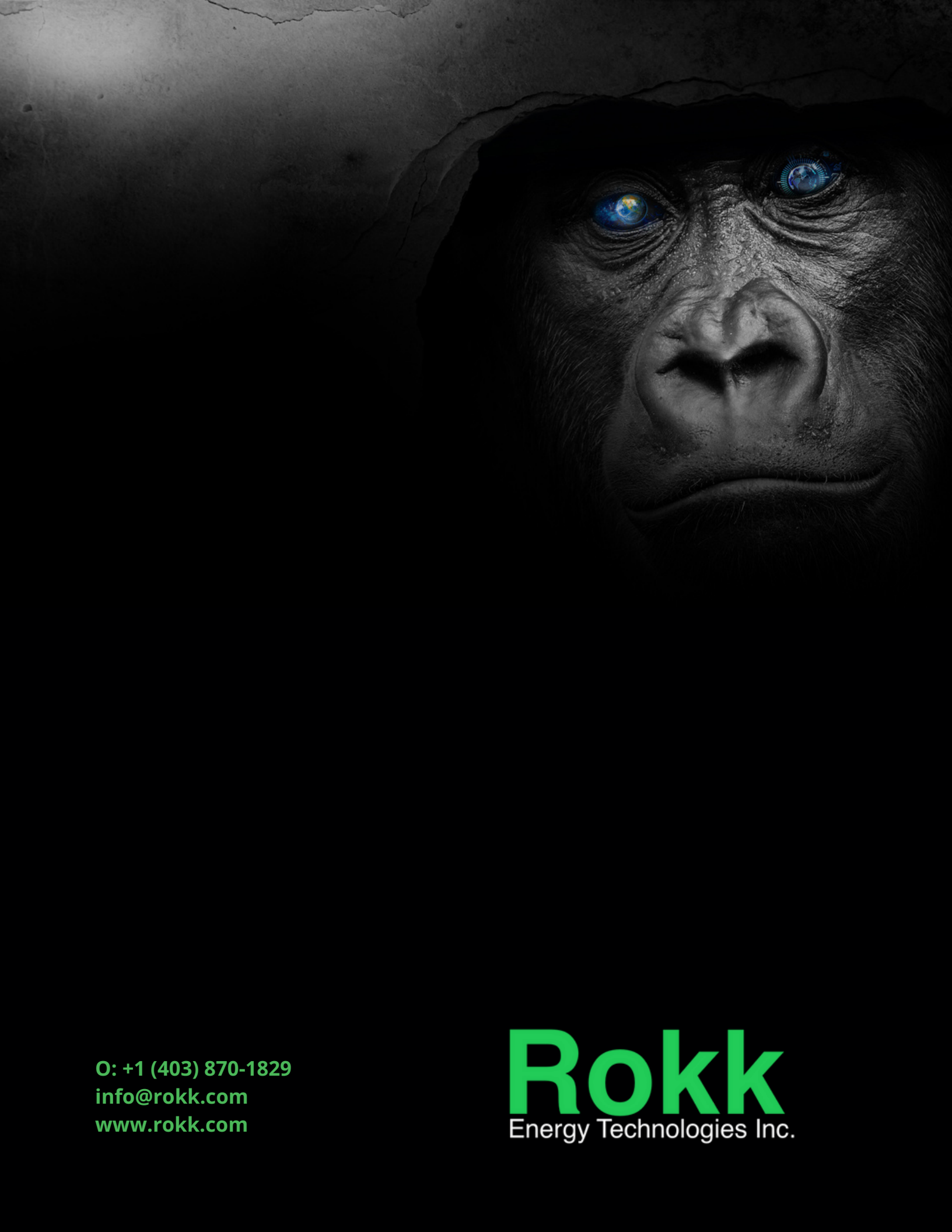
As stated previously, the move toward longstring usage in field development may have environmental concerns, such as an increased possibility of casing vent leaks. In addition, running 4 ½ inch (114mm) or 5 ½ (137mm) inch casing rather than a 7 inch (178mm) intermediate casing string significantly reduces future well utility and essentially turns wells into throw-away assets. After the initial rapid decline, there is no ability to reenter these wells and add either infill, drilling, or additional pay. In most cases, well construction utilizing an intermediate casing string will allow significant valuable asset that has utilization for future drilling potential. Although it may slightly add to the initial well construction costs, **it can turn a plugging liability into a valuable asset for future drilling** throughout the basin not only in the Montney, but also in other areas where infield drilling may have opportunities, or **where uphole potential drilling opportunities may exist.**

Conclusion

Rokk has assembled some of the industry's best talent in the design, manufacturing, and execution of multilateral wells. In addition, Rokk has been laser-focused on building a fit-for-purpose multilateral drilling and completion system for specifically the Montney formation. To get a better insight into the technology and the capabilities that it can provide, please contact in Canada:

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Pad-Free™ Drilling

Montney development has reached its second decade, and has proven to be both vast in reserves and remote for drilling, production, and to market. However, it does not come without its challenges which are many, and will certainly increase with time.

Rethinking Montney Development

Can technology create a new future in the competitive environment of oil and gas development, production, and sustainability? Perhaps the future may look different from today. That is the path of innovation and those who choose to pursue it.