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Using Vault for Change Management in a Rapidly Growing Sustainable Startup

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Learning Objectives

- Learn about how eliminating natural gas flares will significantly reduce greenhouse gas emissions and help mitigate climate change.
- Discover how M2X Energy's chemical-processing technologies will convert natural gas that would be flared into useful products.
- Learn how M2X is partnering with existing companies and using advanced manufacturing techniques to accelerate product development timelines.
- Learn how to implement a document repository in Vault shared across multiple organizations to enhance collaboration.

Description

Approximately 200 billion cubic meters of gas are flared or vented globally each year, of which the United States is a significant contributor. M2X Energy's mission is to mitigate methane and CO2 emissions by replacing flares with systems that produce economically viable, low-carbon chemical products. At scale, MTX's chemical-processing technology will significantly reduce greenhouse gas (GHG) emissions and energy consumption from the domestic upstream oil and gas sector. MTX is a rapidly growing small group of engineers from diverse backgrounds. The firm also draws on industry partners to help design and specify parts of its chemical reactor. During its startup phase and subsequent expansion, MTX has greatly benefitted from using Vault software to manage CAD files and drawings, as well as requirement documents.

Speaker

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Kyle Merical is the Principal Powertrain Engineer at M2X Energy and holds a B.S.and M.S. in mechanical engineering from The Ohio State University. While studying at Ohio State, he played key technical and leadership roles in the University's Formula SAE team and conducted graduate research on automotive powertrains. Since graduation, he has spent his career at the forefront of advanced combustion engine research, design, development, and control. Kyle spent the first half of his career developing piston engines with improved performance and fuel economy. More recently, Kyle has sought out engine programs that focus on mitigating climate change, such as his previous role in control law design and analysis of Pratt & Whitney's geared turbofan jet engine, which drastically reduces aircraft fuel consumption and emissions. His current role at M2X Energy is a further commitment to his mission to help mitigate climate change. The engine-based syngas reformer is part of a larger system that will convert stranded methane gas into useful products instead of flaring it and contributing to greenhouse gas emissions.

Learn more about M2X Energy at: m2x.energy

M2X Energy's Mission

M2X Energy's mission is to solve the flaring problem and to monetize traditionally uneconomic gas streams.

What is flaring?

Natural gas flaring occurs when large pockets of natural gas are encountered during oil drilling operations. In most remote locations, it is uneconomical to transport natural gas from these oil wells to the end user, due to the low density of natural gas. As natural gas mainly consists of methane, which has over twenty times the greenhouse warming potential (GWP) of carbon dioxide, the natural gas is "flared," instead of simply vented to the atmosphere.

Natural gas flare at offshore oil well.

Impact of flaring

Natural gas flaring represents a tremendous waste of resources, and is a large contributor to GHG emissions. Further, not all of the natural gas discovered during oil harvesting, as some is vented to the atmosphere, where it has a far greater impact on climate change than carbon dioxide. In fact, the equivalent of 1.4 gigatons of carbon dioxide was released into the atmosphere by global natural gas flaring alone in 2019. This is roughly equivalent to the carbon dioxide released every year by the global aviation industry!
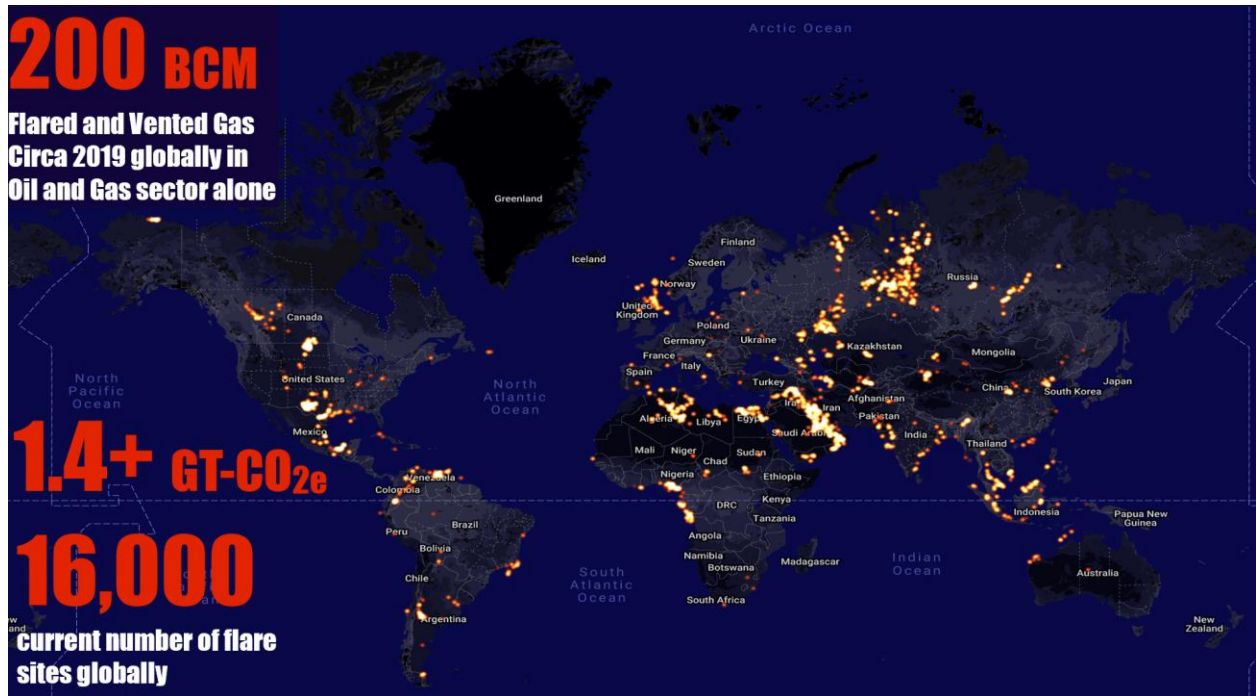
Satellite images of natural gas flares across the world.

M2X Energy's Product

M2X Energy is manufacturing mobile, modular, chemical plants. These units are towed over the road (see rendering below), to remote oil wells and will convert would-be flare gas into useful products, utilizing a gas-to-liquids (GTL) conversion process. This system utilizes mostly commercially available off-the-shelf (COTS) parts, to increase robustness. This product can be scaled to match the natural gas flare of any oil well, by simply adding more units.
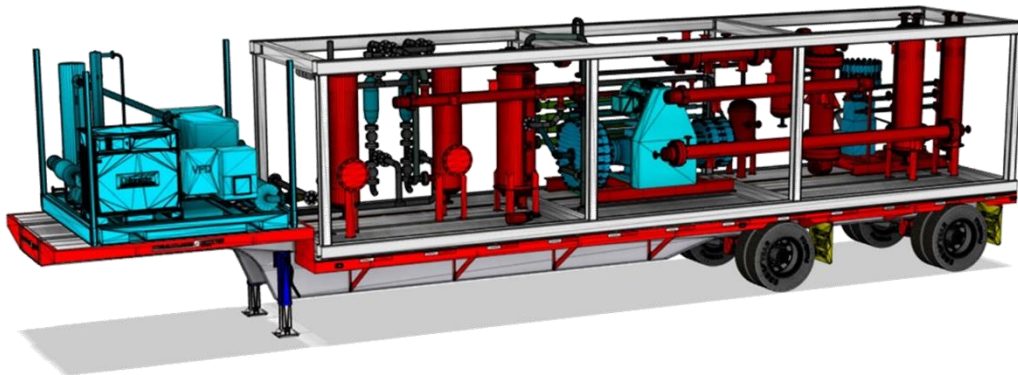
MTX mobile and modular chemical plant.

How does it work?

M2X's chemical process works by first ingesting the natural gas in an engine reformer, which partially oxidizes the hydrocarbons and produces syngas. This intermediary mixture of hydrogen and carbon monoxide is then processed and sent to a reactor that produces liquid methanol.
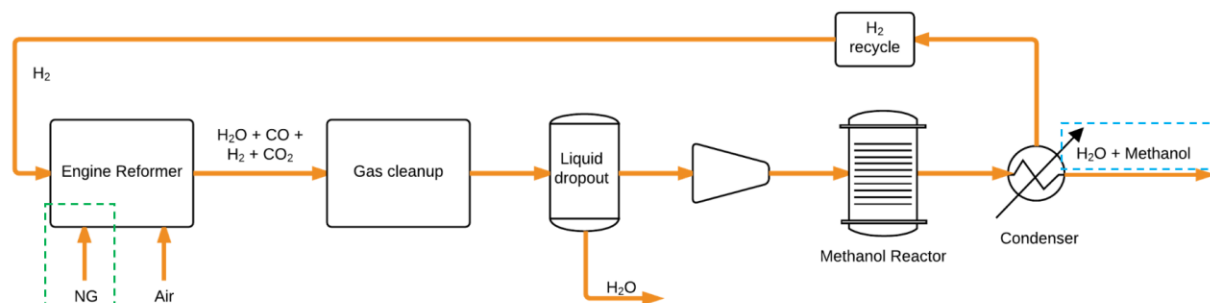

Natural gas to methanol GTL process.

The engine reformer is a key enabler for this process, as it replaces the traditional steam methane reforming (SMR) process used by industrial chemical plants. SMR uses very high CapEx equipment that is not mobile. The engine reformer starts with an automotive derived internal combustion engine, which is very low cost and robust. Internal combustion engines have over a century of design and development behind them, and although complex, are very reliable and are able to be reporpused to make syngas with limited hardware and software changes.

Why make methanol?

Methanol is the simplist of alcohols and is used as a building block for hundreds of everyday products, such as adhesives, foams, and plywood. This allows the carbon atoms in the methanol to be sequestered in building materials, rather than released into the atmosphere. Methanol is also a fungibile intermediate that can be used as a carrier of Hydrogen or chemical energy.

Methanol is typically created by using a feedstock of fossil fuels (coal or natural gas), electrolysis of water, or biomass. However, M2X Energy will be producing Methanol using a flare gas feedstock that is normally wasted by the flaring process. As shown below, using this feedstock prevents the release of carbon dioxide (from flaring) and methane (from venting) from the flare gas, and also displaces methanol produced using other methods, preventing the carbon dioxide emissions that would otherwise be produced from those processes. This results in a negative carbon intensity for methanol created by M2X's process, the amplitude of which varies according to the source of the methanol that M2X is displacing.
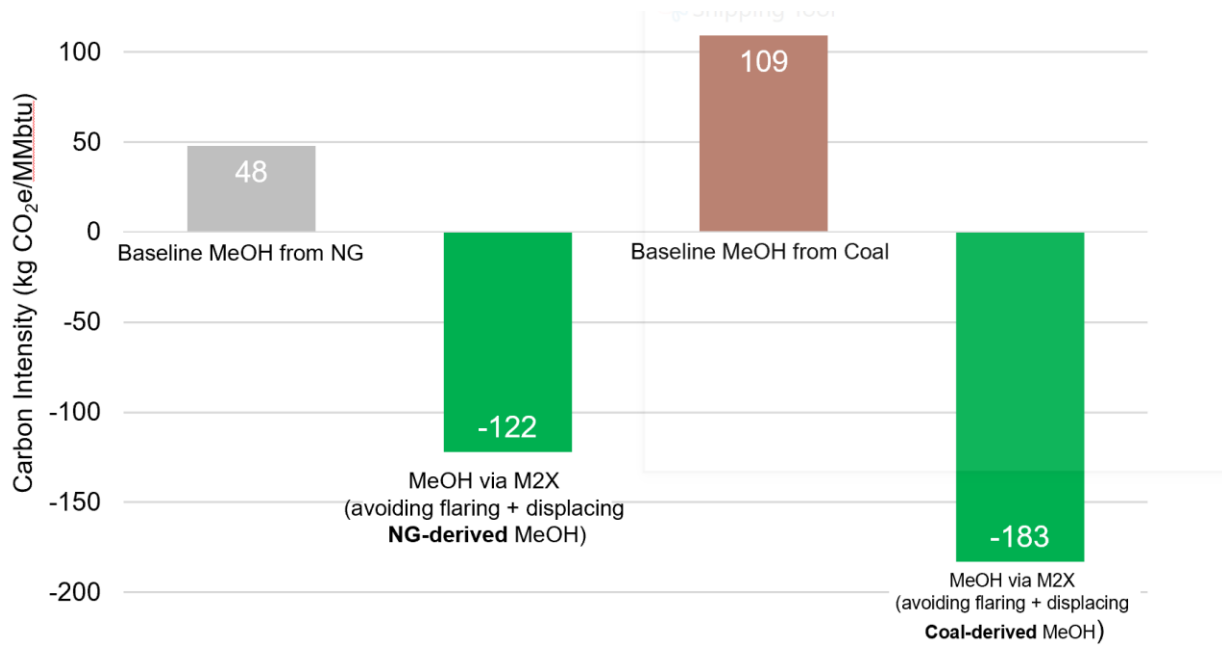
Carbon intensity of methanol produced by M2X.

Rapid Product Development

M2X Energy is partnering with established companies and using advanced manufacturing techniques to accelerate its product development timeline.

Partnerships are key.

Building infrastructure and staffing can be large roadblocks for startups that seek to produce hardware. M2X has avoided these roadblocks by partnering with existing companies that already have the capability to design and manufacture individual components used in our system, as shown below. This lets M2X quickly design and build a pilot demonstration system, while letting its own staff focus on the system-level design and establishment of intellectual property (IP).
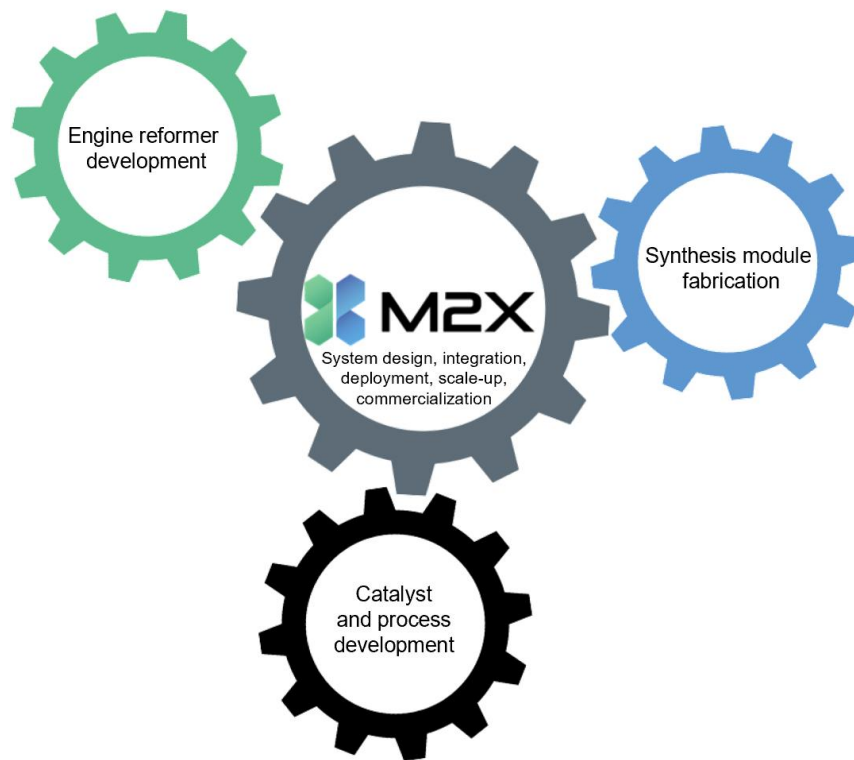
M2X partner roles.

Rapid prototyping.

Repurposing an automotive engine for syngas generation does present its own unique challenges. To achieve the required partial oxidation of the methane, the engine must combine an extremely fuel-rich mixture, which is limited by conventional ignition systems. M2X designed their own novel (patent pending) ignition system that solves this problem. To quickly fabricate these complex parts in the prototype phase, M2X uses a direct metal laser sintering (DMLS) process to quickly 3D print the parts. This allows very quick hardware delivery for testing and allows the part to contain very complex internal passages that would be impossible to machine from a single piece of metal. These parts have proven the concept of M2X's design, and so M2X can now easily continue to field 3D printed parts in production, or adjust the design to fit traditional manufacturing techniques.

Vault Implementation

Vault is an Autodesk product data management (PDM) software that helps manage your design and engineering data, improve collaboration, and take control of your product development processes.

Motivation

Since many of the components in M2X's system are designed and manufactured by external partners, M2X needs a repository that can integrate these various file types with internally designed parts and documents. Further, some of M2X's partners already use non-Autodesk

CAD software to design parts, and Vault is able to still interface with these systems, via add-in software. Vault was also chosen because it can accommodate many external users and setup file/folder permissions for each, to protect the sensitive IP and data of all parties, while still allowing for collaboration.
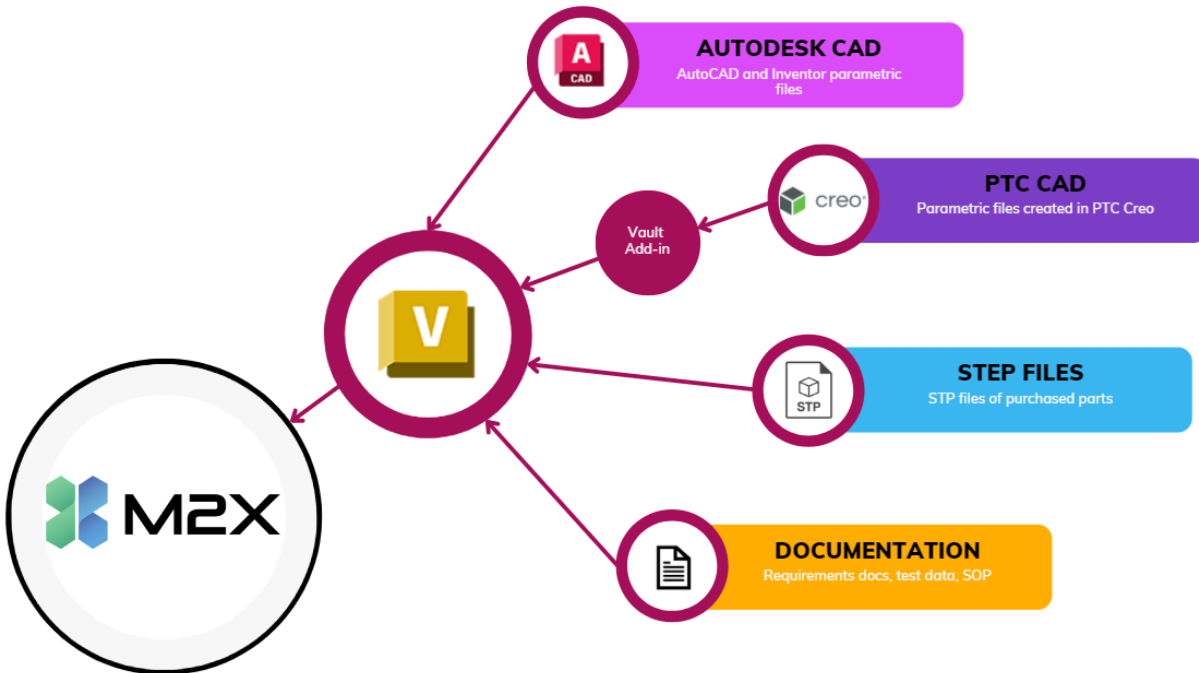

Vault file types and interfaces.

M2X decided to implement Vault by paying for a cloud-based solution, rather than purchasing and setting up our own servers. This was done because M2X has no official headquarters or office space to house physical servers, as members of our team either work at our partner facilities, or work from their homes. Additionally, the cloud-based solution eliminates the burden of procuring and setting up the server hardware and software, allowing us to get started more quickly and not worry about maintenance.

File structure and naming

M2X opted to organize files by system, then subsystem type, then by individual piece of equipment. In the illustration below, you can see how one of our syngas heat exchangers, HX-200, would be categorized in this architecture.
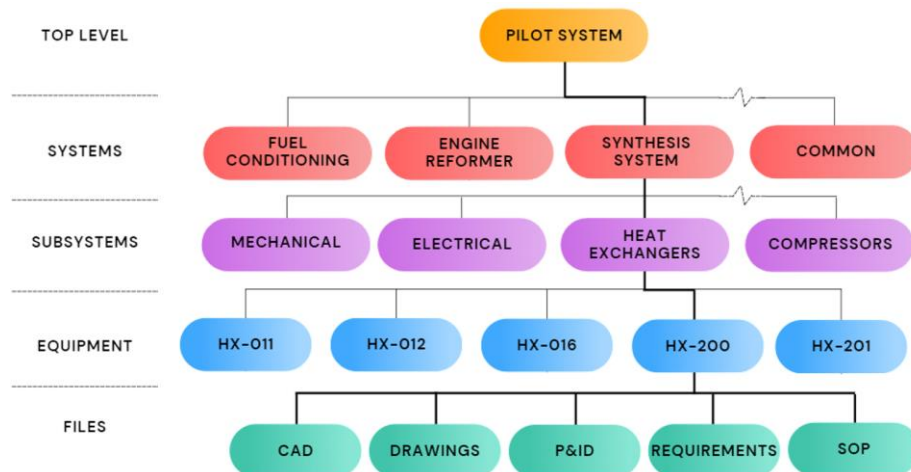
Vault file architecture.

The file structure above is also captured in our file naming convention. We wanted this naming convention to contain coded meta data for our parts. This lets an employee know where in the system a part lives and its function, simply by reading the first four digits of its name. Finally, the last four digits of the part number coincide with labels on our piping and instrumentation diagram (P&ID) for the system.
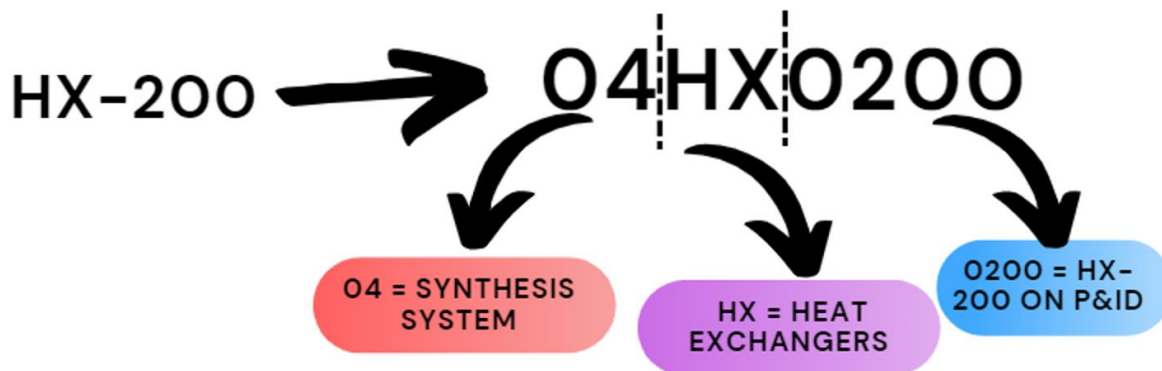
File naming convention.

Key Vault benefits.

Vault has enabled for easier and more secure collaboration between M2X and its several industry partners. Key benefits of Vault for M2X include:

- Easy importing and reorganizination of large CAD assemblies, while retaining dependencies
- Add-ins to integrate Vault with third party CAD software
- Access control for unique folders and files for each user
- Bill of material (BoM) generation

Summary of Key Points

M2X Energy is a startup solving the flaring problem and monetizing traditionally uneconomic gas streams. Our product is a mobile and modular chemical plant that uses a GTL process to convert would-be flare gas into liquid methanol. We are relying on established partners and advanced manufacturing techniques to accelerate our development timeline. Implementing Vault early will allow us to build a reliable system for equipment designs, change management, documentation, while collaborating with our partners.