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Using Vault for Change Management at a Rapidly Growing Sustainable Startup

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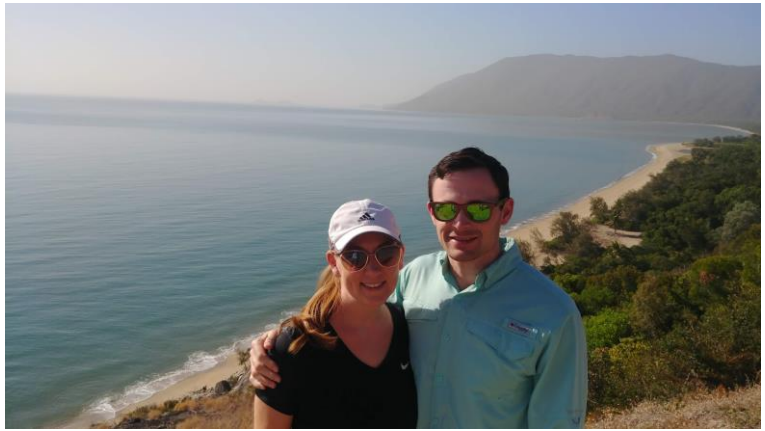
m2x.energy

About me

- Grew up in Ohio and received BS and MS in Mechanical Engineering from Ohio State University
- Spent career researching and developing piston and jet engines
- Moved from FL to NC one year ago to develop engines that reduce carbon emissions at M2X Energy
- I try to maximize time outdoors!

SCAN ME



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Agenda

1. M2X Energy’s Mission and Product
2. Rapid Product Development
3. Vault Implementation
4. Questions

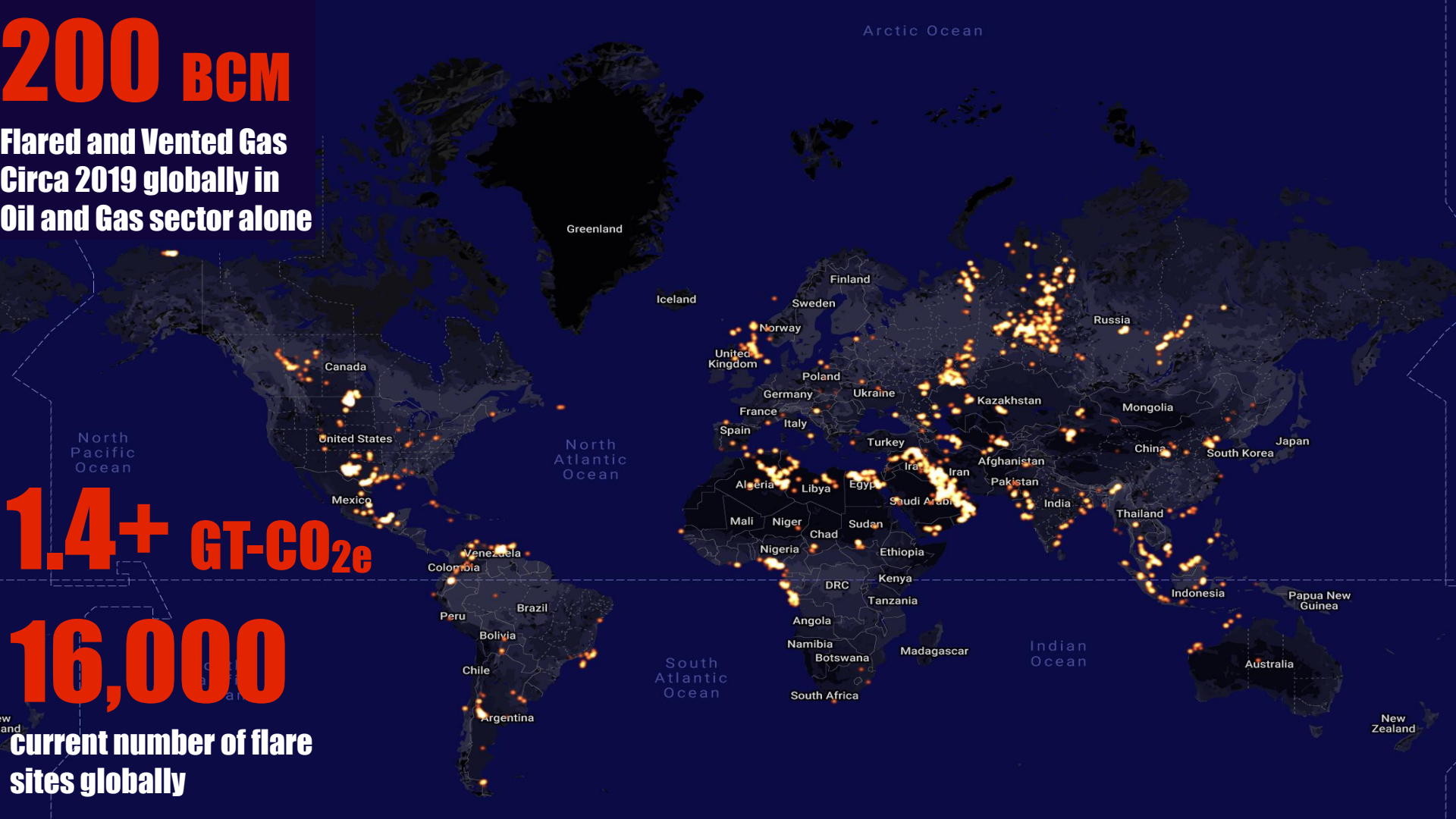
M2X Energy’s Mission and Product

Our Mission: Solve the Flaring Problem and Monetize Traditionally Uneconomic Gas Streams

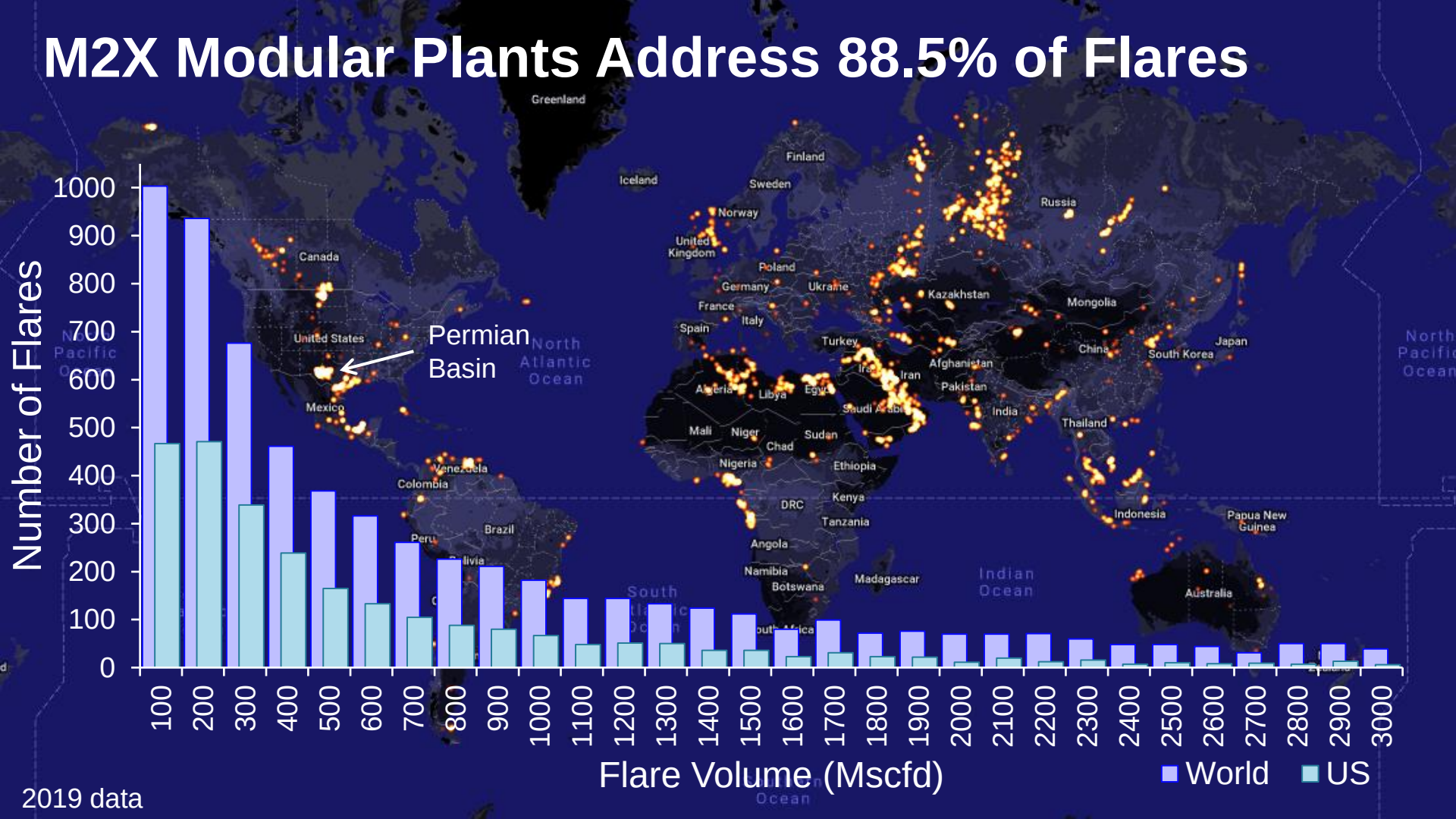
OnShore

Offshore Regions

Energy Deprived Regions


200 BCM
Flared and Vented Gas
Circa 2019 globally in
Oil and Gas sector alone
1.4+ GT-CO2e
16,000
current number of flare
sites globally
Arctic Ocean
Greenland
Iceland
Finland
Sweden
Norway
Russia
United Kingdom
Poland
Germany
Ukraine
Kazakhstan
Mongolia
France
Italy
Spain
Turkey
China
Japan
South Korea
Afghanistan
Iran
Pakistan
India
Thailand
Canada
United States
Mexico
North Pacific Ocean
North Atlantic Ocean
Algeria
Libya
Egypt
Saudi Arabia
Mali
Niger
Chad
Sudan
Nigeria
Ethiopia
Kenya
DRC
Tanzania
Angola
Namibia
Botswana
Madagascar
South Africa
Indian Ocean
Indonesia
Papua New Guinea
Australia
New Zealand
Venezuela
Colombia
Peru
Brazil
Bolivia
Chile
Argentina
South Atlantic Ocean

M2X Modular Plants Address 88.5% of Flares



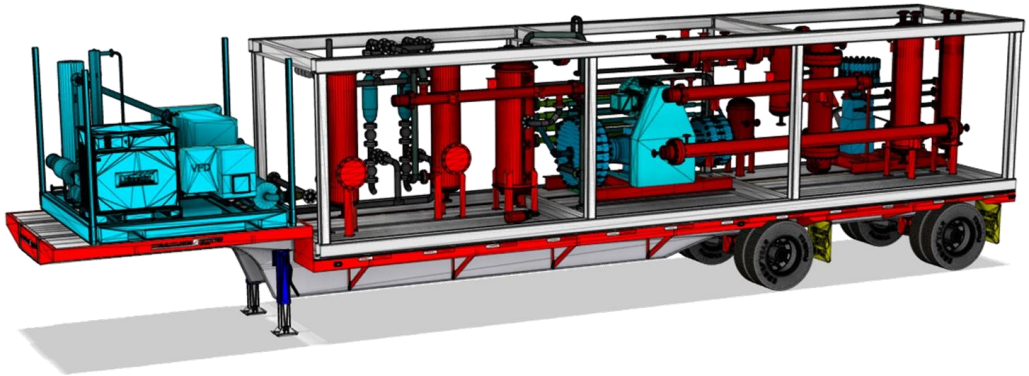
2019 data

The Product

Next Generation Mobile and Modular Chemical Plant

We are deploying mobile units to convert would-be flare gas into useful liquid products:

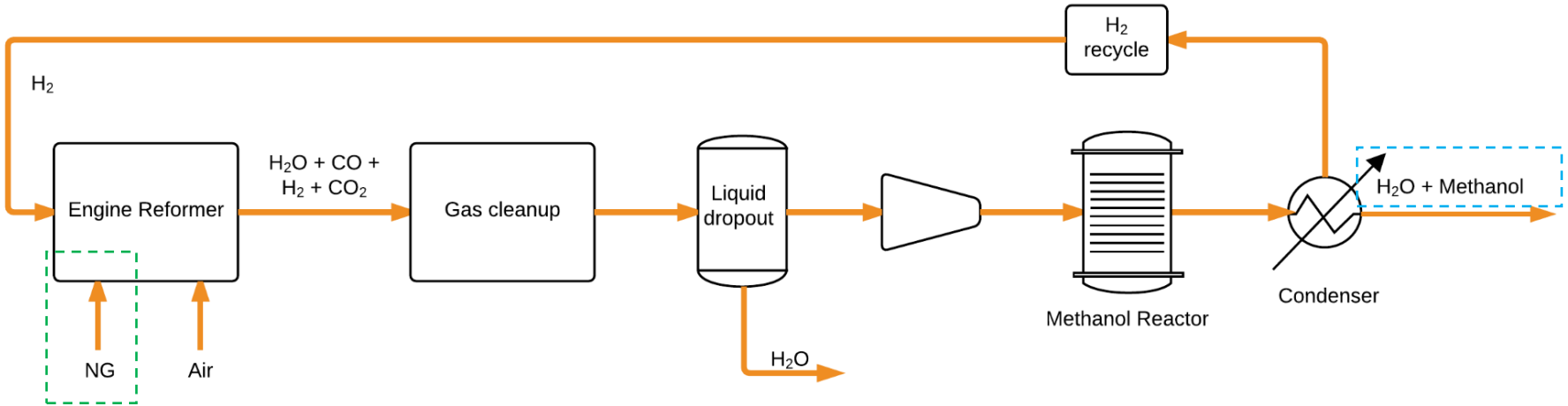
- Using Gas-to-Liquids (GTL) conversion process with engine reformer.
- Mobile unit will allow rapid deployment (and redeployment) to remote areas.
- Repurposing commercial hardware
- Modular system gives scalability to match customer needs.



The Process

Flare gas in, Methanol out

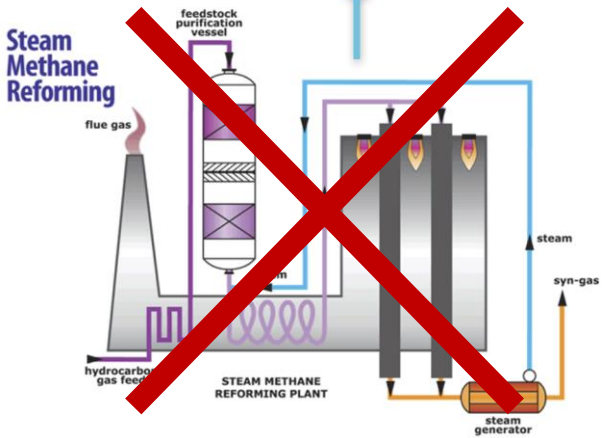
- Flare gas and ambient air ingested by engine reformer, to produce syngas
- Reactor converts syngas into Methanol and water



Engine Reformer Benefits

- Rich partial oxidation (POX) of natural gas in an internal combustion engine to produce synthesis gas (H2 + CO) is integral to our GTL process.
  - Mature hardware
  - Low CapEx
  - Robust and self-sufficient
  - Modular
  - Programmable electronic control
- Conventional steam methane reforming (SMR)
  - High CapEx
  - Not modular or redeployable

Syngas



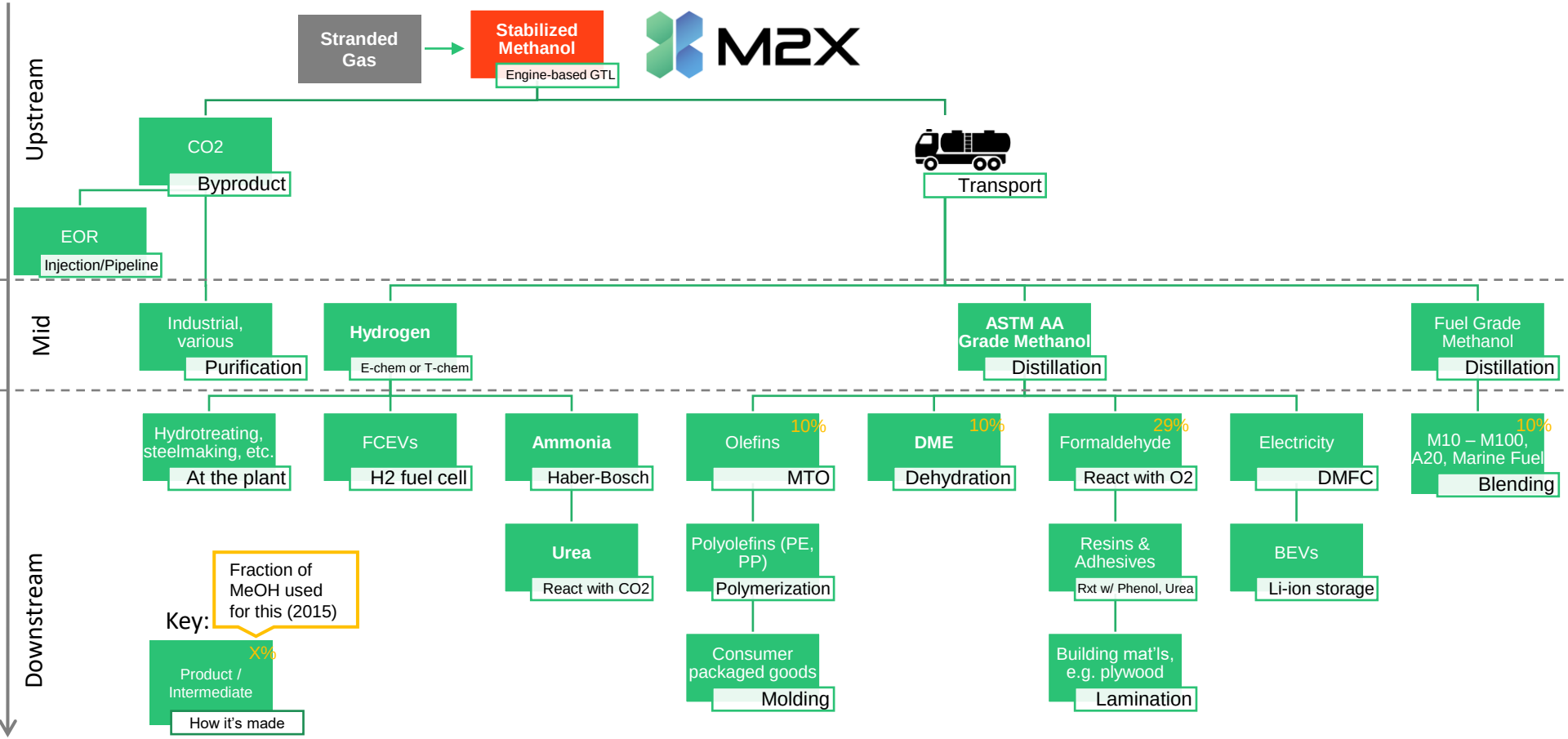
Evolution of Chemical Production (Methanol)

Methanol production (1960s)
Introduction of ICI low-pressure process
Natural gas feed

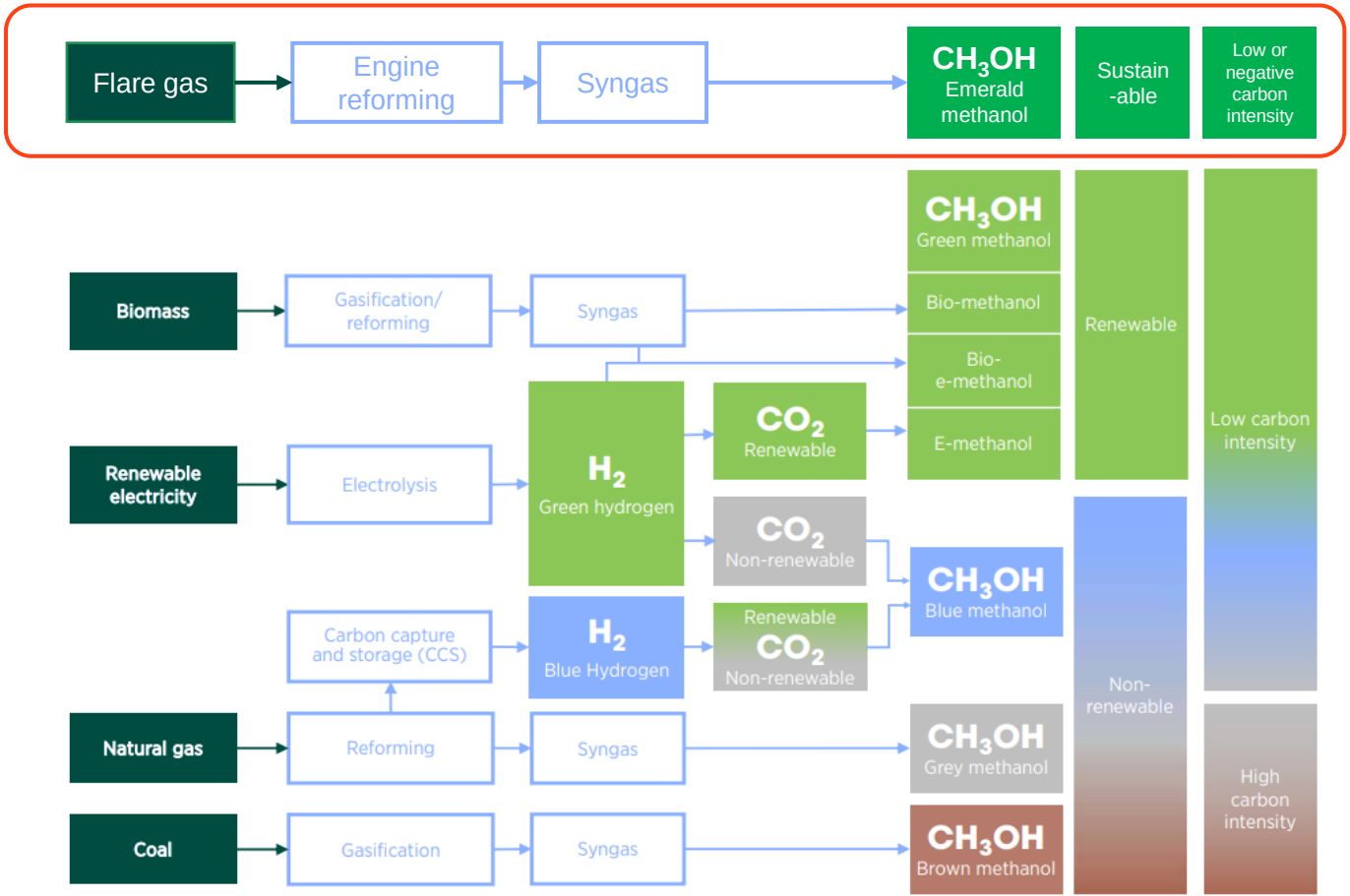
Methanol production (today)
Same basic process, up to 5000 tpd
Natural gas feed

Methanol production (next gen)
Modular, distributed, numbered-up
Flare gas feed

Why Methanol as Product?

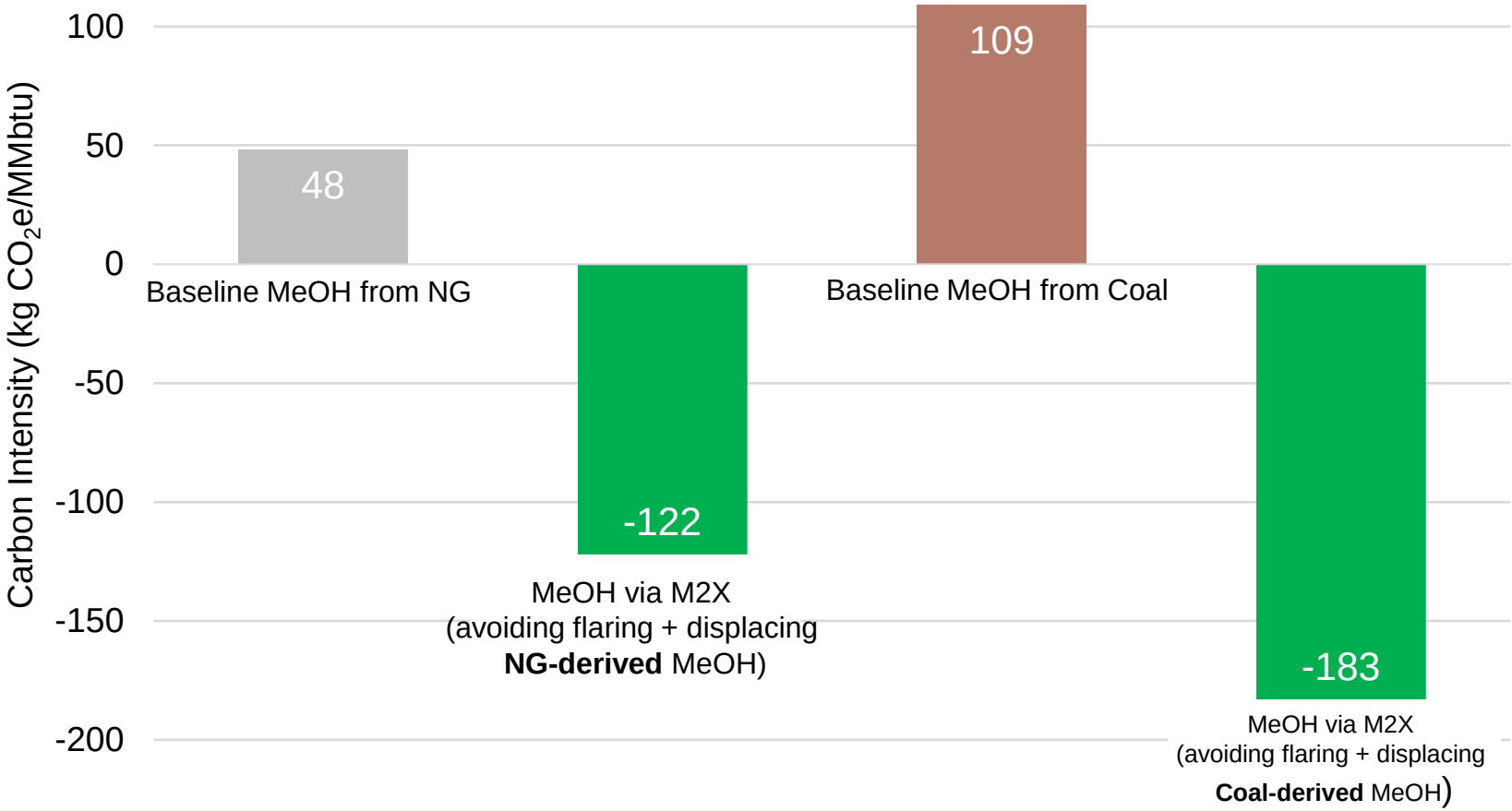


Carbon Intensity of Methanol Production



Modified from *Innovation Outlook: Renewable Methanol*, IRENA, 2021, link

Negative Carbon Methanol from Flare Gas



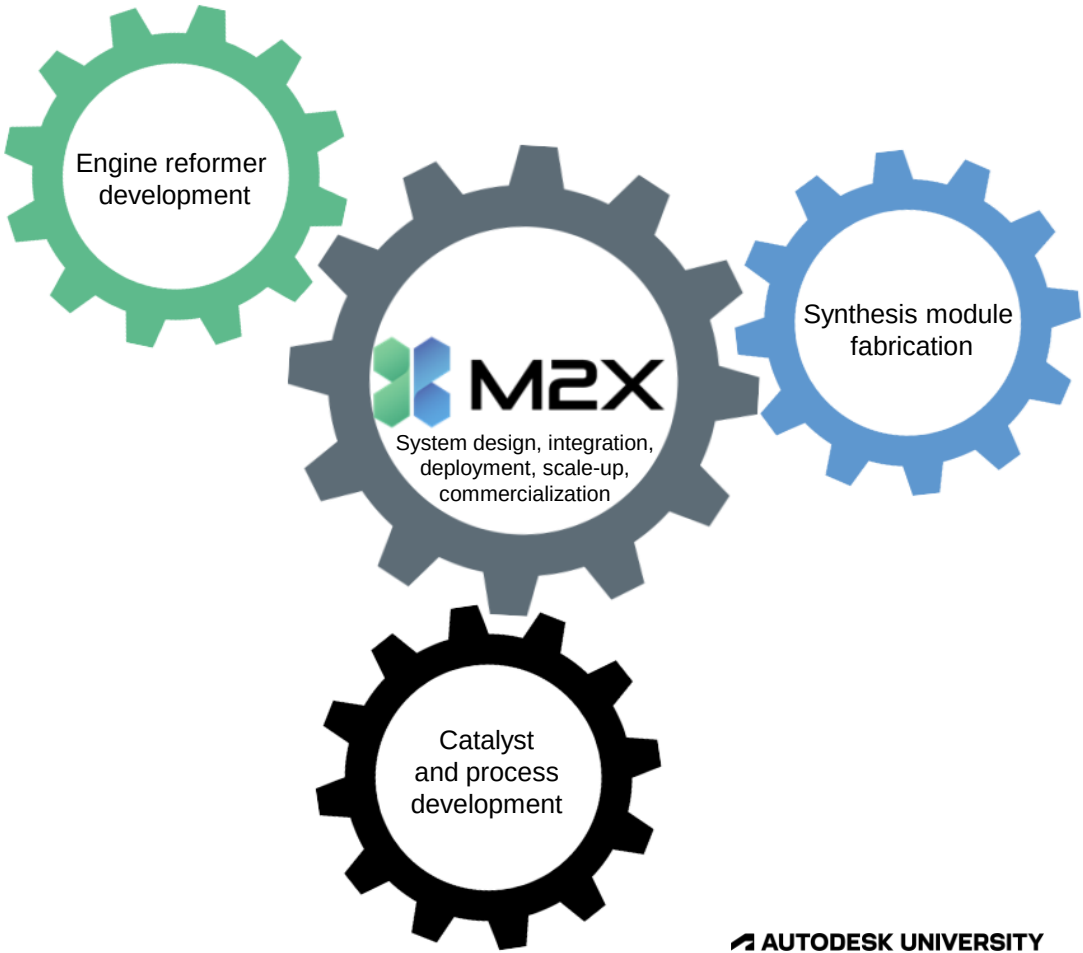
Summary

- Natural gas flaring is a major source of GHG emissions.
- M2X Energy is a startup solving the flaring problem and monetizing traditionally uneconomic gas streams.
  - Product shifts away from legacy chemical plants to a mobile system
  - Engine reformer and other mature hardware lowers CapEx and increases robustness
  - Methanol produced has negative carbon intensity

Rapid Product Development

Key Partnerships

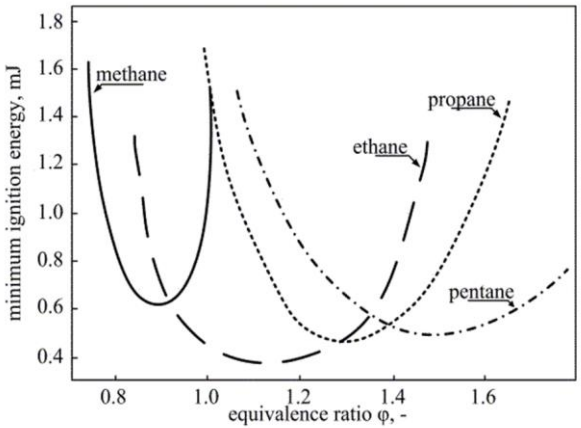
- Leveraging partnerships with established companies for component design and manufacturing
- Fast start – prove product before building infrastructure
- M2X does system level design and development and retains all IP



Engine Reformer Rich Limit Extension

- Engine must be run extremely rich of stoichiometric conditions to achieve partial oxidation and make syngas.

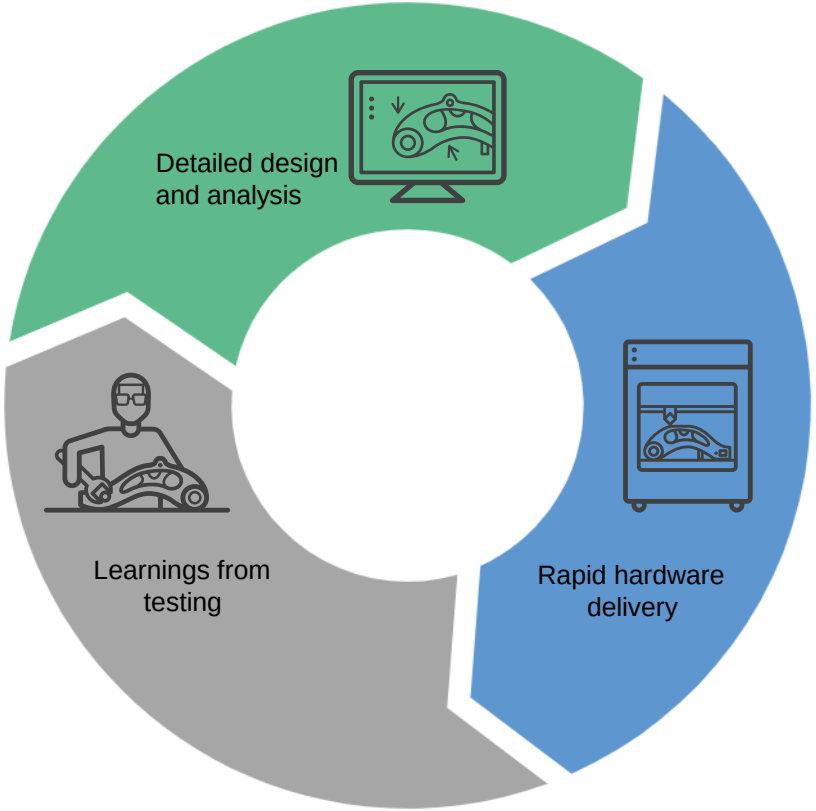
- Combustion development and flame propagation becomes challenging and requires engine hardware changes.

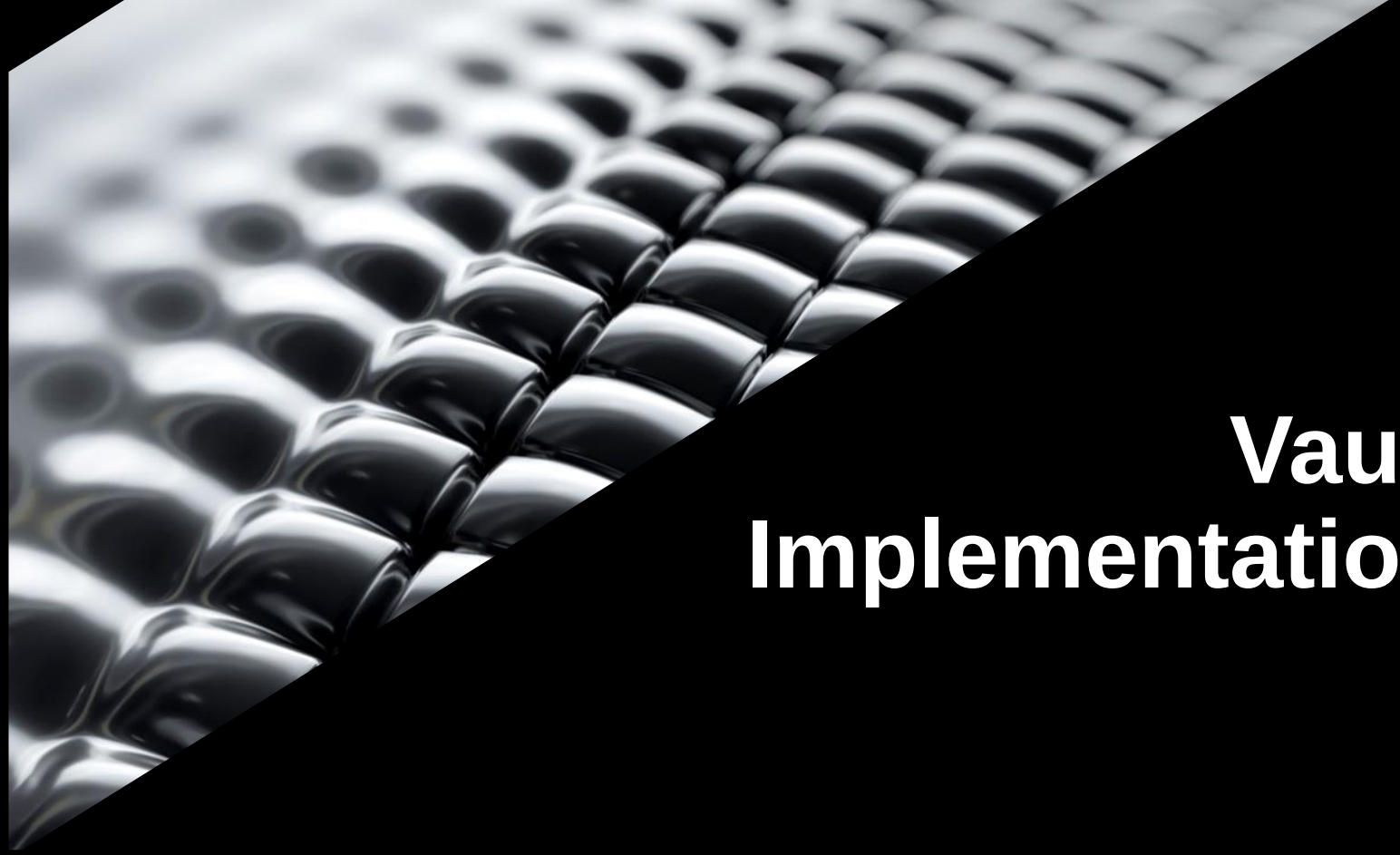


J. Moorhouse, A. Williams, T. Maddison, An investigation of the minimum ignition energies of some c1 to c7 hydrocarbons, Combustion and flame 23 (2) (1974) 203–213.

Rapid Prototyping for Rich Limit Extension

- The ignition system of the engine reformer was quickly identified as a primary limitation.
- M2X designed a novel ignition system for our engine reformer (patent pending).
- Additive manufacturing enables rapid dev. cycle not possible with conventional methods.





Vault Implementation

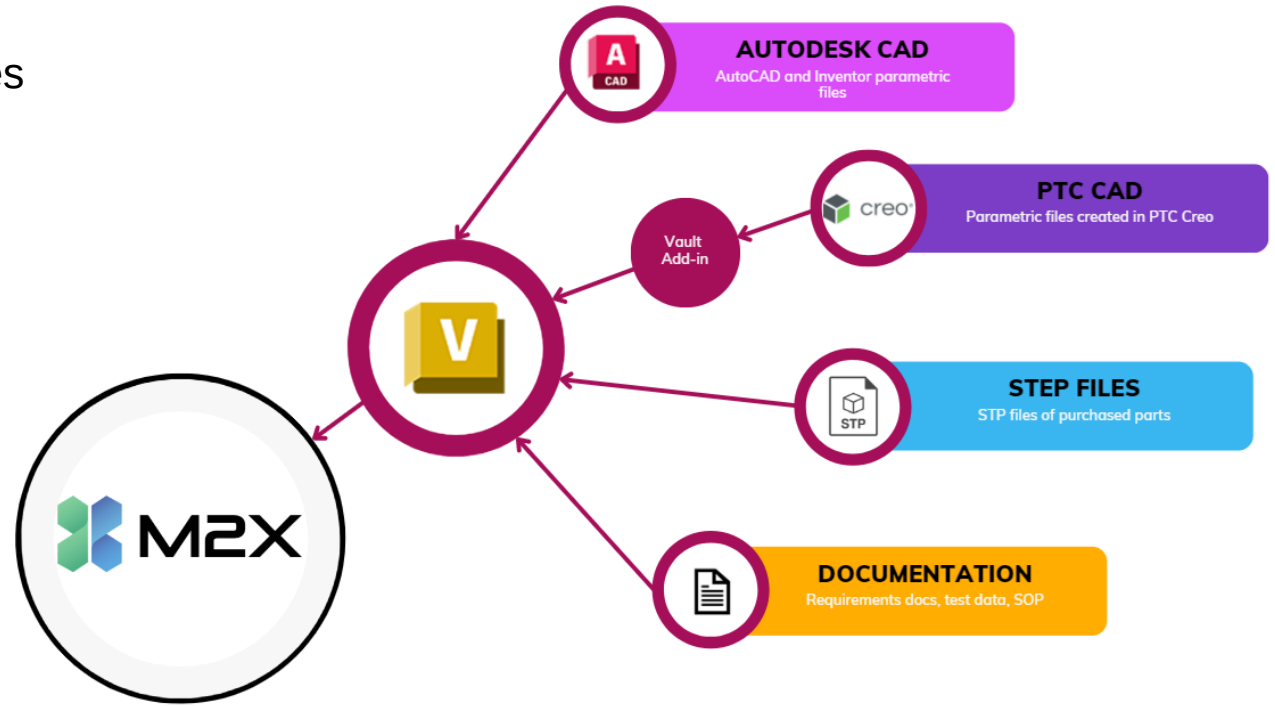
What is Vault?

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

- **Direct CAD integration**
  Manage CAD data in one familiar interface. Autodesk design tools integrate with Vault PDM.
- **Enterprise scalability**
  Eliminate the need for object ownership and simplify your replication environment.
- **Shared views**
  Share native files with external collaborators while protecting IP. Review, mark up, and track comments.
- **Enterprise integrations**
  Extend the value of your data by integrating PDM with other business systems such as PLM and ERP.
- **Data reuse and design automation**
  Save time by easily copying designs and reusing, replacing, or copying components.
- **Engineering change orders**
  Easily manage engineering change orders (ECOs) with an intuitive workflow.
- **Project sync**
  Automatically or manually synchronize files from a folder in Vault with a folder in a cloud drive.
- **Thin client**
  Access and view design data, bill of materials, and change orders using only your web browser and Vault credentials.
- **Concurrent design**
  Enable multiple team members to make concurrent designs from one central location, with safe, simultaneous access to data.
- **BOM management**
  Create and maintain a more accurate and comprehensive manufacturing bill of materials.
- **Duplicate search**
  Combine properties filtering with geometric search capabilities to improve duplicate search workflows.
- **Mobile app**
  Work with your design and engineering data on the go on your mobile phone or tablet.

Motivation for Using Vault

- Consolidate and control multiple types of CAD files we receive from our partners into a system of record.
- Begin building BoM and documentation now



Vault Server Setup

- Vault can be hosted from a local on-site server, or be cloud-based.
- M2X using cloud-based implementation
  - Team is remotely distributed across several states
  - No central office to house a server.

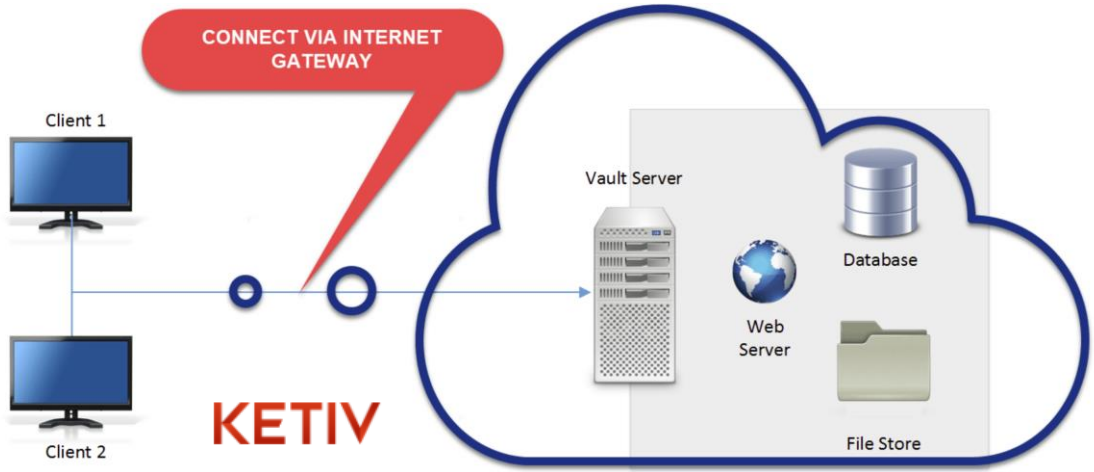
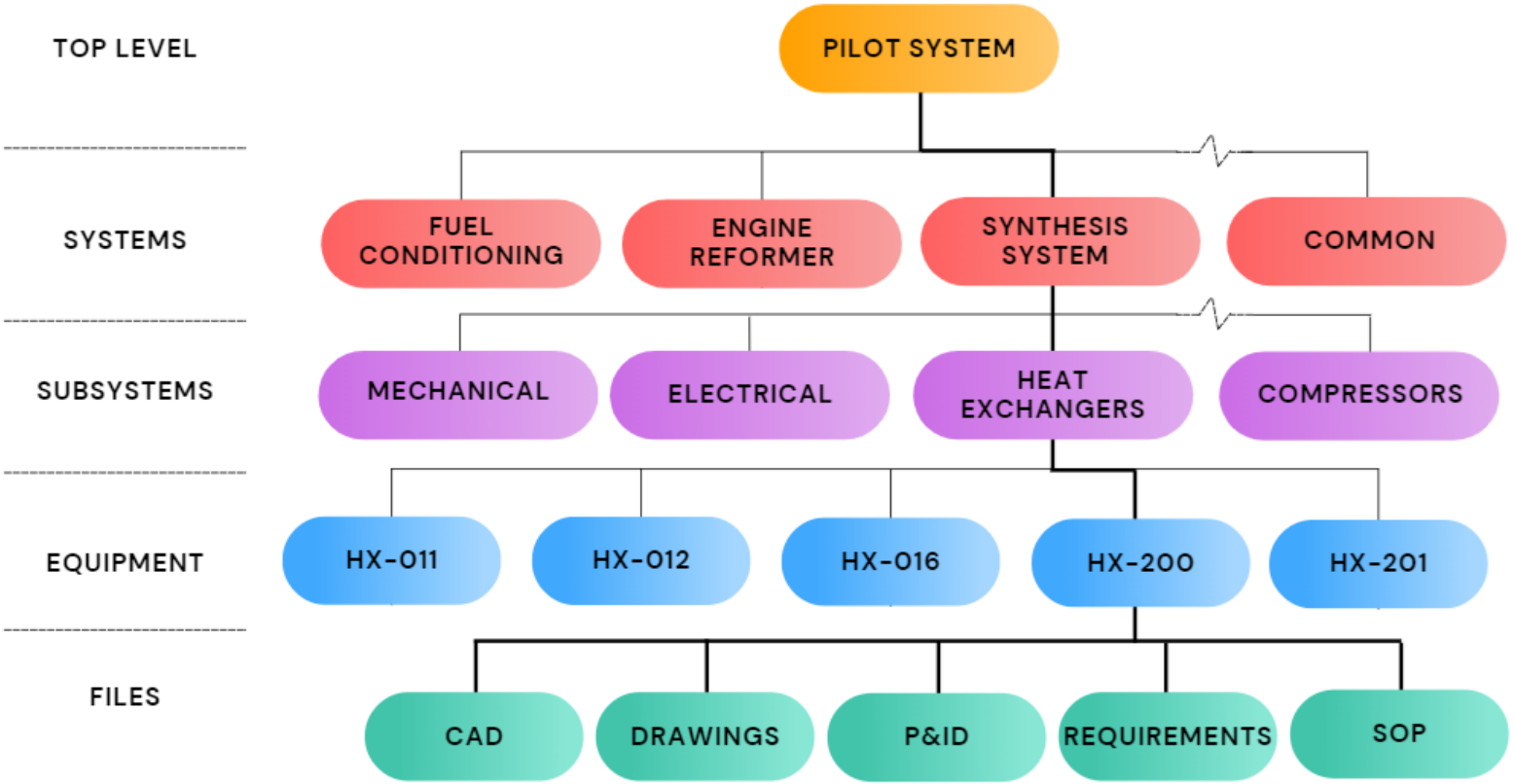


Image credit: https://ketiv.com/blog/vault-on-the-cloud-enabling-remote-work-and-data-management/

Vault Architecture

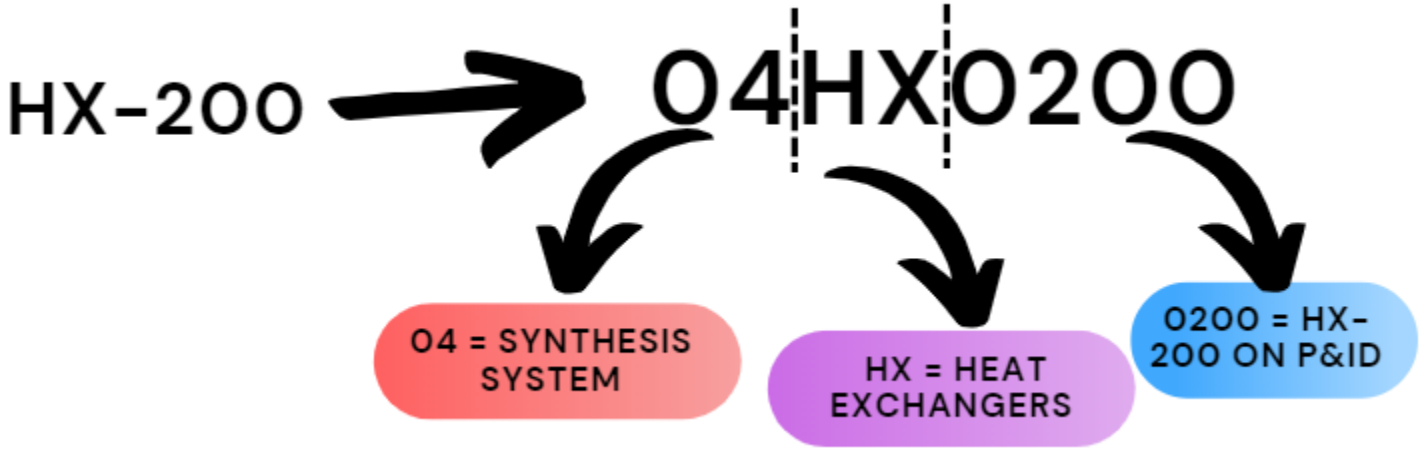
Folder Structure



Vault Architecture

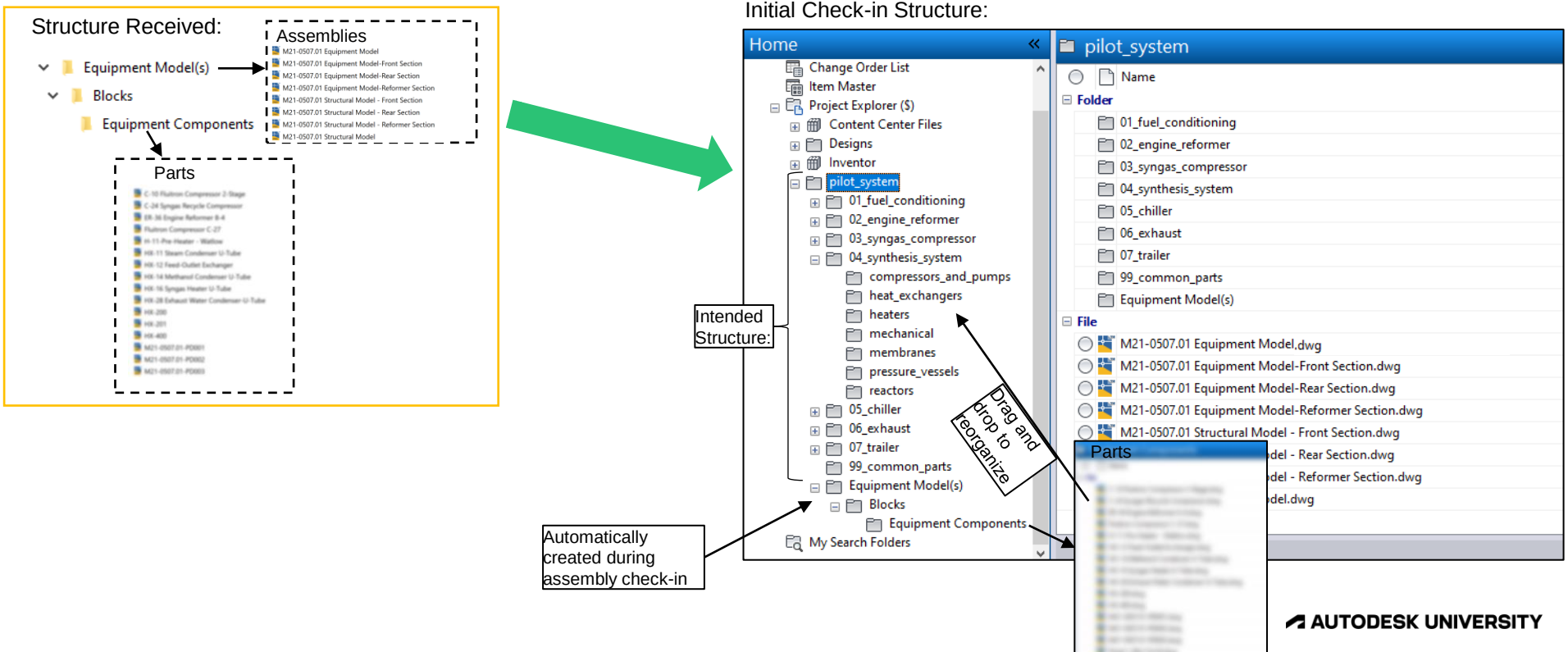
File Naming

- Partners have their own naming conventions, but we are converting our files to a common naming convention:
  - Human readable/conveys meta data
  - Example:



Vault Benefits

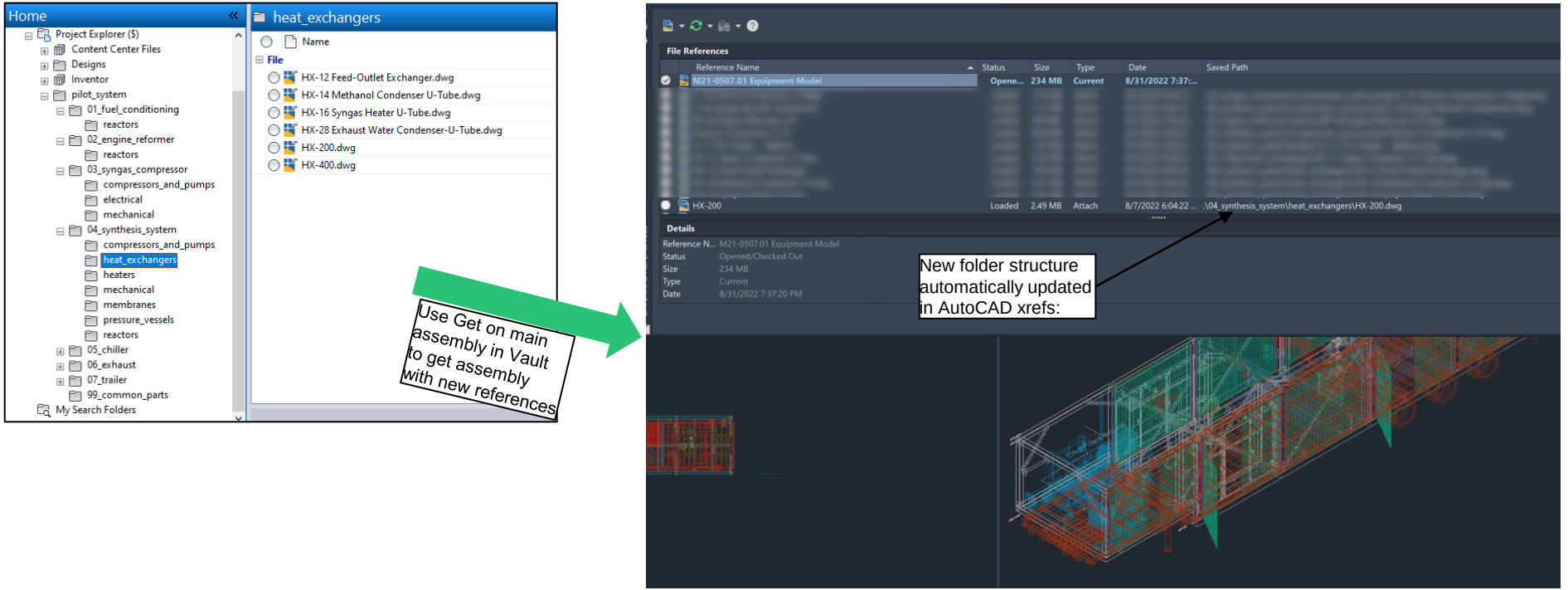
- Easy to check-in entire assembly from partners then rename files and organize



Vault Benefits

- Easy to check-in entire assembly from partners then rename files and organize (cont'd)

Final Check-in Structure:



Vault Benefits

- Easily reorganize and rename files designed by partners while retaining dependencies
- Add-ins to interface with third party CAD software (PTC Creo)
- Access control to individual folders/files
- BoM generation

Key Points

M2X Energy is a startup solving the flaring problem and monetizing traditionally uneconomic gas streams.

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.

Special Thanks to the Autodesk Foundation