

OIL, NATURAL GAS, AND BLOCKCHAIN

How PermianChain Creates Value in Resource Finance and Sustainability

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PermianChain Technologies Inc.

June 2020





Realizing the new promise of the digital economy

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Foreword

The oil industry is certainly challenging for many stakeholders. It affects climate change, which we believe is one of the most compelling issues facing humanity (and many other species) today. The industry's global nature creates a patchwork of regulations (some contradictory) that vary across jurisdictions. To say that it challenges investors is a gross understatement. In April 2020, reduced consumer demand caused oil futures to fall into negative territory—oil firms had to pay entities to take oil off their hands as temporary storage was exhausted. These challenges, while daunting, are the exact type that we can mitigate by using blockchain technology.

A permissioned blockchain-platform-as-a-service offering could improve how production companies and registered exempt market dealers collaborate to develop a digital natural gas marketplace.

This piece explains how the start-up PermianChain is planning to meet these challenges. Specifically, it studies how blockchain and smart contract solutions could foster a trustworthy digital securities primary market that would issue natural asset security tokens and build a natural resource token coded in smart offtake agreements. PermianChain's idea for a permissioned blockchain-platform-as-a-service offering could improve how production companies and registered exempt market dealers collaborate to develop a digital natural gas marketplace.

It also explores a digital energy solution—powering bitcoin mining rigs—that could provide an additional revenue source for oil and gas operators. Given the steadily increasing efficiencies of data transmission networks and hyperscale data centers as well as the potential restrictions on bitcoin mining, we're not clear how large or long-lasting a revenue opportunity it might prove to be.¹ But it is the kind of fresh and creative thinking that the energy sector needs.

We are pleased to partner with Mohamed El-Masri. He is currently the founder and CEO of PermianChain Technologies Inc. and the director and chief investment officer of Brox Energy Holdings Ltd., and so this is an insider's look at what the start-up hopes to do. Mohamed has expertise in the Canadian oil and gas industry as well as experience with investment platforms and enterprise blockchain solutions. He does the math to make the case for PermianChain's vision of the future.



DON TAPSCOTT
*Co-Founder and Executive Chairman
Blockchain Research Institute*





Case in brief

Potential business model innovation ranges from sourcing commodities from producers to converting natural gas into a clean, reliable energy source.

- » Energy companies are exploring the possibilities of blockchain. One of the most investigated blockchain applications is energy trading—a convoluted process dominated by a large number of intermediaries and burdened by back-office costs that blockchain technologies could mitigate.
- » The adoption of blockchain and smart contract solutions could give rise to:
 - › A trustworthy primary market for issuing *natural asset security tokens* (NASTs) to enhance natural resources investment environment and attract smart and sustainable private capital.
 - › *Natural resource tokens* (NRTs) with utility coded in *smart offtake agreements* (SOTAs) for a more efficient natural gas trading environment, with near real-time blockchain-enabled tracking system and improved digital currency payment mechanism.
 - › A digital energy conservation solution for natural gas-powered data mining operations that could provide an auxiliary source of revenue to oil and gas operators.
- » If oil and gas operators adopt NRT with SOTA frameworks, then stakeholders and traders (who ultimately become the NRT holders) can purchase the utility tokens that underpin holding rights to verified natural gas reserves, whether in production or not. NRTs are convertible into electricity for powering on-site data mining containers.
- » Potential new business models range from sourcing commodities from producers to transferring and converting natural gas for a clean, reliable energy source. Parties could eliminate the need to transport and track assets by land and sea; store assets in terminals, tanks, and warehouses; blend assets to meet customer specifications; or deliver assets to the right places at the right times.
- » PermianChain's blockchain-integrated solution could reduce holding period returns for accredited investors. It could also optimize stakeholder value while reducing the potential of smuggling, raising red flags on black market participants, and enforcing international sanctions.



Introduction

We have been studying the use of blockchain in the oil and gas market for two years. The existing platforms that are live, in test mode, or under development have functions that relate to inventory, logistics, and post-trade efficiency. Our research did not identify an oil and gas blockchain platform dedicated to investing in *and* trading oil and gas with an integrated natural gas marketplace for power generation and data mining operators. So we created one.

The PermianChain is a permissioned *blockchain platform-as-a-service* (BPaaS).

- » It solves the funding challenge by simplifying how *exploration and production* (E&P) companies and registered *exempt market dealers* (EMDs) work together.
- » It solves the market challenge by allowing E&P companies to sell field-generated electricity digitally to data center operators for powering on-site remote data mining farms.

Table 1: Blockchain initiatives in oil and gas

Company	Location	Description	Status
Enerchain	Hamburg, Germany	Platform for peer-to-peer wholesale trading of natural gas	Prelaunch
Energía Abierta	Chile	Regulator tracking national energy data for oil and natural gas	Live
Fujairah Oil Industrial Zone, S&P Global Platts	Fujairah, UAE	Oil terminal stock levels reporting	Live
Mercuria, ING, SocGen	Africa	Use of digital documents for oil cargo traded three times en route to China	Test
OneOffice BTL	Europe	Platform to cut post-trade costs for natural gas	Prelaunch
S&P Global Platts	Houston, Texas	Platform for confirming transactions and reporting prices for natural gas	Prelaunch
Sinochem Group, Xiamen Customs, HSBC	China	Simulated gasoline export from Quanzhou to Singapore	Test
Vakt	London, England	Platform to cut post-trade costs for natural gas	Live

Source of data: S&P Global Platts, "Blockchain for Commodities: Trading Opportunities for a Digital Age," foreword by Martin Fraenkel, S&P Global Inc., Sept. 2018.



The BPaaS uses Hyperledger Fabric blockchain integration to allow E&P companies to catalog, manage, and create value from their proven oil and gas reserves (Figure 1).

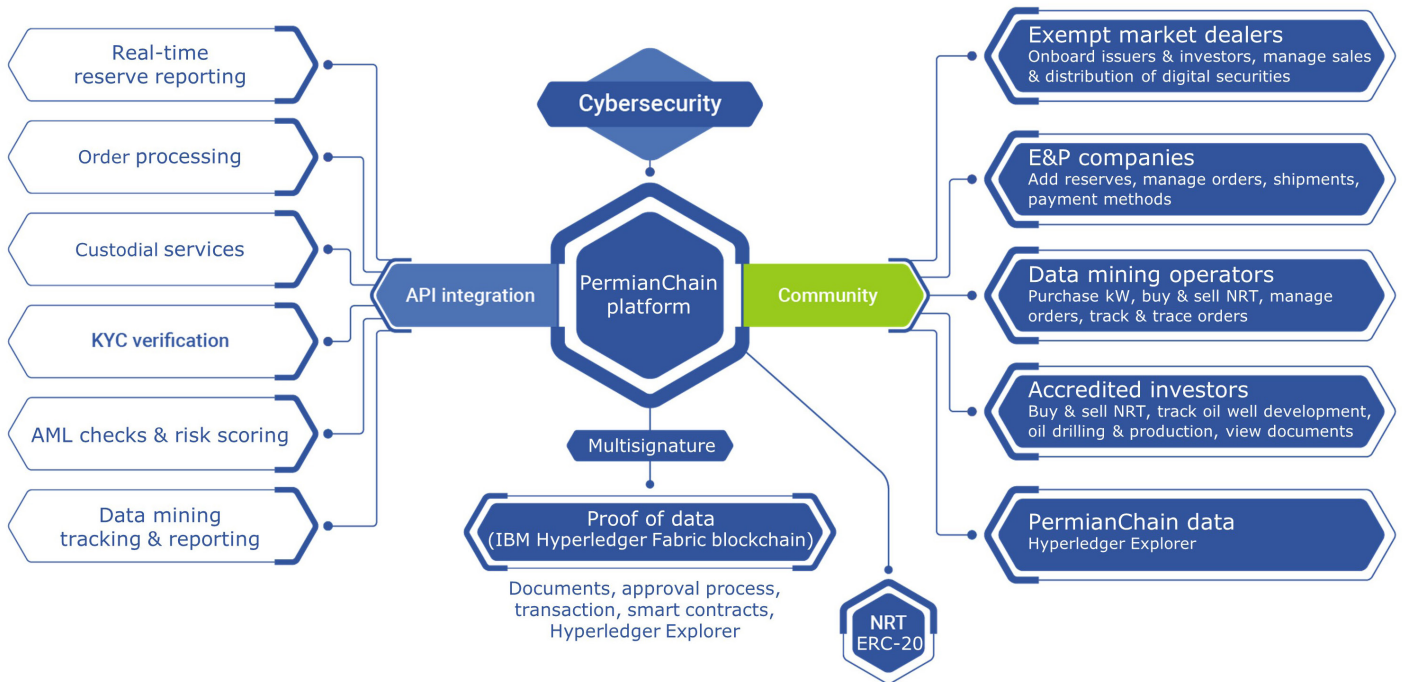
The BPaaS leverages the tokenization process. It features two ERC-20 tokens developed on the Ethereum protocol and compatible with the PermianChain platform:

Natural asset security tokens address the funding challenge, whereas natural resource tokens address the market challenge.

- » *Natural asset security tokens (NASTs)* address the funding challenge. These digital securities enable issuers to offer debt and equity investment opportunities to accredited investors under available prospectus exemptions.
- » *Natural resource tokens (NRTs)* address the market challenge. These utility tokens enable users to buy and sell natural gas operators’ field-generated power instantaneously.

All transactions, once executed, are immutable and recorded in the distributed ledger and reflected on the token register of the platform. The data registered on the BPaaS are updated by authorized verifiers and users on the platform. For example, once the dealing representative of a registered EMD verifies a NAST transfer, the data are updated on the Ethereum network as well as on the platform’s real-time token register in compliance with securities regulations. When E&P companies must upload or update oil and gas reserve reports and company valuations, authorized petroleum consultants must verify them on the platform before these data are pushed to

Figure 1: PermianChain BPaaS ecosystem



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Hyperledger Explorer. Petroleum consultants contributing to the platform receive NRT tokens.

Oil and gas data reports are uploaded and accessible to accredited investors in a private virtual data room. Accredited investors must first be admitted to PermianChain's primary digital securities issuance platform to subscribe for NASTs by their registered EMD. Key data from these reports (e.g., proven reserves, barrels of oil equivalent, valuations, etc.) appear on the investor dashboard so that investors have key indicators relevant to the value of their holdings.

In the PermianChain marketplace, the use of NRT utility tokens provides buyers of transformed natural gas the access to data related to these natural gas assets, reserves, and the amount of power generated in kilowatts. Users can access data relevant to pricing, supply, demand, and production to exercise SOTAs; they do not have access to proprietary information.

Investing in oil and gas

Investors can invest in oil by buying oil futures or oil futures options, commodity-based oil exchange-traded funds, or energy sector exchange-traded funds.

Investors have several options for getting involved with oil investing. These methods come with varying degrees of risk and range from direct investment in oil and gas as a commodity to indirect exposure through the ownership of energy-related equities.

One direct method of owning oil is through the purchase of oil futures or oil futures options. Futures are highly volatile and involve high risk. Additionally, investing in futures may require the investor to do much homework and invest a large amount of capital.

Another direct method of owning oil is through the purchase of commodity-based oil *exchange-traded funds (ETFs)*. ETFs trade on a stock exchange; investors can buy and sell them similarly to stocks. For example, buying one share of the US Oil Fund (USO) would give an investor exposure to roughly one barrel of oil.

In addition, investors can gain indirect exposure to oil through the purchase of energy sector ETFs, like the iShares Global Energy Sector Index Fund (IXC), and to energy sector mutual funds, like the T. Rowe Price New Era Fund (PRNEX). These energy-specific ETFs and mutual funds invest solely in the stocks of oil and oil services companies and come with lower risk.

The downside of conventional direct investments

Many private oil and gas opportunities are structured with upfront fees. Advisors and brokers profit just by placing investors' money in the deal. That means fewer investor dollars go into the project, and it motivates the offering company to fill the deal quickly for fast profits rather than stay engaged with investors or offer deals more likely



According to one of the largest foreign holders of Canadian energy stocks, investors and companies will continue to avoid the Canadian energy sector unless more is done to improve market access.

to yield better returns on production. Any innovation must address these issues in the oil and gas private capital market:

- » Convoluted transaction processes
- » High barriers to entry
- » Long holding periods for private investors without expectations of dividend distributions
- » Uneconomic infrastructure requirements to bring natural gas to market
- » Wasted and stranded natural gas resulting in lost profits and opportunity costs

An array of operational problems from equipment repairs to dry holes can negatively affect shareholder returns. Companies should address these with investors in near real time, yet companies may go silent when problems arise, particularly if they downplayed the risks when soliciting investors. Too many companies fail to provide their investors access to important project updates. Consequently, investors have less confidence in the performance—even the legitimacy—of oil and gas investments.

The upstream Canadian oil and gas sector has become a less attractive investment in recent years, whereas major production areas in the United States have become more attractive. One of the largest foreign holders of Canadian energy stocks is Darren Peers, an analyst and investment manager in Los Angeles. In an open letter to Prime Minister Justin Trudeau, Peers warned that investors and companies will continue to avoid the Canadian energy sector unless more is done to improve market access.²



Refinery Pump Oil Pump Industry Oil Rig Gas Fuel by John R Perry (jp26jp), 2014, used under Pixabay license of 27 March 2020. Cropped.

Using smart contracts, blockchain, and other digital innovations, PermianChain expects to streamline inflow of capital for oil and gas exploration and production.

Streamlining direct investments through blockchain

PermianChain developed its solution for conventional direct investments, to solve the capital requirements of oil and gas exploration and production. To a certain extent, its development democratized direct investment for accredited investors. Using smart contracts, blockchain, and other digital innovation, PermianChain expects to streamline inflow of capital. The benefits are several:

- » Buyers of blockchain-based digital securities have an immutable proof of ownership, whereas buyers of paper share certificates rely on third-party transfer agents to ensure that the issuer has not sold the same certificate to multiple people.
- » Scaling up or down according to the number of parties involved improves the system's efficiency without more paperwork.
- » Storing data in an encrypted, digital distribution ledger improves accessibility for every party in the blockchain. Key stakeholders will be able to access status updates and track performance of underlying assets in real time.
- » Implementing *electronic know-your-customer* (e-KYC) requirements helps to determine viability and raises red flags for regulated activities. EMDs registered on the platform can provide access to relevant regulators, auditors, and compliance personnel.
- » Cryptography and key-based encryption thwart efforts to tamper with documents and contracts within the blockchain.

Digital securities and tokenization

Tokenized securities are transforming oil and gas campaigns into digital assets. Digital securities (a.k.a. *security tokens*) are financial instruments created through smart contracts representing rights to financial securities. Transactions with the token recorded on the distributed ledger cannot be undone or erased. Access to the information is customizable based on the ledger setup (e.g., public, private, or hybrid). The tokenization process allows private companies to issue a digital token, which can represent equity in proven oil reserves and ongoing oil and gas production campaigns. The objective is for E&P companies to meet working capital requirements by efficiently implementing capitalization events and monetization strategies on their proven oil and gas resources.

Using smart contracts, we can now replace paper and complex agreements that are cumbersome, difficult to transfer, and hard to track for buyers of exempt securities. PermianChain's solution for investing in exploration and production of oil reserves allows upstream companies to digitize the private placement process under a compliant framework that leverages the blockchain (e.g., Ethereum, Hyperledger), resulting in a digital security that represents ownership



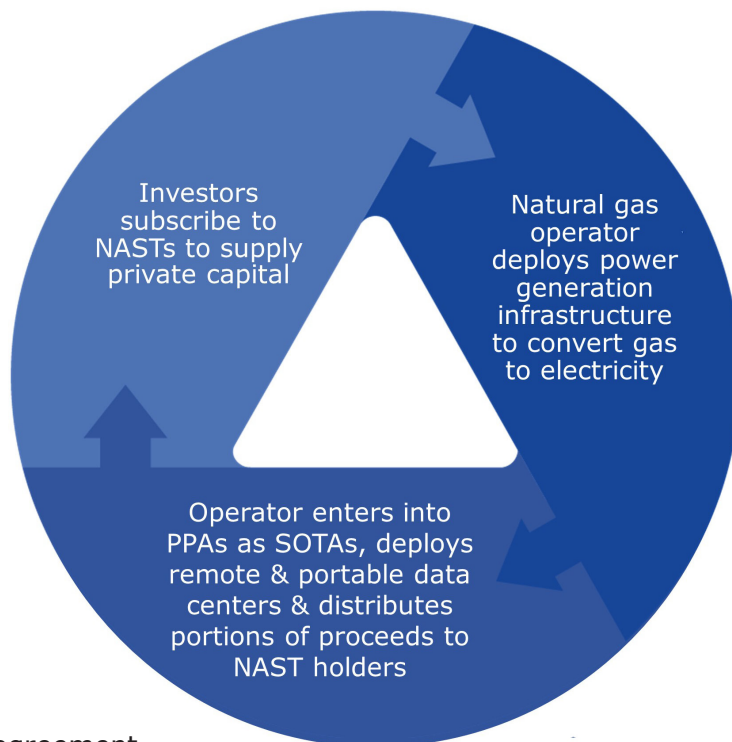
Adopting digital securities in the natural resources sector could increase liquidity in the energy industry and help meet its working capital and capital expenditure requirements.

(e.g., equity, shares) in reserve-based assets on a dedicated digital platform. (See Figure 2, “Natural gas tokenization process.”)

Now let’s consider that, according to the Central Intelligence Agency, there are 1.665 trillion barrels of oil recoverable globally.³ The United States represented approximately \$182 billion in capital expenditure while Canadian capital expenditure stood at approximately \$38.5 billion at the end of 2018.⁴ For the oil and gas industry as a whole, capital expenditures in Canada in 2018 were about 21 percent higher than in 2016; capital expenditures were also about 21 percent higher in the United States.⁵

Initial public offerings (IPOs) for small to midsize oil and gas companies have declined, and other factors have affected the continuous flow of capital requirements for E&P companies to scale and meet production capacity (Figure 3, next page). Tokenization of natural gas and oil assets as well as the electricity they help to generate could be a more suitable alternative. Adoption of digital securities in the natural resources sector could increase liquidity in the industry. It could meet working capital and capital expenditure requirements by reducing the barriers to entry and digitally streamlining financing and investment processes through tokenization.

Figure 2: Natural gas tokenization process



PPA = power purchase agreement

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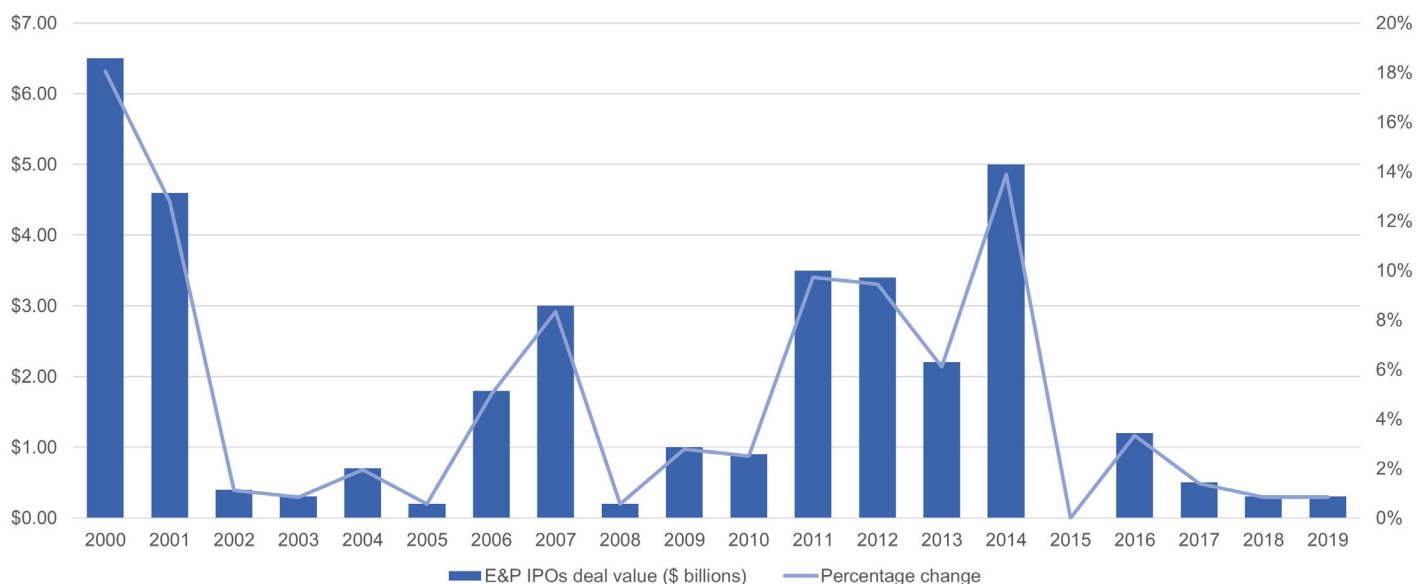


E&P companies could issue digital securities on blockchain-based platforms like PermianChain to capitalize on their oil and gas reserves and support related assets and operations.

E&P companies usually reinvest their cash flows into new projects where they must purchase property, equipment, infrastructure, and so forth. These large upfront capital expenditures eat into an E&P company's cash. E&P companies frequently require taking on the equity and debt positions placed by lenders and private investors. Before their investors realize a return, E&P companies aim to recoup their expenses first, plus servicing the debt. E&P companies will need to present a differentiated growth story, a clear strategy for the energy transition, and to show that they are taking measures to meet environmental, social, and governance criteria that command investors' attention.

To support such efforts, E&P companies can issue digital securities to capitalize on their oil and gas reserves to support related assets and operations. The digital security enables the shares of a privately held upstream company to be digitally bought, sold, and transferred with the capability of automating dividend distributions in the form of digital currency (e.g., ETH, BTC) from *oil and gas blockchain-integrated framework* (OGBiF) and SOTA revenue models (Figure 4, next page). As the only reserve-focused tokenization platform, PermianChain expects that NASTs can become a critical instrument for attracting private capital and offer an ever-expanding range of investment exposure to the oil and gas sector using blockchain technology.

Figure 3: Historical US exploration and production IPO activity



Source of data: James Chenoweth et al., "IPOs and Capital Markets Developments in the Oil and Gas Industry," GibsonDunn.com, Gibson, Dunn & Crutcher LLP, 26 Feb. 2019.



Trading oil and gas

Trading firms aim to maximize the differential between the price they pay for (untransformed) commodities and the revenue they earn by selling (transformed) commodities.

The process leading up from extraction to trading of oil and gas includes a lengthy process that spans from upstream integration, joint ventures, prepayments on offtake agreements, and technical support requirements. Oil and gas companies can benefit from a streamlined approach on a blockchain-enabled digital platform that enforces the functionalities of a smart contract.

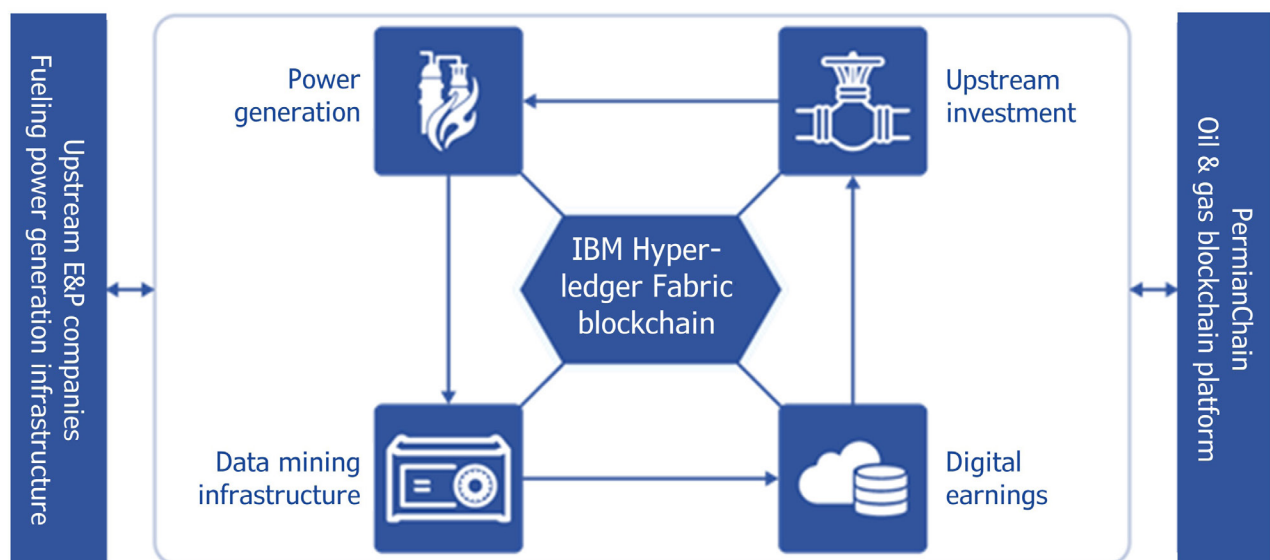
Trading firms aim to maximize the price differential between the price they pay for (untransformed) commodities and the revenue they earn by selling (transformed) commodities. Their priority is minimizing the overall cost of acquiring commodities. They work with producers to secure a long-term, cost-effective supply.

Processing quality is equally important. Trading firms need to be careful where they source these. Some oil fields, especially in conflict areas, do not conform to international health and safety standards. In a world that is moving toward increased transparency, suppliers that source from oil fields with poor social, environmental, and production performance run a significant reputational risk.

Poor integration, long-term contracts, and opacity

Keeping up with capital requirements over time is a real challenge. Upstream integration is a cash intensive business and requires ongoing access to capital and various sources of financing to maintain production growth to meet offtake and demand.

Figure 4: Oil and gas blockchain-integrated framework



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The lack of transparency throughout the energy supply chain, from extraction to trading, can lead to the mismanagement and misappropriation of revenues.

An offtake agreement is an agreement between an oil and gas producer (upstream) and an oil and gas buyer (midstream) to sell some or all of the production expected from the upstream company's production campaigns.

A long-term *power purchase arrangement* is also known as a form of an offtake agreement, usually used for purchasing electricity between utility companies and power-generation facilities; or, in our case, natural gas operators with power generation as a line of business. Conflicts related to offtake agreements can arise from termination, price review negotiations, unforeseen events, compliance, regulations, accountability, dispute resolution, and more. All are major challenges to consider for energy trading.

The lack of transparency throughout the supply chain, from extraction and power generation to trading, can lead to the mismanagement and misappropriation of revenues. Ongoing reporting obligations (i.e., Canada's Extractive Sector Transparency Measures Act) can burden small and medium-sized enterprises (SMEs) in this sector.

Smart contracts

Imagine a group of companies that want to trade oil and gas with one another. Normally members of this group would exchange paperwork and keep their own lists of trades. If they could move to a blockchain-based system for trading their oil and gas, they could potentially reduce paperwork and have more robust record-keeping. Many conglomerates are formed to replace paper trading systems with blockchain trading systems. They rarely aim to tokenize real-world assets directly; instead, they use a blockchain system for trading real-world assets. This is a hybrid of the old paper record approach and the new blockchain approach. The tokens have value only within the context of a contractual system involving all the past and future participants.

A smart offtake agreement is a type of smart contract—that is, a set of promises written into a distributed application intended to facilitate transactions between natural gas producers and data mining companies.

Now let's add fungible and tradeable smart contracts to such a system. A *smart contract* is a set of promises, specified in digital form—specifically as a distributed application—that includes protocols within which the parties execute these promises.⁶ The SOTA is intended to function as a smart contract that facilitates transactions between natural gas producers and data mining companies to enforce trading of field-generated electricity. SOTA's benefits allow multinational SMEs to cut costs on legal barriers, allowing well-enforced, cross-border transactions and providing encrypted digital signature capabilities. SOTAs can be programmed using Solidity language on the Ethereum network. The deployment and compatibility of SOTAs on the PermianChain platform will allow buyers and holders of natural resource utility tokens to exercise their business-to-business (B2B) offtake agreements. Each SOTA transaction will be registered on the Ethereum network. Reports of other relevant resulting data are also published on the PermianChain platform using IBM's Hyperledger for enterprise and private blockchain solution (Figure 5, next page).

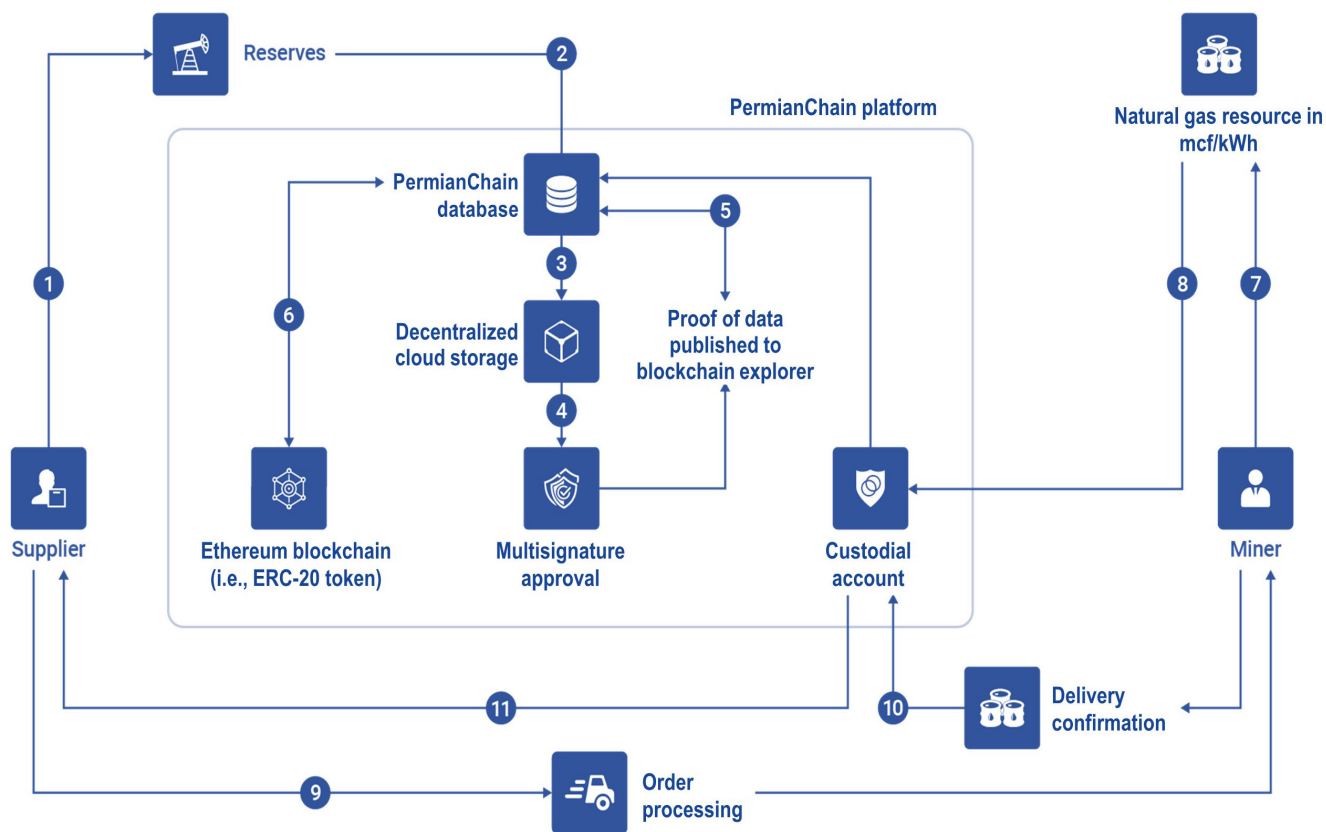


Among PermianChain's experts and advisors are geologists, petroleum engineers, acquisitions and divestitures consultants.

How the PermianChain ecosystem works

1. Supplier gathers documentation on reserves for PermianChain's due diligence prior to adding a production campaign to the PermianChain platform.
2. Supplier uploads documents through PermianChain's dashboard.
3. PermianChain compresses, encrypts, and saves documents in decentralized cloud storage.
4. PermianChain notifies experts and advisors (e.g., geologists, petroleum engineers, acquisitions and divestitures consultants) of a new submission. They conduct due diligence on each supplier in exchange for NRTs. Experts also monitor the decision-making process to ensure that it meets ethical standards and yields the proper number of tokens.
5. If at least two experts approve the submission, then proof of submission, proof of approval, and hashes of supplier's datasets are automatically published to PermianChain's blockchain explorer (IBM Hyperledger Fabric).

Figure 5: How PermianChain gas-to-power trading works



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6. The PermianChain-appointed treasurer unlocks a quantity of NRTs and makes the tokens available for sale.
7. Data miner buys tokens to secure power from natural gas resources.
8. Data miner submits purchase order and sends order amount to custodial account to hold in escrow until miner receives natural gas power.
9. Supplier processes order to deliver power via on-site power generation. That is, the miner must ship equipment (i.e., mining servers) to the supplier for installation in supplier's containerized data centers.
10. Data miner confirms receipt of power on the platform, once the mining equipment is up and running.
11. The confirmation of receipt releases funds in escrow to the supplier.

PermianChain's BPaaS also serves as a blockchain-enabled private B2B marketplace. It offers a trading system with redemption rights to data mining companies that seek to buy cleaner and more economic sources of electricity from natural gas operators. It allows independent oil and gas companies to sell proven reserves not yet produced, and natural gas that is in production but is wasted because of the lack of capital or sales pipeline infrastructure. BPaaS addresses working capital requirements without changing any business operations; suppliers can more efficiently monetize their resources.

On the other hand, the adoption and integration of such technology will allow suppliers to effectively maximize on market volatility to generate higher and more stable revenues when they enter into early offtake agreements with oil traders. By using blockchain, suppliers can dramatically reduce their operational expenses by effectively eliminating the need for brokers.

BPaaS addresses working capital requirements without changing any business operations; suppliers can monetize their resources more efficiently.

The utility of natural resource tokens

Offtake agreements represent an attractive alternative method of financing for oil and gas companies. By adopting smart contracts and blockchain solutions, upstream companies and offtakers can efficiently transact using natural resource utility tokens as a bridge currency governed by a smart contract from within the suppliers' closed-loop B2B exchange. This allows for a stable and increasing token price on the platform.

Imagine an oil and gas company owning land that has proven reserves of 100 million *barrels of oil equivalent*. The oil barrels, though not yet produced, can be tokenized by having ownership held by a company that has a standing offer to token purchasers to gain exercisable rights of tokens for a fraction of the assessed value of the barrel of oil and/or gas.



Consuming and conserving natural gas

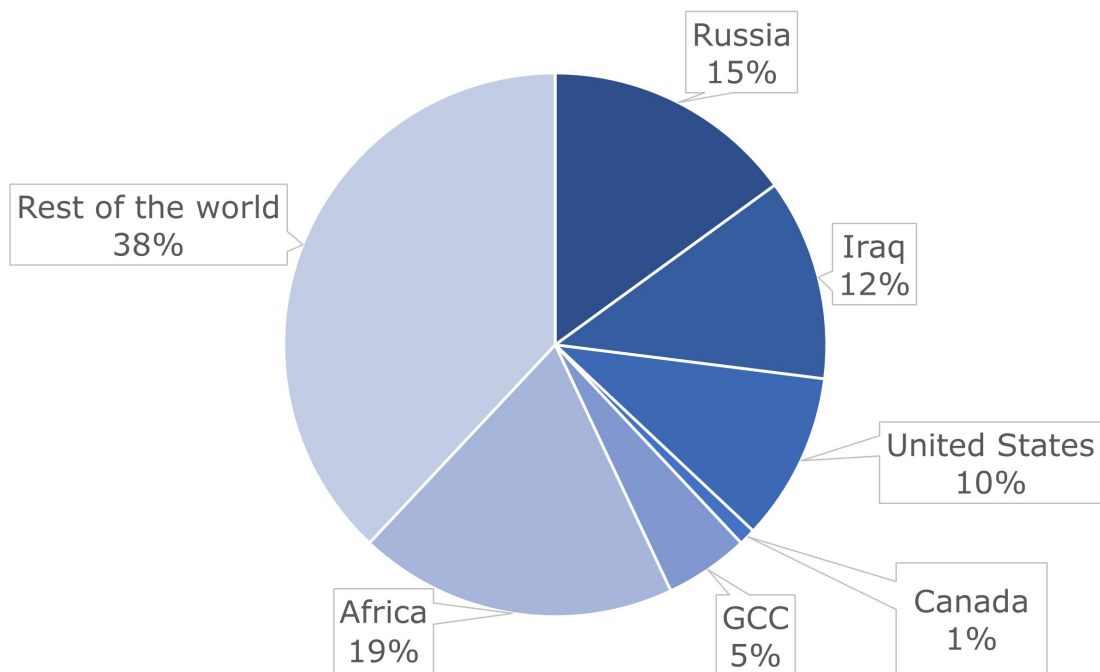
Waste and inefficiency

For many oil and gas companies upstream, stranding or burning gas on-site often costs less than taking it to market because of high infrastructure cost.

There are two main forms of natural gas waste: (1) the controlled release of produced gas, commonly known as *flared gas*, burning into the atmosphere and (2) stranded natural gas, which is untapped gas that cannot be extracted because of logistical and economic barriers. These are traditional practices for dealing with the excess gas produced. Because of the high cost of infrastructure, stranding the gas or burning it on-site often costs less than taking it to market for many oil and gas companies upstream. An investment in gas pipelines is a sunk cost, usually irrecoverable. Around the world, the industry flares approximately 150 billion cubic meters of natural gas at a cost of over \$16 billion (Figure 6).⁷ That's a high opportunity cost.

A separate but relevant data point is the energy consumption of commercial data centers and data transmission networks: combined, they need roughly two percent of the world's electricity.⁸ About 40 percent of that goes to cooling.⁹ But environmentalists are concerned about the lack of transparency in reporting exact amounts of energy that these data center and data network operators actually use, and the impact of this usage on climate change.¹⁰

Figure 6: Global gas flaring volumes



GCC = Gulf Cooperation Council (Saudi Arabia, United Arab Emirates, Kuwait, Bahrain, Oman, and Qatar)

Source of data: Zubin Bamji, "Global Gas Flaring Inches Higher for the First Time in Five Years," Open Data Blog, Global Gas Flaring Reduction Partnership, World Bank Group, 14 June 2019.



It is easier to draw a one-to-one correlation between financial returns and the energy use of bitcoin mining servers because those servers do only one thing—mine bitcoin—whereas enterprise servers handle different applications.

Some data center and network operators are concerned as well. Microsoft for one has pledged to cut its carbon emissions by 75 percent of its 2013 level over the next decade.¹¹ Toward that goal, it chose natural gas to power the fuel cells feeding a small server farm tucked away in Seattle.¹² It was a test of what Microsoft could do to make its data centers more cost effective and energy efficient and to reduce its dependence on the electrical grid.¹³

Another relevant data point—and it's relevant because we're looking at a blockchain-based solution—is the energy consumption of blockchains. Unlike enterprise servers where it is difficult to draw a one-to-one correlation between server energy use and financial return, this correlation is readily obtainable from cryptocurrency mining operations, partly because cryptomining servers are designed to do only one thing—mining—whereas enterprise servers may handle many different applications.

In one 30-month study, Bitcoin mining consumed an average of 17 megajoules (4.72 kWh) of electricity to generate one dollar, whereas conventional mining of gold used only five megajoules (1.39 kWh) to yield the same value.¹⁴ The same study concluded that the Bitcoin network emits far more CO₂ than Ethereum, Litecoin, or Monero; together the four cryptocurrencies produced as much as 15 million tons of CO₂ in the period studied.

According to the International Energy Agency, recent estimates of Bitcoin's electricity consumption range from 20 terawatt-hours (tWh) to 80 tWh per year.¹⁵ That's about 0.1 percent to 0.3 percent of global electricity use, compared to the 10 percent consumed by air conditioners and electric fans deployed to cool various environments such as homes, commercial buildings, and industrial systems.¹⁶



Winter Alaska Pipeline Oil Snow Sculpture by Robson Machado (Robzor), 2015, used under Pixabay license of 27 March 2020. Cropped.

Understanding the influencing parameters when planning a new mining data center will provide valuable data and analysis techniques to maximize the owner's return on investment.¹⁷

Natural gas-powered data centers

Reducing waste of natural gas upstream creates a new market for upstream companies, increasing their netback and net benefits.

We believe that PermianChain's marketplace should focus on data center operations as an opportunity and that natural gas operators with power-generation capabilities should serve these businesses. In 2019, the global data center construction market grew to an estimated \$22.73 billion.¹⁸ Data centers consumed roughly 200 tWh of energy, almost one percent of global demand for electricity.¹⁹

Data center operators require locations for scalable operations, ongoing flow of electricity, and efficiency that reduces downtime and less reliance on the electrical grids. Virtually all these data centers are powered by the electrical grid: electricity flows from a power plant, through multiple substations and transmission lines, and then is converted into the right voltage for a data center. Operators can manage data centers remotely with scheduled maintenance requirements or on-site management in case of emergencies. By receiving power directly from a natural gas line, we can streamline the power chain and eliminate the energy losses that occur through long transmission processes. The opportunity to reduce waste of natural gas introduces a new market for upstream companies, increasing netback and net benefits. This process significantly reduces the amount of energy lost in power generation, transmission, and power conversion.

Bitcoin mining is a reasonable gateway for natural gas E&P companies to enter the data center powering business. To be a viable source of revenue, it requires a clean source of low-cost electricity, which natural gas operators can supply. We can mitigate operational unknowns by using standard mining server design such as *application specific integrated circuits (ASICs)*, standard data center structure and envelope (e.g., containerized units), and standard cooling equipment. Additionally, we can more easily account for energy consumption and cost through upfront analysis on location, system type, and server performance.

To be a sustainable revenue stream, bitcoin mining needs a clean source of low-cost electricity, which natural gas operators can supply.

Finally, we can implement OGBiF and introduce a new oil and gas business model wherein we transform excess or wasted natural gas into electricity to power on-site data centers housing the ASICs connected to the Bitcoin network. In exchange for bitcoin mining rewards and transactions fees, the ASICs would solve algorithmic equations that make bitcoin transactions possible. Oil and gas operators could use this business model to:

- » Register natural gas reserves and conserve energy on the PermianChain blockchain, which uses Hyperledger to store data transaction hashes
- » Receive an auxiliary source of revenue in the form of bitcoins that they could liquidate into cash flows for operational expenses and/or distribute to shareholders as dividends



Brox Energy Holdings has registered its proof of concept on the PermianChain platform so that it can test its idea for selling power in kilowatts to third-party bitcoin miners.

By deploying on-site power-generation infrastructure to convert natural gas to electricity, oil and gas operators can power on-site data centers for various data mining operations and conserve natural gas, thereby increasing netback and net benefit. By using NRTs and SOTAs, they can create a new market for natural gas trading in the form of electricity. Bitcoin miners can now purchase cost-effective sources of electricity, and producers can meet regulations on wasted natural gas.

PermianChain is now testing a pilot project with Brox Energy Holdings Ltd. (Brox), an Alberta-based energy company. Brox has deployed a 100-kilowatt bitcoin mining data center using as little as 30,000 cubic feet of natural gas to power 26 ASICs. This proof of concept (POC) is now registered on the PermianChain platform so that Brox can sell power in kilowatts to third-party bitcoin miners who wish to participate in co-location space (i.e., they want to place their own mining servers in Brox-owned data centers) or to deploy their own mining data centers on locations operated by Brox while purchasing on-site field-generated electricity using SOTAs.

Our analysis shows electricity costs as low as \$0.01 to as high as \$0.05 per kilowatt-hour compared to the usual \$0.07 to \$0.12 per kilowatt-hour on the market today. For mining data centers, a significant reduction in operational expenses makes for higher profits and lower payback periods.

Creating a circular economy

The world's need for data centers will continue to grow as long as digital technology and the Internet continue to grow. The emergence of artificial intelligence (AI), Internet of Things, and blockchain technologies is inevitable. The world will need to conserve energy and manage resources efficiently to allow for these advancements in digital technology.

Offering digital currency mining solutions not only reduces waste and creates an auxiliary source of revenue, it brings data analytics to a new level.

Offering digital currency mining solutions not only reduces waste and creates an auxiliary source of revenue, it brings data analytics to a new level. Secured revenues translate into stable cash-flow projections that increase net-present value of a company. Petroleum consultants valuing these assets might begin to take into account the value derived from converting natural gas into electricity and not just the standalone value of natural gas flowing through sales pipelines at Alberta Energy Company (AECO) prices. By adopting OGBiF, the industry should be able to consider what is commonly known as the *spark spread*. The spark spread is the difference between the wholesale market price of electricity and its cost of production using natural gas.

Let's put this into perspective. In many cases, Canadian natural gas operators usually sell their gas into the Alberta market based on the AECO benchmark price. Assuming the AECO price is at CAD 1.60 per thousand cubic feet (mcf), then natural gas operators would generate their revenue based on that price.



If natural gas operators deployed a one megawatt-hour power plant facility near the well-site to transform natural gas into electricity, then they could base revenues on the electricity price instead of the AECO price. If a kilowatt-hour (kWh) sells for CAD 0.05, a 1,000-kWh facility, which equates to one megawatt-hour (MWh) could equal to the following example:

$$1,000 \text{ kWh} \times 24 \text{ hours} = 24,000 \text{ kW/day}$$

$$24,000 \text{ kW/day} \times \text{CAD } 0.05 = \text{CAD } 1,200$$

Compare that with selling 300 mcf, which is the estimated amount required to generate a 1,000-kWh facility.

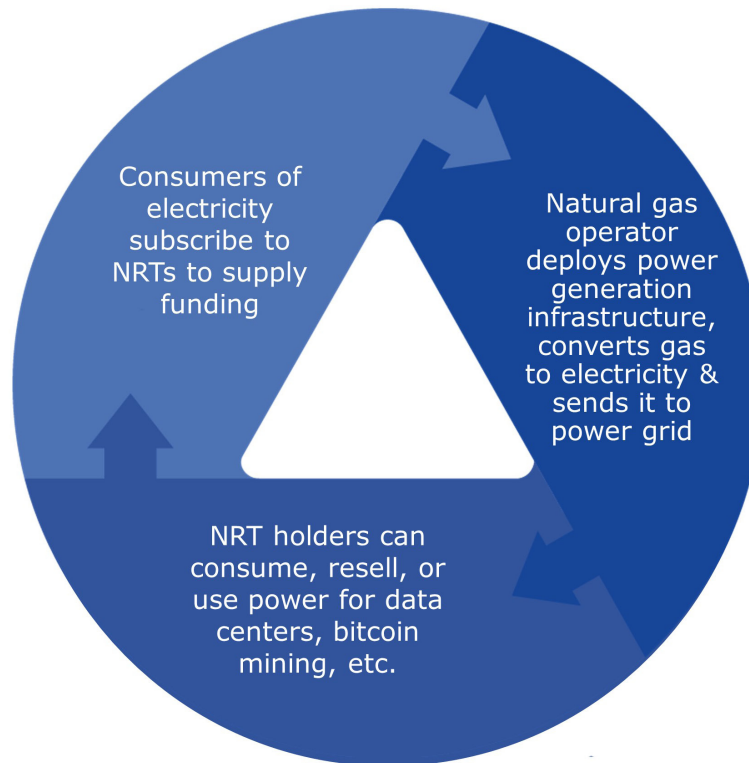
$$1 \text{ mcf} = \text{CAD } 1.60$$

$$300 \text{ mcf} \times \text{CAD } 1.60 = \text{CAD } 480$$

Based on those rough estimates, a natural gas operator could make around 2.5 times netback per mcf if that same amount of gas was converted and transferred into electricity to be sold on the market or to third-party data center operators for as low as five cents a kWh.

If natural gas operators deployed a one megawatt-hour power plant facility near the well-site to transform natural gas into electricity, then they could base revenues on the electricity price instead of the AECO price.

Figure 7: Circular energy economy



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By providing cheaper and more reliable computing power for data mining operations on-site, natural gas companies can reward shareholders with auxiliary income.

Now let's assume that natural gas operators go the extra mile and integrate the OGBiF business model to deploy natural gas-powered bitcoin mining data centers. Let's also assume that the 1,000 kWh generated are not sold to the electrical grid or any third-party data center operator but are used by the natural gas operator to power its company-owned bitcoin mining data centers.

Based on our findings from a recent POC, a 1,000 kWh bitcoin mining data center would fit approximately 289 ASICs of the latest models. Those 289 ASICs running on 1,000 kWh would generate around 0.3 bitcoins per day for a 30-day period; that would translate to nine bitcoins per month. The netback would depend on the value of bitcoins at the time of liquidation. If bitcoin's price was \$9,000, then those nine bitcoins would generate a whopping \$81,000 before expenses and operating costs. If operating costs involved simply equipment maintenance and ongoing gas supply (which is in excess, stranded, or wasted), then the netback here could be as much as five times per mcf.

The result on shareholder returns would derive from converting clean natural gas into electricity and delivering a cost-effective energy source that could power the world's data storage centers and data mining farms. Ultimately, by providing cheaper and more reliable computing power for data mining operations on-site, we can reward shareholders with an auxiliary source of income, through company-owned bitcoin mining operations or third-party electricity sales.

Implementation challenges

Attracting capital while remaining competitive in global markets is challenging. Despite its relatively large size compared to other industries within Canada, the oil and natural gas industry will continue to compete for investment and capital in an increasingly globalized world that still needs oil and gas to meet the growing energy needs.²⁰

Oil and gas companies must develop patient strategies when applying blockchain and digitization methods to solving the industry's funding and market challenges.

To compete in the global economy, we are challenged by first leading our regional economy to address the difficulties of achieving a prosperous oil and gas industry. Innovation through financial technology and digital transformation is a challenge in itself. Blockchain companies planning to deliver a user-friendly experience and industry standard processes must consider platform development costs, appropriate systems, and efficient and reliable networks. Oil and gas companies must also develop patient strategies when applying blockchain and digitization methods to solve the industry's funding and market challenges.

Laurent Martin, former vice president of special projects and strategic growth at Envion AG, recently discussed the challenges of implementing a natural gas-powered data mining operation.



"It is a good time—and there is room for profit—if we apply the pricing mechanism from the gas-to-power businesses. Natural gas conversion is key to take advantage of the economics of mining bitcoin."

 LAURENT MARTIN
Former Vice President
Special Projects and
Strategic Growth
Envion AG

Envion was a start-up based in Berlin. In early 2018, the Envion team registered in Switzerland to raise \$100 million in an initial coin offering (ICO). The funds were to support Envion's development of mobile blockchain data centers that would operate on-site at power plants. Martin said that Envion's designers had to consider, for example, the proper air-flow dynamics and the control of heat moving through the data mining units. Laurent's team also focused on energy efficiency so that its fabricator could manufacture the design cost-effectively.²¹

According to Envion's ICO prospectus, the team came up with "a proprietary combination of technologies for the crypto mining industry," which Envion called *mobile mining units* (MMU) housed in standard twenty-foot freight containers and featuring "proprietary pattern of air flows and high performance fans."²² Its choice of and modifications to hardware reduced the unit's power consumption further.²³ The MMUs would run autonomously with minimal overhead expenses. The start-up had rolled out plans to build and distribute these MMUs strategically worldwide to take advantage of cheap energy sources.

Of PermianChain's OGBiF and SOTA applications, Martin said, "It is a good time—and there is room for profit—if we apply the pricing mechanism from the gas-to-power businesses. Natural gas conversion is key to take advantage of the economics of mining bitcoin."²⁴ Unfortunately for Envion, the start-up went into liquidation after a dispute between its chief executive officer and its founders.²⁵ Envion's founders have distanced themselves from the former CEO and are seeking opportunities to put their MMU designs to work.²⁶



Industry Business Transportation System by Iebone, 2018, used under Pixabay license of 27 March 2020.

Scalability of the platform

E&P companies can scale this new-generation oil and gas business by collaborating to consolidate assets on the PermianChain. They can implement an integrated solution for oil and gas that includes digitization of energy resources coupled with financial technology that opens access to private capital for innovative on-the-ground operations and increases the bottom line and netback per cubic foot of gas. The sector can achieve scalability by satisfying growing demand from:

- » Investors seeking upside value under a trusted, reliable, and environmentally conscious business model
- » Data center operators looking for remote locations and power purchase agreements as a package allowing for more efficient methods of purchasing electricity under a controlled pricing model
- » Bitcoin mining operators seeking economic sources of power to sustain their long-term operations and high volatility of bitcoin

Steadily meeting the needs of energy investors, data center and bitcoin mining operators, and small to mid-sized oil and gas companies will more likely engender loyal and scalable adoption of such a platform.

A bottom-up approach would more likely engender loyal and scalable adoption of such a platform. We see the pressing demand for this solution coming from SMEs in the upstream sector across Canada and the United States. Any platform must successfully address efficient, smart, and patient capital needs. Kris Jones, former ministerial assistant to the Honorable Lori Carr of the province of Saskatchewan, said, "Overall investment is a concern for CAPP [Canadian Association of Petroleum Producers] members. ... Operators are already using flare gas at well sites and might be interested in the mining on-site solutions in addition to a platform for tokenized reserves project."²⁷

Adoption of such a platform needs the support of the private capital markets. EMDs who are authorized and regulated by their province's financial regulator to market exempt securities are key to sponsor such initiatives. For a digital securities issuance platform to comply with regulatory requirements, EMDs must sponsor the offering of those oil and gas companies' digital securities and support raising capital for those companies on a best-effort basis. Including EMDs brings about a more well-rounded consensus amongst industry participants as EMDs can instill credibility and ensure compliance with securities regulations.

Governance of an investment platform

The platform is governed by its users, which include expert petroleum consultants, oil and gas companies, investors, and shareholders who subscribe to the NAST issued by oil and gas companies; they are registered on the platform and by the EMDs that foster platform compliance and facilitate NASTs under strict securities regulations. Holders of NASTs own a digital representation of shares, which give them rights to equity in the oil and gas companies registered on the platform.





Refinery Oil Aerial Natural Gas Gasoline by jpenrose, 2009, used under Pixabay license of 27 March 2020. Cropped.

PermianChain's platform is governed by its users, which include expert petroleum consultants, oil and gas companies, investors, and shareholders who subscribe to the security tokens issued by oil and gas companies according to securities regulations.

The platform operates under a set of predefined governance and reporting frameworks that are brought forward by registered EMDs to comply with securities regulations and that are coded into the platform's functions and the NAST smart contracts. The functions on the platform are executed with the participation of third-party verifiers (e.g., dealing representatives, compliance officers, custodians, trustees, etc.) to ensure regulatory approvals, compliance, and standard reporting. Each verified function or transaction on the platform is then pushed to the platform's blockchain and distributed ledger (i.e., Ethereum network for token register and Hyperledger blockchain for timestamped data and transparent reporting).

Interoperability with other platforms

By adopting OGBiF, the platform allows communication between a company and its stakeholders by opening a delivery mechanism of data captured by on-site data mining operations; it captures natural gas consumption that can be translated into data that tracks conservation and natural gas revenues in real time. Likewise, blockchain data mining on the Bitcoin network can not only provide holders of NRTs and NASTs with real-time data on revenue generation from natural gas but also distribute dividends in real time to shareholders. Furthermore, the integration of remote sensors and remote monitoring application on-site that are connected to existing enterprise resource planning (ERP) software, such as Oracle NetSuite, can reflect key data to stakeholders and have such data pushed on a blockchain-enabled platform by way of an application programming interface (API).

We can digitize oil fields to supply real-time tracking of select data that would bolster investor sentiment. Upstream companies



To adopt, integrate, and test the potential of different systems for interoperability would require a minimum base of users that could produce around 1,000 barrels of oil equivalent per day.

According to Forester Yang of Sinochem Energy Technology, distributed ledger technology platforms should always include the human touch in their governance frameworks to comfort stakeholders.

could attract more sources of capital as they optimize revenues through proper data analytics and simulation. Commercializing such interoperability is a work in progress requiring industry participation. We believe that to adopt, integrate, and test the potential of different systems for interoperability would require a minimum user base that could produce around 1,000 barrels of oil equivalent per day.

Regulation and regulatory uncertainty

Regulation of digital securities depends on the structure of each offering. The global standard is to regulate according to the rules of jurisdiction in which the company will issue and distribute the financial security. The current paper-based regulation sometimes does not work well for all-digital securities, though regulators have granted exemptions from certain requirements as long as they don't undermine investor protections. In Canada, provincial and territorial regulators generally collaborate with each other through the Canadian Securities Administrators (CSA) Regulatory Sandbox so that they treat novel applications uniformly across Canada.²⁸ The hope is the CSA's sandbox can deal with issues faster to provide service to this fast-paced part of the financial industry.

As for regulations around the natural gas market, the solution of OGBiF with on-site data mining addresses concerns around gas flaring volumes. It is a positive response to the industry's wasted natural gas resources.

Forester Yang, head of blockchain application development for Sinochem Energy Technology in China, shared his views on how the political challenges of governance would create uncertainty for such a platform in countries where oil and gas are national commodities and where private investors do not own mineral rights.²⁹ He elaborated on how distributed ledger technology platforms should always include the human touch in their governance frameworks to comfort stakeholders.

A balance between human responsibility and digital automation is how the PermianChain platform implemented its functions. As an aggregator of oil and gas data sets owned by its users, PermianChain must ensure the quality and veracity of information recorded on its platform. That's why experts (e.g., petroleum consultants, geologists, engineers, and landmen) must verify the data sets before they are recorded to the blockchain. Proof of ownership of each set is also recorded to PermianChain's distributed ledger.

Implications and key takeaways

Managing execution risk for upstream companies as they consider shifting and transforming their business into an OGBiF is a growing concern because of the nascency of the technology. The rise of big oil consortia within this space is a validation of a gradual internal move



With a close-knit industry participation, bringing a more commercially viable and compliant platform to the data mining market—one that is accessible by investors globally—is a very achievable task.

between companies and their stakeholders to test and implement trading activities on the blockchain, where they have proven to cut post-trade costs by almost 40 percent.³⁰ Leaders within the industry should carefully plan and implement a gradual shift before going to market.

Rigorous planning and coordination. The OGBiF model requires careful planning relative to cybersecurity, physical security, crisis management, and regulations, from exploration and production of oil and gas to financial securities. With a close-knit industry participation, bringing a more commercially viable and compliant platform to the data mining market—one that is accessible by investors globally—is a very achievable task. PermianChain is a pioneer member of the Blockchain Research Institute and a start-up member of the Petroleum Technology Alliance Canada (PTAC), gaining key stakeholder feedback to commercialize its application.

Diversity of talent. The success of OGBiF depends on a variety of experts. The implementation phase relies on the skills and knowledge of electricians, petroleum engineers, technicians, and data center ecosystem professionals. Leveraging investments after implementation requires the expertise of investment advisors, information technology professionals, and natural gas field operators. PermianChain was founded by a corporate finance regulation professional, a legal specialist, and a petroleum geomechanics engineer. These practitioners help to ensure economies of scale, economic growth, and profitability of the OGBiF business model.

Compliant frameworks. Business models must comply with laws across industries and jurisdictions. To that end, PermianChain has been in close and ongoing discussions with regulatory bodies in Canada and the United Arab Emirates. Likewise, current oil and gas blockchain consortia such as Vakt and OOC Oil and Gas Blockchain Consortium are addressing use cases around post-trading efficiencies, data management, dispute resolutions, and project management. Sinochem Energy Technology is also developing its own post-trading platform focused on petrochemicals in the Chinese market.³¹

Research and development. Ongoing R&D is critical, and it includes prospective user feedback. For example, PTAC hosted an online webinar that showcased PermianChain's OGBiF business model and the advantages of blockchain adoption for resource financing and cash-flow optimization.³² According to participants, natural gas-powered blockchain data mining would need an ultra-low emissions power source so that adopters could earn emissions credits. If we can profitably use gas to generate electricity, then why would we want to sell gas if we can sell power? However, we see little synergy between gas producers and power generators, perhaps because of the lack of openness in local markets for innovation.

Industry consensus. Consortia and showcases under PTAC can bring industry players together to drive technological innovations that attract new sources of capital and maintain growth of clean



energy in domestic and international markets. The focus here is on consolidating small and medium-sized oil and gas companies that need to revive their businesses. To solve their funding and market challenges and to manage execution risk, the industry needs to support the use of one platform for business-to-business transactions. Philip Collins, CEO of Brox Energy Holdings Ltd., summarized the situation nicely:

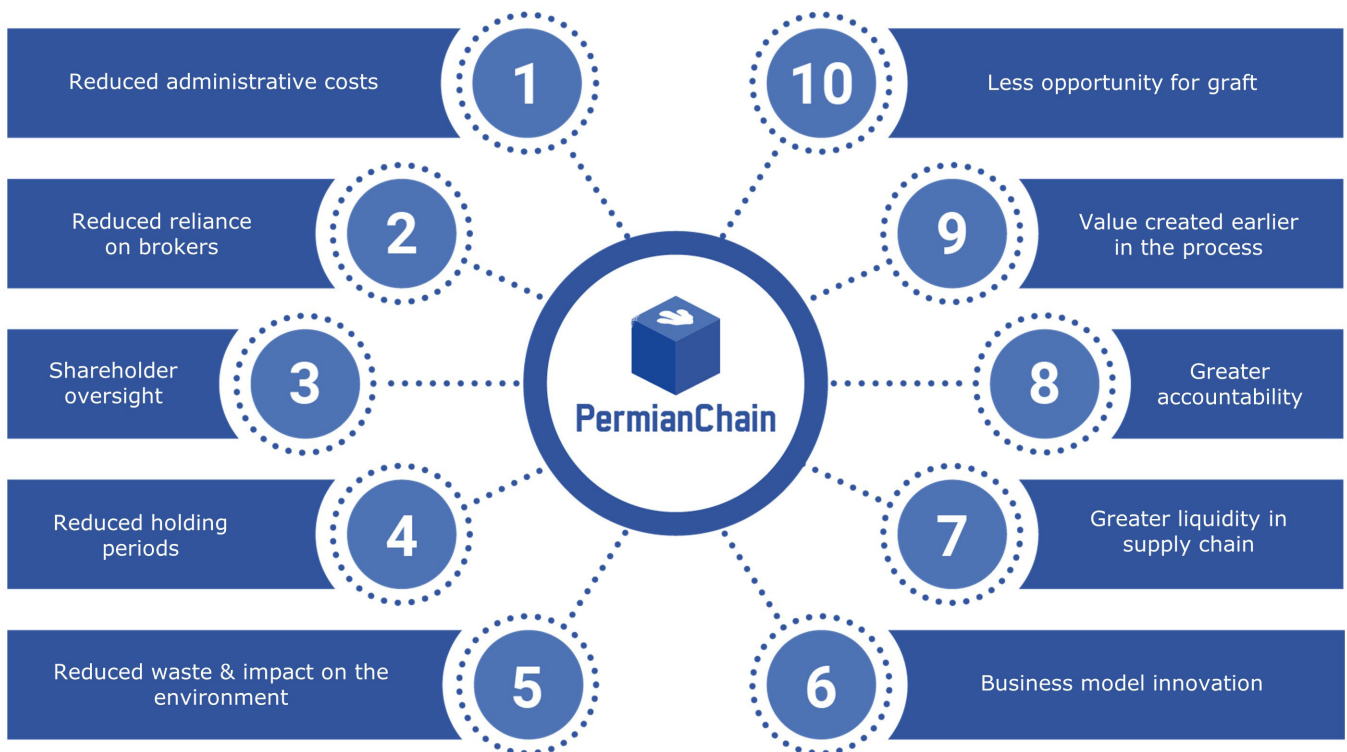
"Digital transformation, blockchain adoption, and power generation facilities are becoming key growth drivers for the future of the oil and gas industry."

 PHILIP COLLINS
Chief Executive Officer
Brox Energy Holdings Ltd.

The industry faces many challenges including capital constraints and fast evolving environmental policies. This has left many small and mid-cap E&P companies cash-strapped despite their significant growth potential, proven reserves, and quality assets. Digital transformation, blockchain adoption, and power generation facilities are becoming key growth drivers for the future of the oil and gas industry ... to create a new market for our region's [Canada] wasted and stranded natural gas while digitally transforming our business model to focus on efficiency and increase shareholder value. These are desperate times for North American oil and gas.³³

Through its proof of concept, PermianChain demonstrated that it could support innovative ways of doing business for many undervalued companies that joined its platform.

Figure 8: Summary of potential benefits of PermianChain's solution



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About the author

Mohamed El-Masri is the founder and CEO of PermianChain Technologies Inc.³⁴ With over seven years of corporate finance experience, he developed a comprehensive understanding in structuring alternative investment products. His entrepreneurial aspirations led to the pursuit for research and development on primary market investment platforms and enterprise blockchain solutions that serve small and medium-sized enterprises. Mohamed's expertise is in structuring tailored alternative investments and employing financing solutions for high growth companies. He recently directed his focus to Canada's oil and gas industry, which he explains in his open letter to Canada's oil and gas executives.³⁵

Mohamed is also the director and chief investment officer of Brox Energy Holdings Ltd., an energy and data mining company based in Calgary, Alberta. He leads the corporate finance division for Ento Capital Management Ltd., an investment advisory firm based in the Dubai International Financial Centre and regulated by the Dubai Financial Services Authority.

Mohamed studied political science and economics at Concordia University in Montreal, Canada. He earned his Canadian securities qualification from the Canadian Securities Institute to pursue his career in the Canadian securities market at the time. Mohamed holds a general securities qualification certificate with the Capital Market Authority of Riyadh, Saudi Arabia. He is a certified member at the Chartered Institute for Securities and Investments, where he has attained his certification in corporate finance regulations as a prerequisite for the diploma in corporate finance.

Disclosures

The author is the founder and CEO of PermianChain Technologies Inc. and director and chief investment officer of Brox Energy Holdings Ltd., both of which are investing in some of the solutions described in this research.





About the Blockchain Research Institute

Co-founded in 2017 by Don and Alex Tapscott, the Blockchain Research Institute is an independent, global think tank established to help realize the new promise of the digital economy. For several years now, we have been investigating the transformative and disruptive potential of blockchain technology on business, government, and society.

Our syndicated research program, which is funded by major corporations and government agencies, aims to fill a large gap in the global understanding of blockchain protocols, applications, and ecosystems and their strategic implications for enterprise leaders, supply chains, and industries.

Our global team of blockchain experts is dedicated to exploring, understanding, documenting, and informing leaders of the market opportunities and implementation challenges of this nascent technology. Research areas include financial services, manufacturing, retail, energy and resources, technology, media, telecommunications, healthcare, and government as well as the management of organizations, the transformation of the corporation, and the regulation of innovation. We also explore blockchain's potential role in the Internet of Things, robotics and autonomous machines, artificial intelligence, and other emerging technologies.

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