



Visualize and Forecast Gas Flaring Volume using Satellite Data

Company background

bpX energy — bp's US onshore oil and gas business — operates world-class unconventional oil and gas assets in Texas and Louisiana. bpX is a leader in reducing methane emissions. Since acquiring its Permian assets in 2019, bpX's flaring intensity has decreased dramatically, from roughly 16% to less than 0.5% today. In addition, bpX is actively improving its methane detection and monitoring programs using drone and aerial monitoring surveillance. Embracing new technologies enables bpX to produce hydrocarbons more efficiently with fewer emissions to help drive bp's transition to net zero.

Project Description

bpX energy has set a target to achieve zero routine flaring by 2025. Routine flaring of natural gas occurs when gas is flared during normal production operations when gas gathering, processing, or infrastructure are insufficient or unavailable. Routine flaring does not include flaring for the purpose of controlling emissions or safety flaring, which is flaring of gas to ensure safe operations of a facility, or intermittent short duration event flaring such as equipment failure, preventative maintenance, process upsets, and well testing or clean up after initial completion or workover. bpX is taking significant steps operationally to reduce flaring, including investing in over \$1B worth of infrastructure and implementing a sophisticated leak detection and repair program.

The primary goal of this project is to assess the quality of bpX's efforts using external data. Satellite data assisted by advanced computing (e.g., data from the Visible Infrared Imaging Radiometer Suite, VIIRS) can help monitor flaring activities and estimate flaring intensity and volume (Figure 1). Additional operational data such as site locations (Figure 2), production rates, and measured flaring rates will be supplied by bpX as required to achieve project objectives. A standard Non-Disclosure Agreement will need to be executed before using bpX data — bpX will provide the agreement and the process will not be onerous.

This project includes two parts.

Part I: The students will build an “interactive” dashboard that visualizes the Nightfire data from VIIRS and the derived flaring volume and intensity intuitively and efficiently. The scope will be limited to US and Permian basin starting in 2019. Ideas to consider:

- It includes maps of bpX facilities and time-series of flaring volume/intensity
- It includes filters by facility identifiers, location (state, county), and datetime.
- It includes analysis and visualization of flare volume/intensity change before and after each bpX flaring reducing initiative, which bpX will provide a list of.

- It includes a comparison of satellite data and bpx data.
- It includes visualization of results from Part II.

Part II: Develop machine learning models and/or analytical methods to forecast flaring volume/intensity for the next five years. Compare and validate forecasting models. Quantify the uncertainty of the predictions.

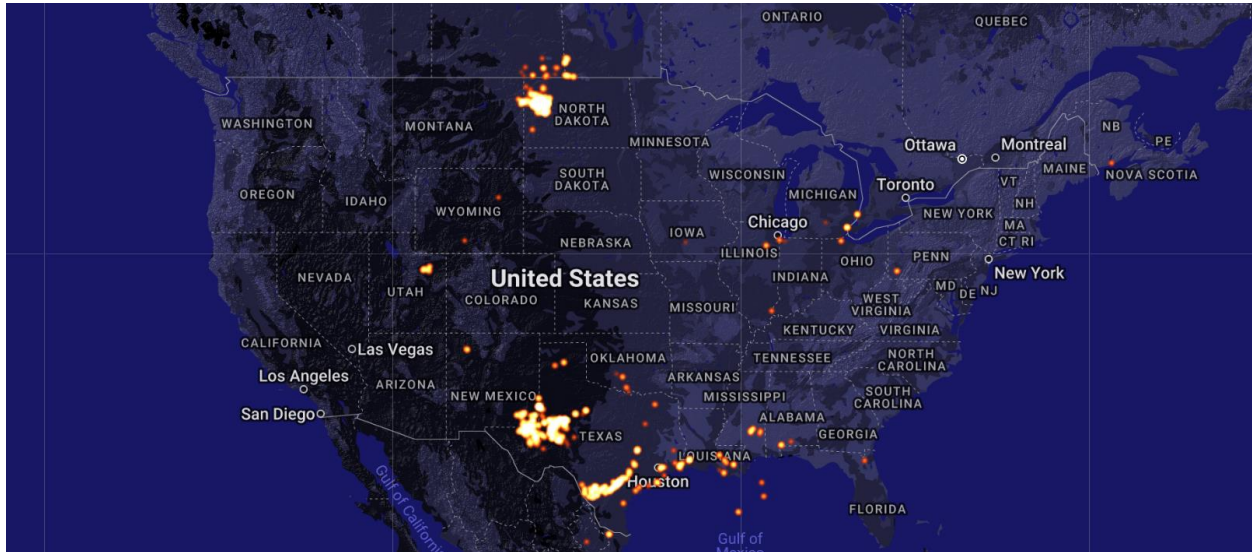


Figure 1 Gas Flaring in USA on July 7th, 2022. Source: Earth Observation Group, Payne Institute for Public Policy, Colorado School of Mines, via Skytruth.org

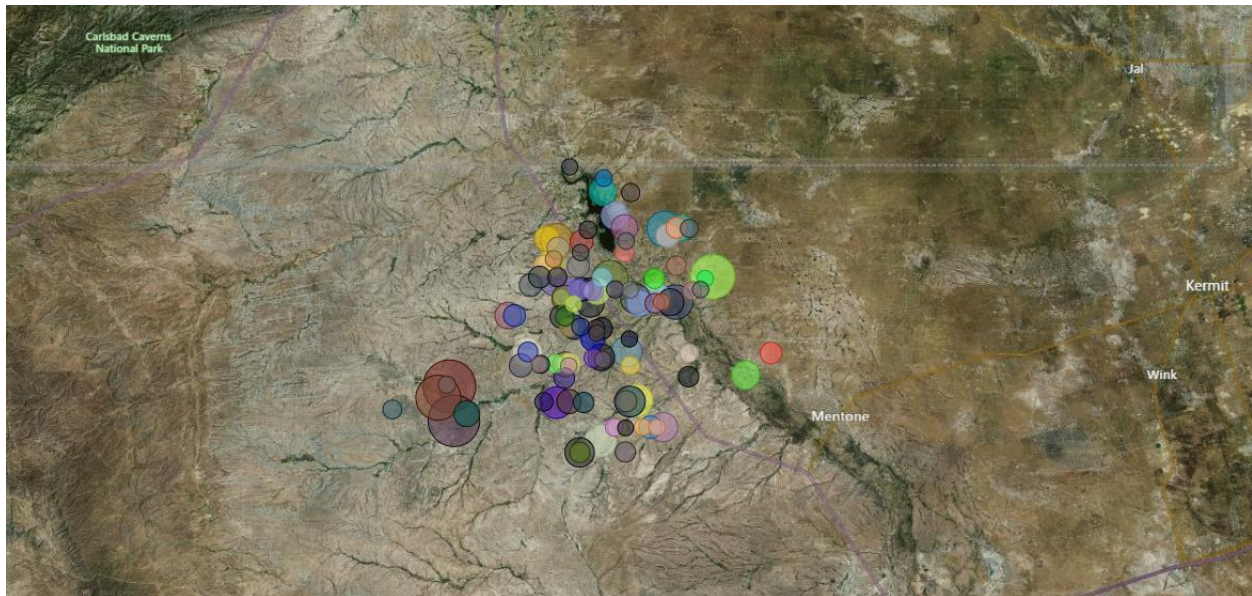


Figure 2. Approximate locations of bpx facilities of interest.

Underlying work includes but is not limited to:

- Prepare and store raw data for fast and convenient data access.
- Correlate VIIRS flaring volume and intensity with specific bpx's field activities.

- Quantify flaring volume/intensity change of any selected time window and selected region (bpx facilities, Permian region, regions of interest, entire US)
- Develop multiple models to forecast flaring volume/intensity.
- Export graphs for reports.

Desired Skillset

Web front end UI (JavaScript, React, HTML) or Python Dash for interactive data visualization.

Explorational data analysis, time-series forecasting, regression and other machine learning modeling skills in Python

Preferred Team Size

We expect this work to be more suited to a team of 3 students, up to a maximum of 6.

Internship Possibilities

Upon completion of the field session, bpx is open to discuss internship opportunities.

Location

Students will work at CSM campus or their agreed location and meet with their bpx contact on a bi-weekly basis in person or via teleconferencing.

Resources

<https://www.worldbank.org/en/programs/gasflaringreduction>

Elvidge, C.D., and M. Zhizhin. 2021. Global Gas Flare Survey by Infrared Imaging, VIIRS Nightfire, 2012-2019. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/1874>

Contact

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bp^xenergy



MINES CS CAPSTONE PROJECT – FALL 2022

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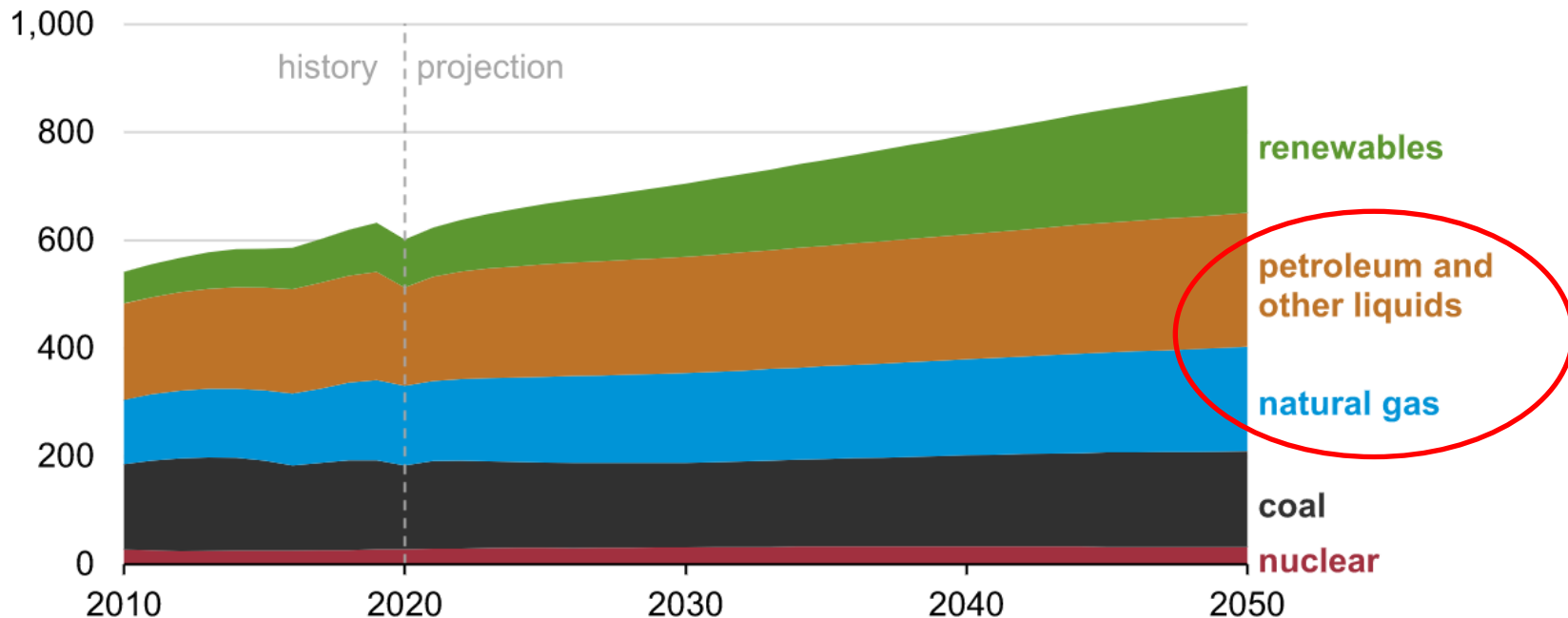
Julian Liu, Data Scientist

How Can We Reduce Carbon Emission while Providing Energy to the World?



Global primary energy consumption by energy source (2010–2050)

quadrillion British thermal units



Source: U.S. Energy Information Administration, *International Energy Outlook 2021* Reference case

Note: *Petroleum and other liquids* includes biofuels.

Project Background

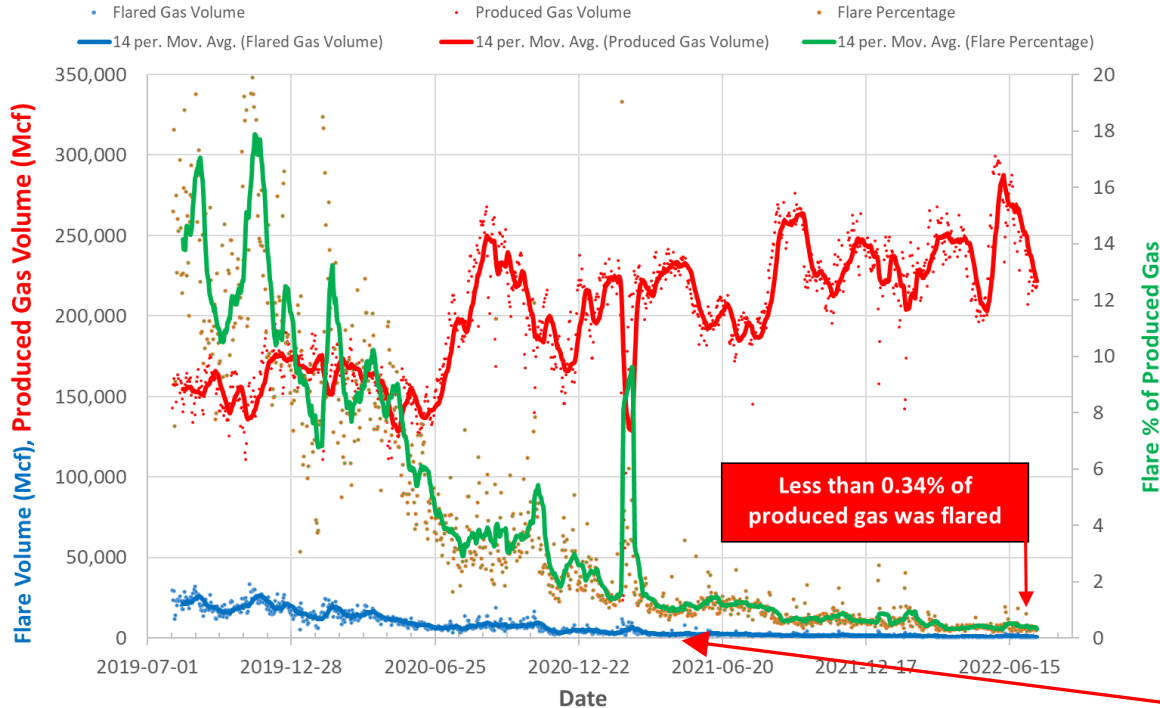
- Gas flaring is a common practice during fossil fuel production
 - It is the act of burning off excess natural gas from oil wells when it cannot economically be stored and sent elsewhere or for safe operation reasons.
- Satellites can capture flaring activities and estimate flaring intensity and volume (Figure 1).



Figure 1 Gas Flaring in USA on July 7th, 2022. Source: Earth Observation Group, Payne Institute for Public Policy, Colorado School of Mines, via Skytruth.org

Company Background

bpx reduced flaring intensity from about 16% in 2019 to less than 0.5%.



bpx's gas flaring volume and percentage in Permian Basin since 2019 (bpx's internal data).

Compare satellite data with bpx's metered flare data



Project Description

Part I: Build an “interactive” dashboard that visualizes the Nightfire data from VIIRS and the derived flaring volume and intensity intuitively and efficiently.

- Skills: Web front end UI (JavaScript, HTML) or Python (Plotly Dash) etc.
- Ideas to consider: maps of bpx facilities and time-series of flaring volume/intensity; filters by facility identifiers, location (state, county), and datetime; analysis and visualization of *flare volume/intensity change before and after each bpx flaring reducing initiative*; visualization of results from Part II.

Part II: Develop machine learning models *and/or* analytical methods to forecast flaring volume/intensity for the next five years. Compare and validate forecasting models. Quantify the uncertainty of the predictions.

- Skills: explorational data analysis, *time-series forecasting, regression* and other machine learning modeling skills, preferably in Python

Be creative!