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OIL AND GAS CRYPTO-MINING

ENVIRONMENTAL AND LOGISTICAL STRATEGIES

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02 FUNDAMENTALS

Cryptocurrency (generally referred to in this paper as “Bitcoin”, though there are many different cryptocurrencies) mining is a process in which sophisticated computers with specialized chips are used to solve complex mathematical equations. When the miner is the first to complete a 1 MB block of transactions, 6.2 Bitcoins (approximately $270,000 in today’s price) is awarded to the miner.

Though the process and the monetary market for cryptocurrency is complex, the focus of this discussion is how to power that process. The computers with the specialized Application-Specific Integrated Circuit (ASIC) chips and graphics cards needed to mine Bitcoin use a LOT of energy to run.

The Digiconomist's Bitcoin Energy Consumption Index [1] estimates that one Bitcoin transaction takes 1,544 kWh to complete, or the equivalent of approximately 53 days of power for the average US household.[2]

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03 FUNDAMENTALS

In the oil production process, natural gas flows up the wellbore along with the coveted oil and the water byproducts. Oil producers have to do something with that “associated” gas. It should absolutely not be released to the atmosphere because of potential health effects and its global warming potential (methane is a 25x more-potent greenhouse gas than CO2).

In an ideal world, that gas would be captured and routed to a gas processing facility to become natural gas that we use to heat our homes and businesses. However, the reality is that there is not sufficient infrastructure to capture and route that gas to processing in all geographies, and there are operational instances in which gas capture is simply an inadequate solution.

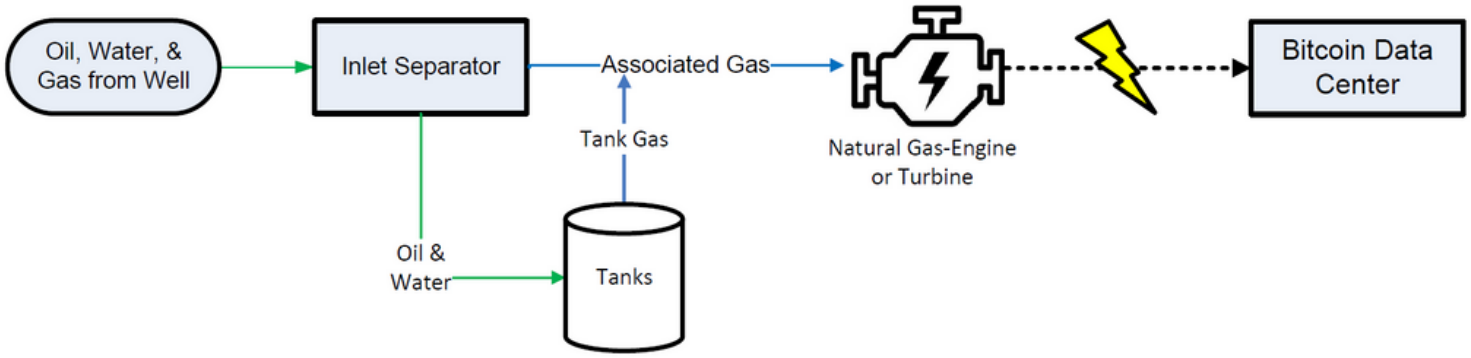
In situations where the gas cannot be captured, the next best thing is to flare – or burn – the gas so that the hydrocarbons are broken down in a combustion reaction to CO2 and water. When gas is flared, it is essentially wasted in the sense that the energy content of that gas was not put to good use.

According to the Global Gas Flaring Tracker Report, 142 billion cubic feet of gas were flared globally in 2020.[3]

04 FLARED GAS BITCOIN MINING HOW IT WORKS

The concept of using oilfield associated gas for some purposes other than wasting it is not a new concept. Operators have been creatively using this gas as a power source or a fuel source for other equipment at a wellhead, such as generating onsite power via a natural gas generator or as a pilot gas for other equipment. Following the same concept, this gas that would be flared can instead be used to power one or multiple natural gas engines that can be used to generate electricity that is used to power a portable trailer that houses Bitcoin computers and equipment.

Instead of wasting the gas by burning it in a flare, that gas is instead put to good use to create electricity for another purpose.



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05 LOGISTICS RECOMMENDATIONS

In order to effectively run engines and turbines and the Bitcoin data center itself, consider the following:

- Gas flow must be steady. Intermittent flows will not provide the reliable energy needed to power the data center.
- Gas should have sufficient heat content to power the engine. For example, a 2.5 MW (3,350 hp) power generator set will require approximately 350 MCFD of 1,500 BTU gas or 200 MSCFD of 2,500 BTU gas.
- Sour gas high in H2S is problematic and is not recommended due to safety concerns and engine fouling.
- Need space for engine skid(s) and trailer-mounted Bitcoin data center.
- Maintain the flare at the site for emergency backup.
- Data center will need a steady communication line. Ensure cellphone coverage is adequate.
- Data centers get hot. Cooler ambient temperatures are preferable.
- Although oilfield engine maintenance technicians are used to remote locations and travel through rough country, the Bitcoin maintenance technicians are not, and maintenance contracts will reflect that in their pricing. Consider ease-of-access, especially in colder climates with snow cover.
- Provide heightened physical security and restricted access.

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06 AIR EMISSIONS FROM FLARES AND ENGINES

Air emissions from both flares and engines arise from the fact that the gas is being combusted, destroying the hydrocarbons, and converting the hydrocarbons to carbon dioxide (CO2). Presented below is an example of the combustion reaction of propane:

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

Neither flaring nor burning the gas in an engine will have 100% complete combustion of the hydrocarbons, so carbon monoxide (CO), partially remaining hydrocarbons, and soot (particulate matter) will be present. Oxides of nitrogen (NOx) are formed in the combustion process either by fixation of atmospheric nitrogen with oxygen, or through intermediate stages. If hydrogen sulfide is present in the gas, the H2S will thermally form sulfur dioxide (SO2) emissions; but remember, sour gas is not recommended here.

ENGINES

Air emissions from engines are calculated as function of the heat input required for the engine (MMBtu/hr) and guaranteed or measured emission factors (grams/hp-hour) for CO, Non-Methane and Non-Ethane Volatile Organic Compounds (VOCs), NOx, CO2, and hazardous air pollutants (particularly formaldehyde). Air emissions from engines are nationally regulated by the US EPA through New Source Performance Standard (NSPS) 40 CFR 60 Subpart JJJJ and National Emissions Standards for Hazardous Air Pollutants (NESHAP) 40 CFR 63 Subpart ZZZZ. These standards set maximum allowable emission factors for engines; however, engine manufacturers and operators can, or may be required to, exceed those standards (have lower emissions) by installing catalysts. This will increase up-front and maintenance costs.

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07 AIR EMISSIONS FROM FLARES AND ENGINES

FLARES

Air emissions from oil and gas flares are typically calculated (not measured) and are based on the heat content of the flared gas (MMBtu/hr) and emission factors established by the EPA for CO, NOx, and CO2. VOCs, hazardous air pollutants (HAPs), and SO2 are estimated based on applying a 95-99% flare destruction efficiency to the composition of the inlet gas.

ENGINE VS. FLARE COMPARISON

Based on an analysis of engine specification sheets for several readily-available natural gas engines ranging from 1,000 – 2,500 KW, Bright Sky can generally conclude that air emissions of CO and NOx are higher for the engines as-specified by the vendor than predicted for the flares.

This can be mitigated by purchasing and installing catalysts that exceed the NSPS JJJJ standards. As a site handles richer gas (higher BTU and VOC content), the VOC emissions from flaring are higher than the guaranteed VOC emissions from the engines. Not much information is readily available for CO2 emissions from engines; however, engines appear to generally estimate higher CO2 emissions than flares. Bright Sky recommends that engine manufacturers start to include CO2 emission factors in their specification sheets.

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08 BITCOIN MINER AIR PERMITTING STRATEGIES

Ihe natural gas engines will need an air permit PRIOR to setting the engines on-site. There are some instances where a permit may not be required in some states (if it is only a temporary project less than a year), but we recommend that you conservatively consider the engine to be a permanent stationary source.

Each state has different air permitting thresholds for the kinds of permits it allows. In general, the lower the emissions from a site, the easier it is to obtain and stay in compliance with a permit and the faster it takes for permit approval. From a federal perspective as discussed previously, the engine(s) must comply with NSPS JJJJ and NESHAP ZZZZ as applicable. We recommend that you maintain air emissions less than the Title V major source threshold, which is if any of the following apply:

- 100 TPY of VOC, NOx, and CO each (This limit may be lower if located in a non-attainment area, such as Houston.)
- 25 TPY total HAP;
- 10 TPY single HAP (in this case, formaldehyde).

In order to do this, you must balance your kW requirement and the emissions guarantees from the engine manufacturer. It is feasible that formaldehyde emissions may trigger major source permitting prior to NOx, CO, and VOC. Catalysts will likely be required to lower emissions to less than NSPS JJJJ standards and to reduce formaldehyde emissions; otherwise, the major source emissions threshold could be easily consumed by a mere 4,000 hp (3,000 KW). Performance testing of the engine(s) will likely be required routinely.

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09 BITCOIN MINER PERMITTING STRATEGIES

If the emissions from the engines cross the major source permitting thresholds, the following air compliance issues will arise:

- Increased wait time (one year or longer), higher consulting fees, and air permitting fees to approve the project. An air permit is required before any engine may be set at the site.
- Possibility of more rigorous air dispersion modeling required for air permit approval (costly).
- Requirement for a Title V air operating permit and public notices.
- More-onerous compliance requirements once installed, including semi-annual air permit deviation reporting, annual emissions inventory reporting, and compliance certifications by the responsible official of the company.
- If major for HAPs, additional operational and compliance requirements for the engines themselves, including catalyst pressure and temperature monitoring, performance testing, notifications, and reporting requirements for MACT ZZZZ.

Because of the inherent difficulties of permitting (i.e., long approval timelines and increased permitting cost) and staying in compliance with state and federal engine regulations, we recommend that Bitcoin miners interested in obtaining power from non-traditional gas sources consider a distributed network of employing multiple small generators (i.e., 5 MW-total) at large oil and gas central facilities in more-remote areas as opposed to constructing a large operation with a power capacity of say 50 MW.

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10

ABOUT BRIGHT SKY

Founded in 2018 in Austin, Texas, Bright Sky Environmental is an environmental consulting firm dedicated to the oil and gas industry. We support the responsible development of oil and gas resources by helping our clients comply with State and Federal Rules.

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Kat Galloway is the founder and president of Bright Sky Environmental, LLC. With nearly 20 years of environmental consulting and air permitting experience focused on the energy industry, her goal is to help oil and gas companies develop and operate assets in accordance with environmental regulations. As ESG protocols emerge, she helps her clients identify emissions reductions opportunities to deliver impactful environmental results to shareholders.

She has managed the preparation of hundreds of air permits for upstream and midstream facilities across the US. She is a Member of the Board of Directors of the Texas Alliance of Energy Producers and a host of the Energy Strong Podcast.

Kat invests in cryptocurrency and crypto-funds, and is actively supporting air permitting efforts for Bitcoin mining and oil and gas operators.