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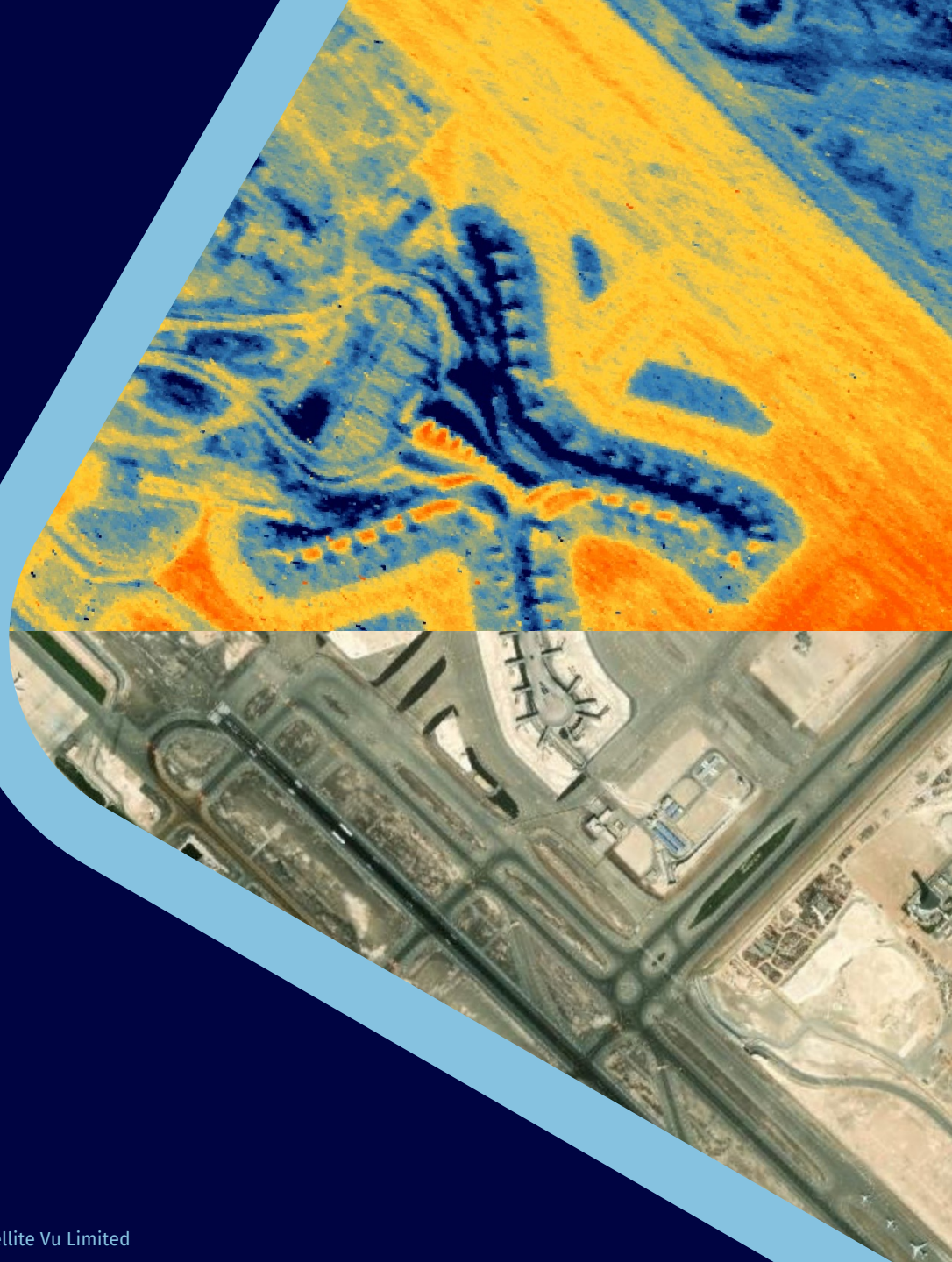
SatVu

Oil Facilities Monitoring with High-Resolution Thermal Satellite Data

Mykola Kozyr

Platform Product Lead



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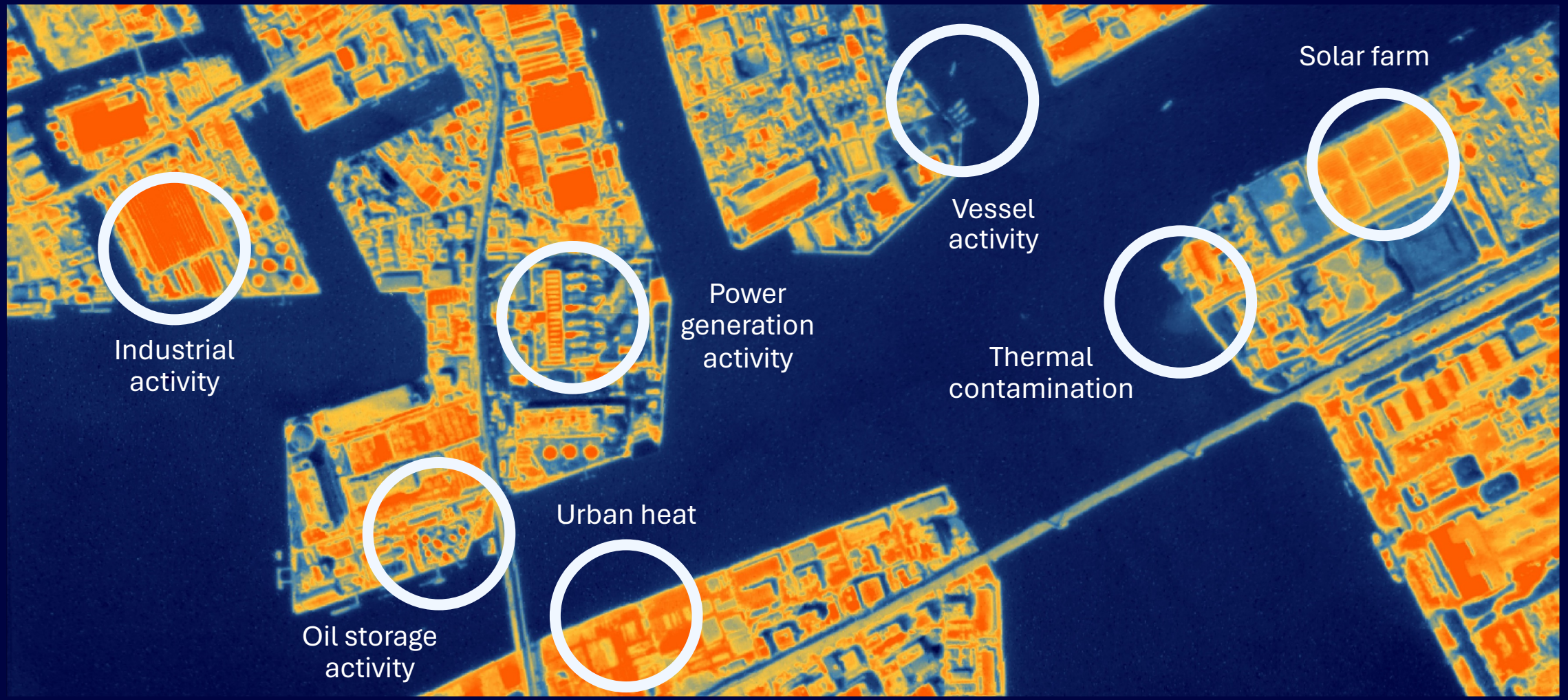
High-resolution thermal data from space

Yokohama, Japan – 24 October 2023



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SatVu – The world’s thermometer

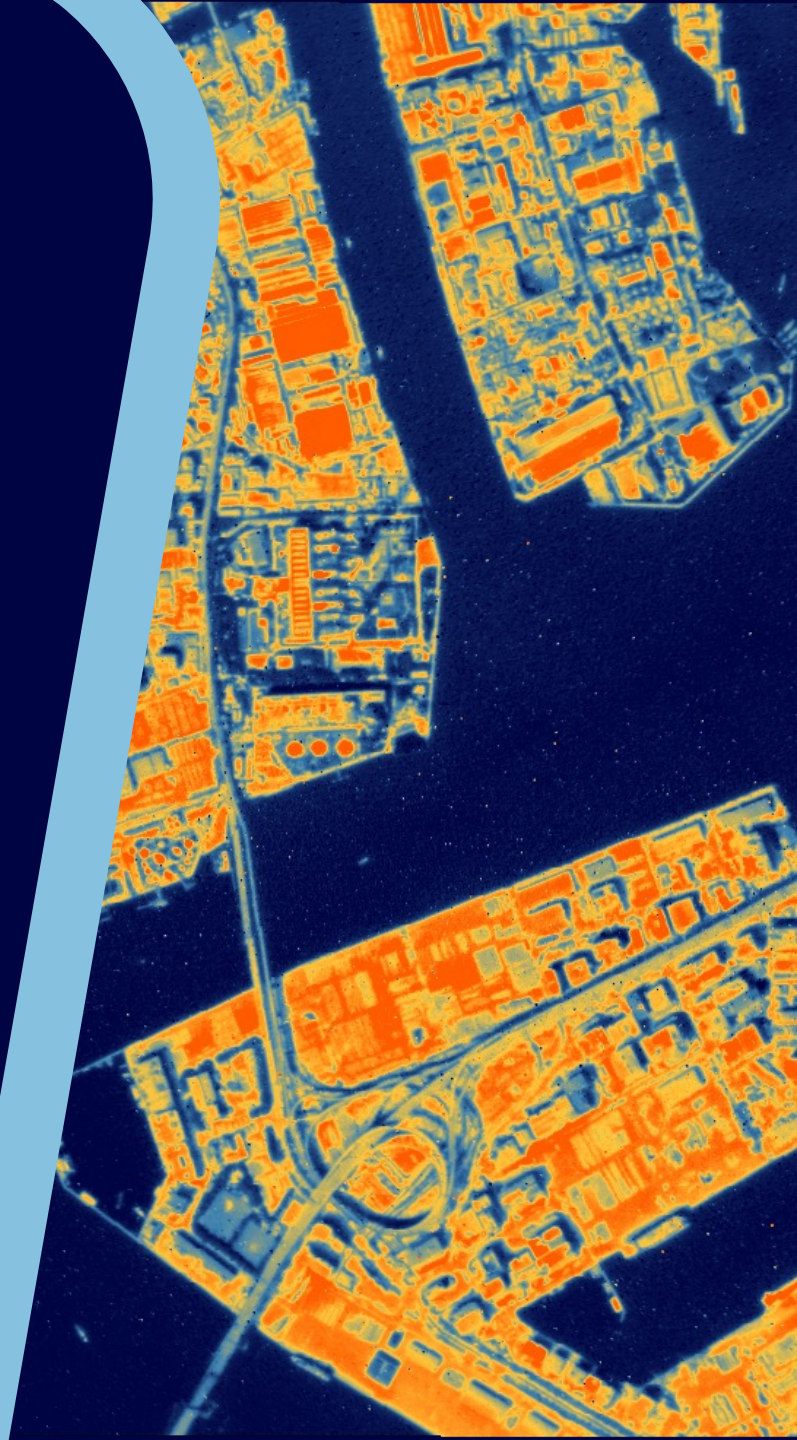
High-resolution thermal data: The data captured by SatVu show heat variations across the surface of the Earth at a resolution of up to 3.5 m.

Monitor activity at night: Unlike high-resolution optical, SatVu’s data can ‘see’ at night. It can also ‘see’ through smoke.

Video capability: SatVu is the only company capable of providing thermal data in the form of both still image and video up to 60 seconds long.

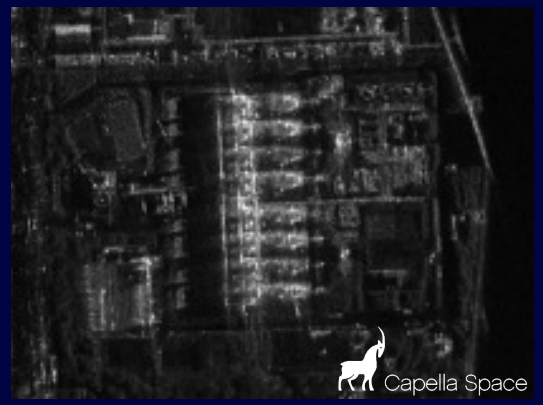
A globally scalable solution: Unlike thermal data captured from aeroplanes or drones, SatVu can capture data from any point on the earth’s surface, and it can do this in a uniform way.

Satellite in orbit: To date, SatVu remains the only company that has already captured high-resolution thermal imagery from space.

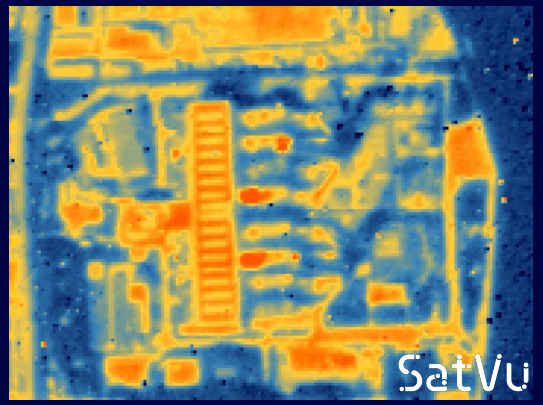


Thermal infrared on the electromagnetic spectrum

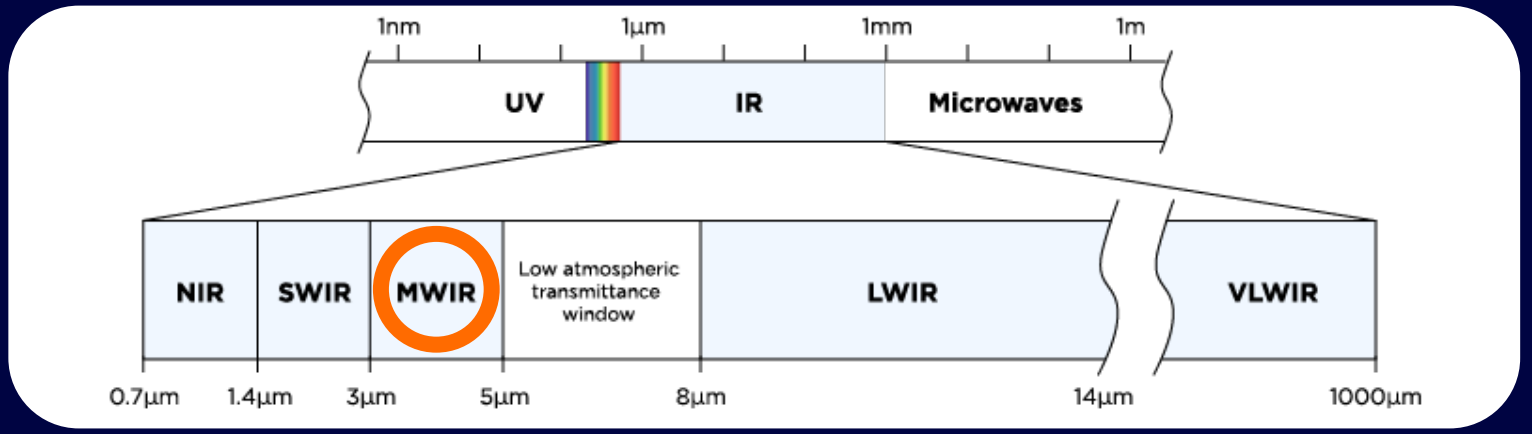
Visible imagery only shows the outside of structures during the day



Radar imagery shows the edge of structures day and night



Infrared can indicate activity inside structures day and night



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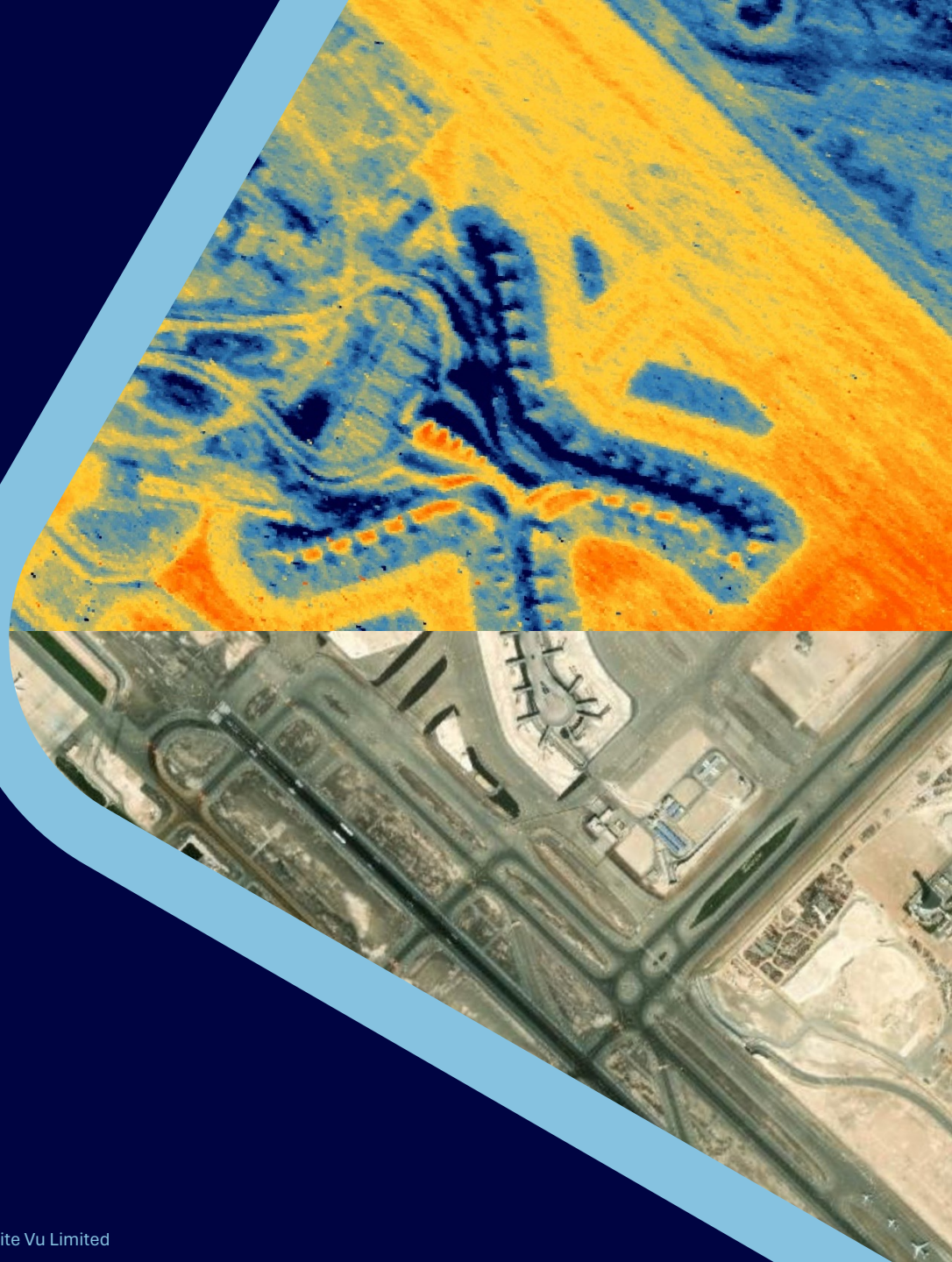
Oil Storage Analytics

Use Case 1



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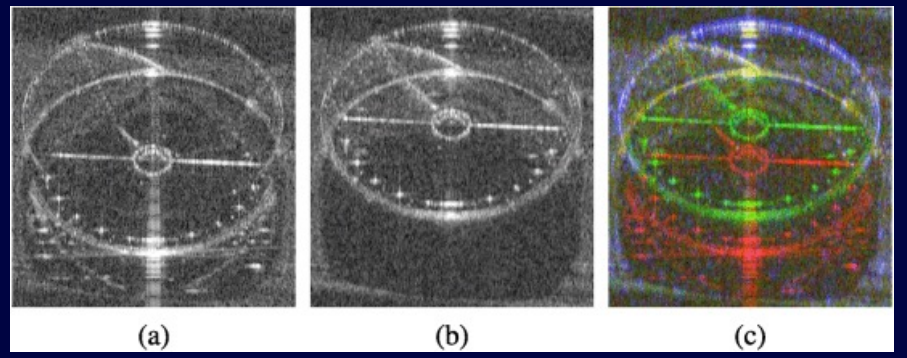
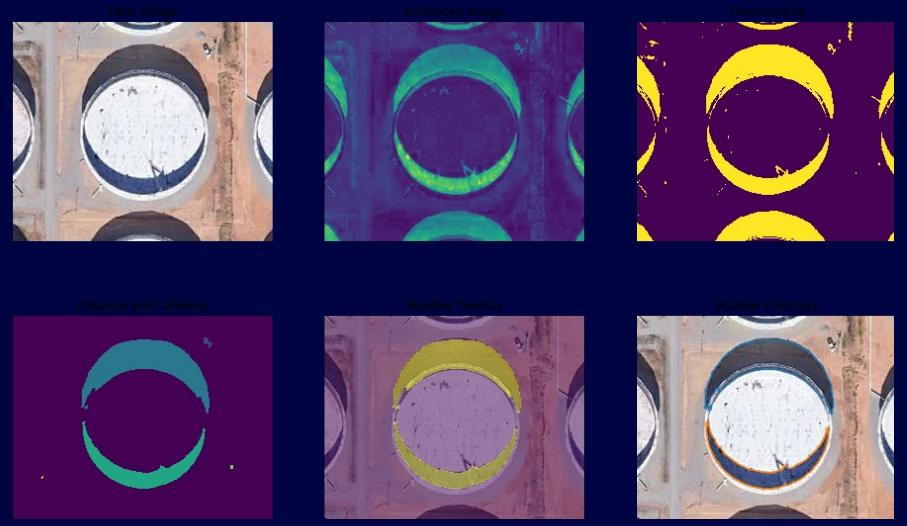
EO data usage in oil storage analytics

Earth Observation (EO) data has been used to estimate storage levels in tanks. SAR and Optical data are used to estimate the volume of oil in **floating-roof** tanks.
With frequent data collection, crude oil analytics companies can provide inventory reports earlier than official agencies.



SAR images of an oil storage tank with a floating roof at two different dates. (a) First image. (b) Second image. (c) Multitemporal color composite image with the two amplitude images in the red and green channels, and coherence in blue [C. Villamil Lopez and U. Stilla].

The main **limitation** in using EO data was the **inability** to estimate the storage level of the **fixed-roof** tanks.
In the areas of access, the only way to achieve that is to use thermal sensors on drones. However, this approach is not scalable.



Shadow Extraction and Volume Estimation algorithms application on top of high-resolution optical data.

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Fixed-roof tanks analytics

While floating-roof tanks are more common in crude oil facilities globally, fixed-roof tank inventory could significantly impact the analytics for each facility.

Even with covering ~7% of Cushing's overall capacity, a study shows that "... full transparency on fixed-roof tanks can significantly enhance the accuracy of weekly deltas for Cushing inventories." – Kayrros, 2021

Global Oil Inventory – floating roof tanks represent only 30% of total tanks – PetroSA refinery, South Africa. Ursa Space - Oil Inventory Dataset sample via SkyFi.

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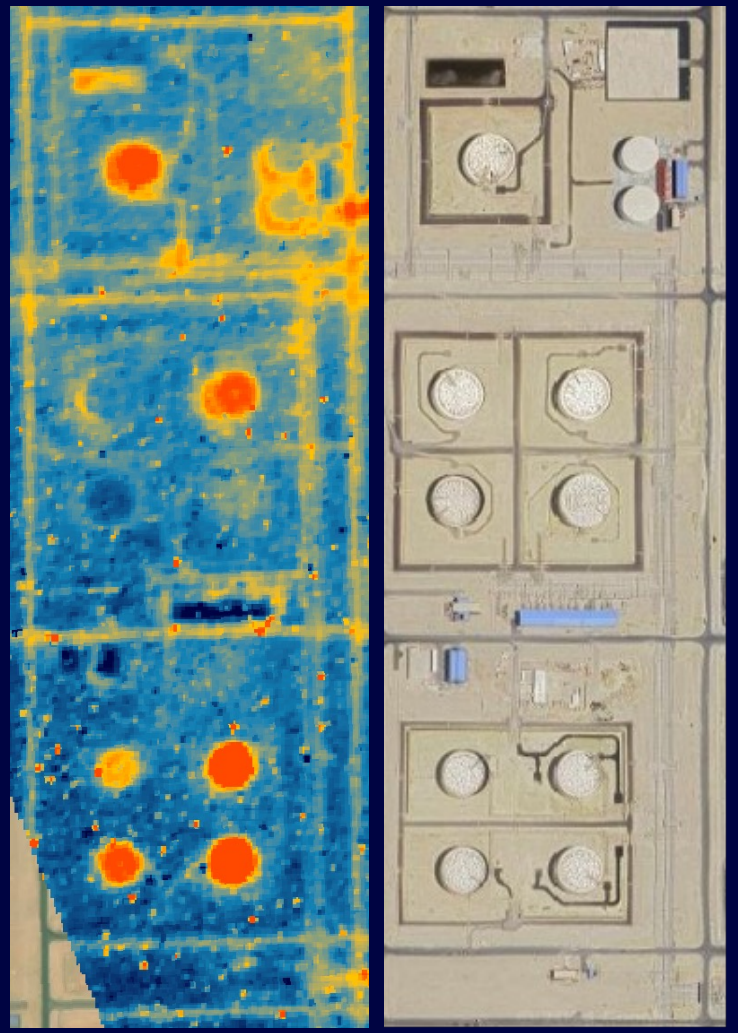
Fixed-roof tanks analytics

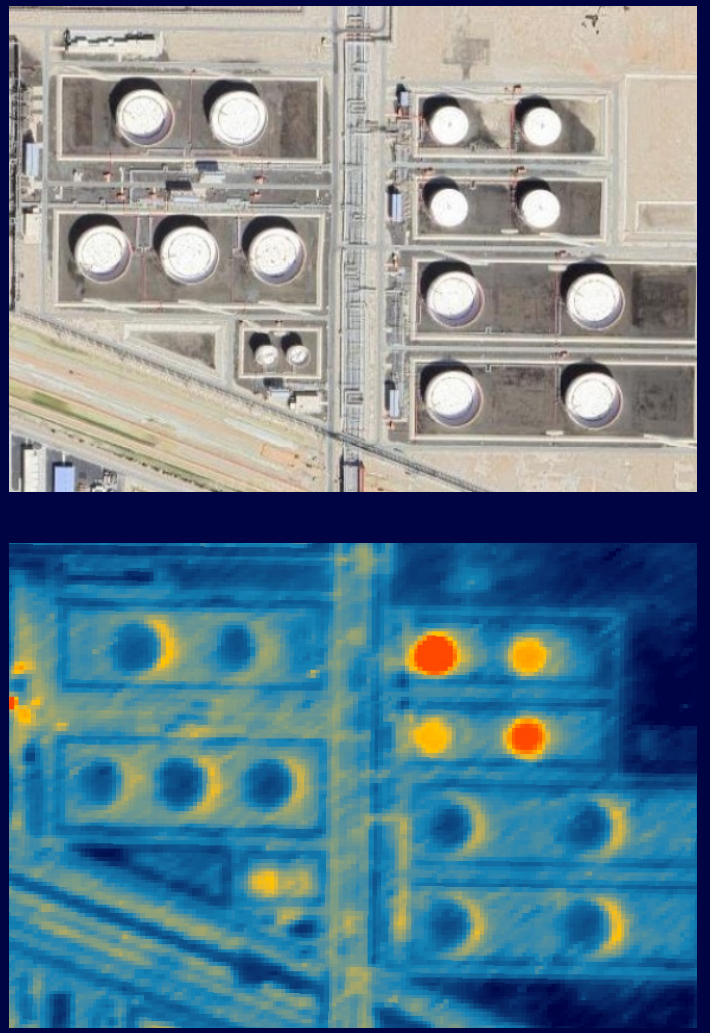
SatVu provides the unique capability of estimating oil storage capacity for both **moving-roof** and **fixed-roof** tanks.

Tanks provide different thermal output when having different volumes of crude oil stored.

There is a visible difference in close-to-nadir imaging mode and even more insightful data with more oblique imaging.



Example of different thermal output in floating-roof tanks.



Example of different thermal output in fixed-roof tanks.

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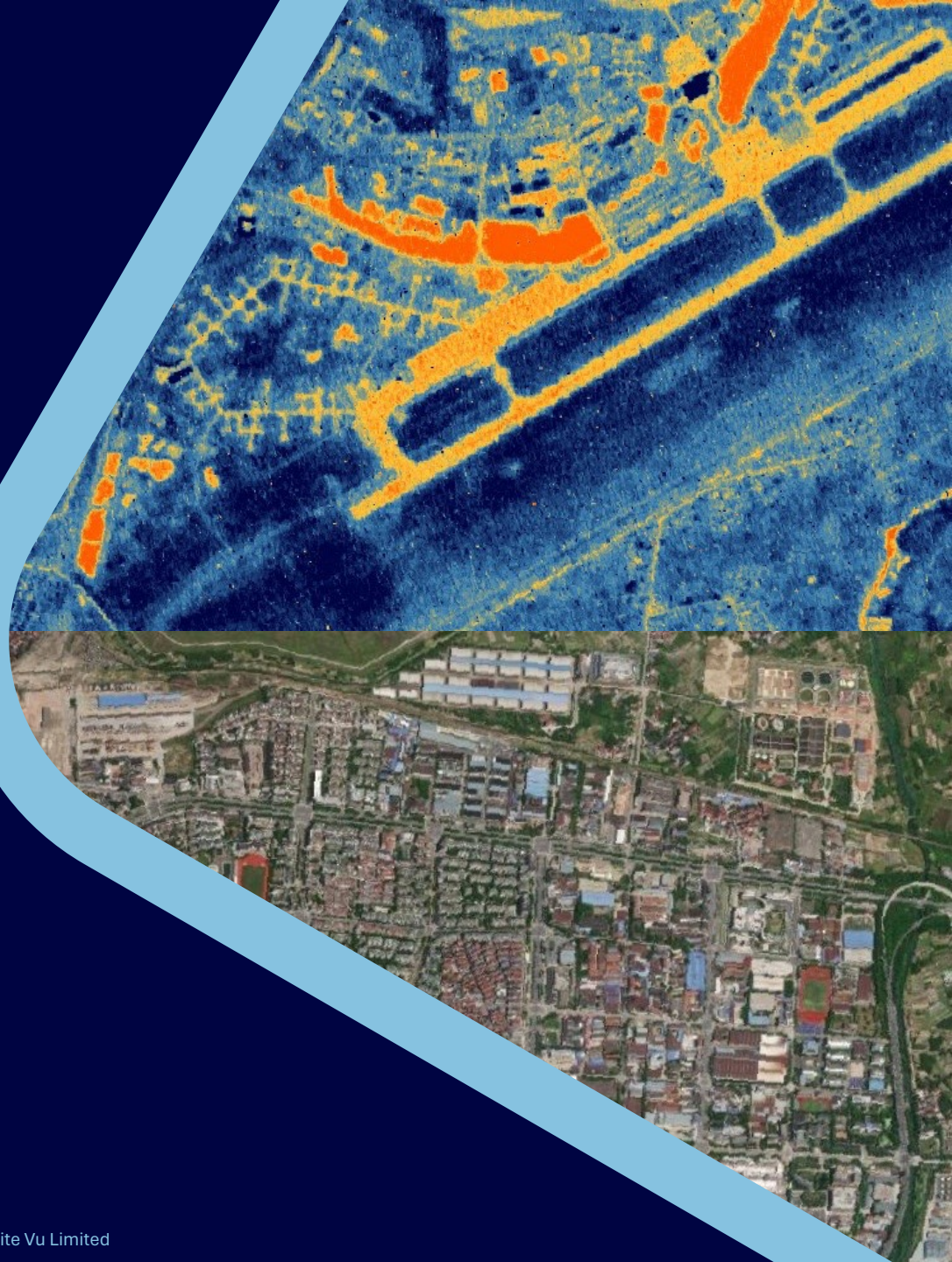
Oil Refineries Production

Use Case 2



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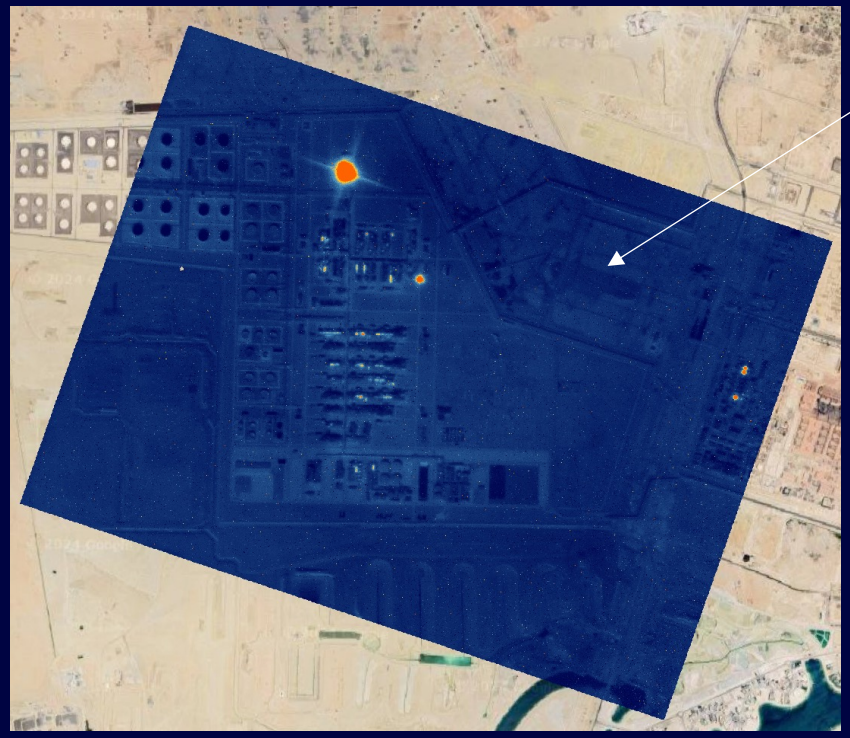
Facilities detailed analytics

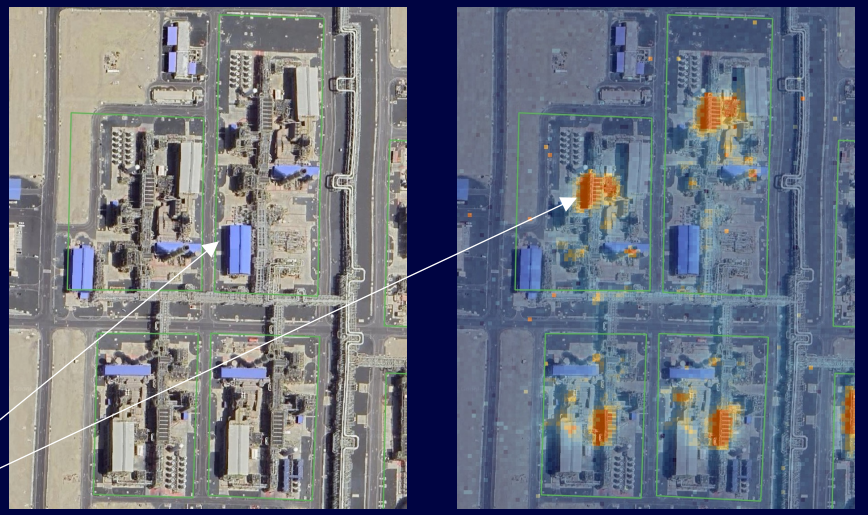
SatVu’s image capabilities enable performing detailed analytics on oil facilities:

- GSD of 3.5 m shows activity on a sub-plant level.
- Day and night imaging mode with frequent revisit enables constant monitoring.
- Scene size captures an entire facility.



Full Image

SatVu’s resolution highlights sub-plant level activity



Characterise sub-plants:

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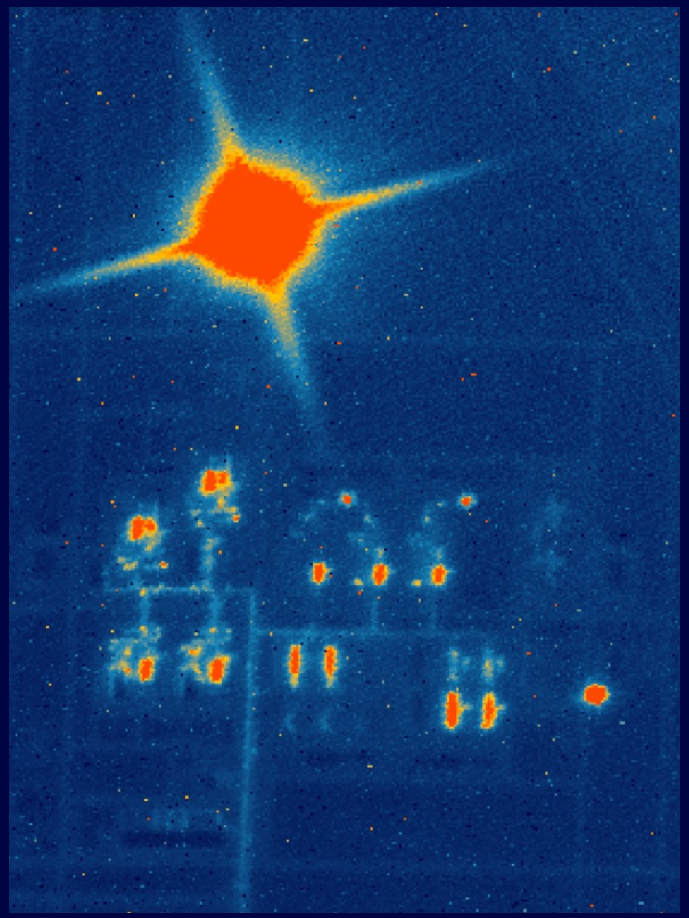
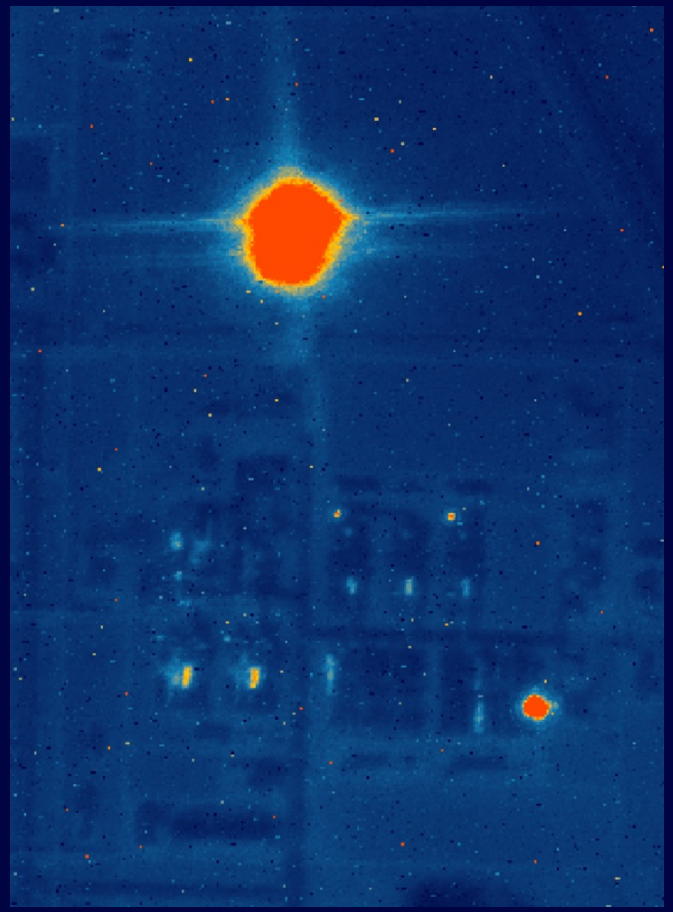
Fire event in Al Zour



2023-11-04 HotSat-1 Night Time



2023-11-17 HotSat-1 Day Time

Nov 16, 2023 - 08:28

Al Zour 615kbd Refinery Has "Limited Fire" Thursday During Ramp Up

A fire broke out at the 615kbd KIPIC Al Zour refinery earlier Thursday in a desulphurization unit according to the operator.

- The fire has now been extinguished.
- Al-Zour was already offline as it was ramping back up again because of an interruption in fuel gas supplies last week.
- The restart of the refinery is reported as unaffected. The official X account tweeted Wednesday that full restart would take 10 days (before the fire struck)
- KIPIC tweeted after the fire "The Kuwait Integrated Petroleum Industries Company confirms that restart operations, low-sulfur fuel transfer operations to electric power generation stations, or external export operations have not been affected as a result of the limited fire accident that was controlled this morning in record time"

- A fire incident took place on November 16th.
- Captured observations of the plant before and after the fire, taken days apart.
- The before and after comparison shows the impact of the fire on operations.

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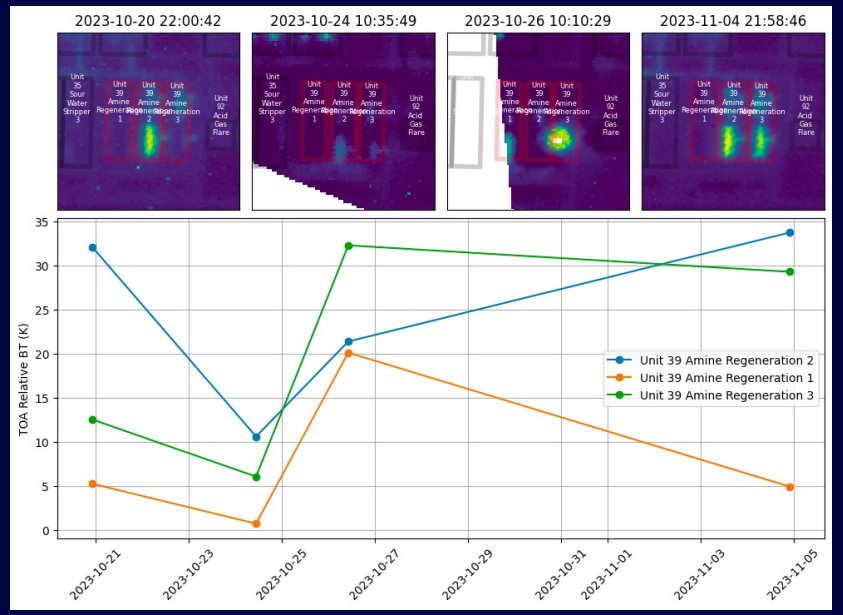
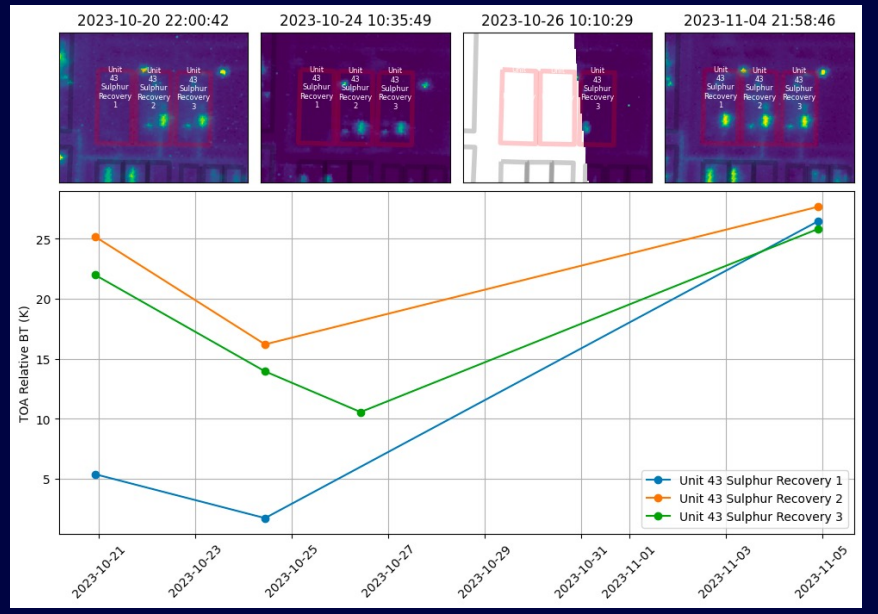
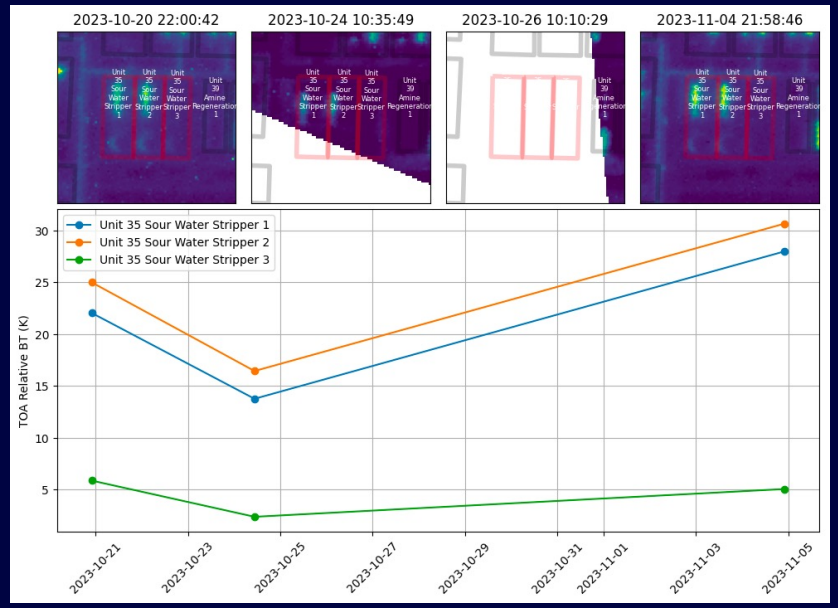


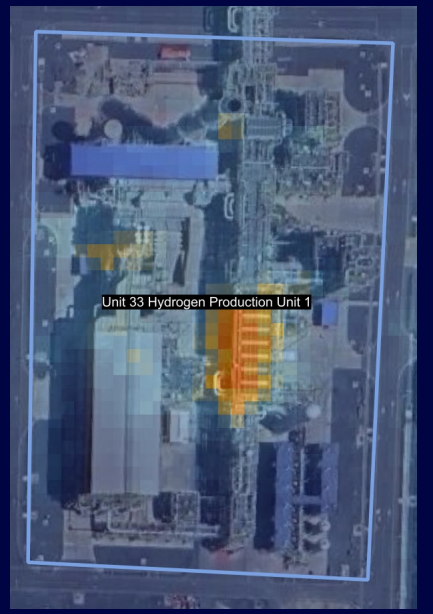
Amine Regeneration Units



Sulphur Recovery Units



Sour Water Strippers



Hydrogen production units

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SatVu Platform

SatVu's capabilities in providing insights for oil facilities monitoring.

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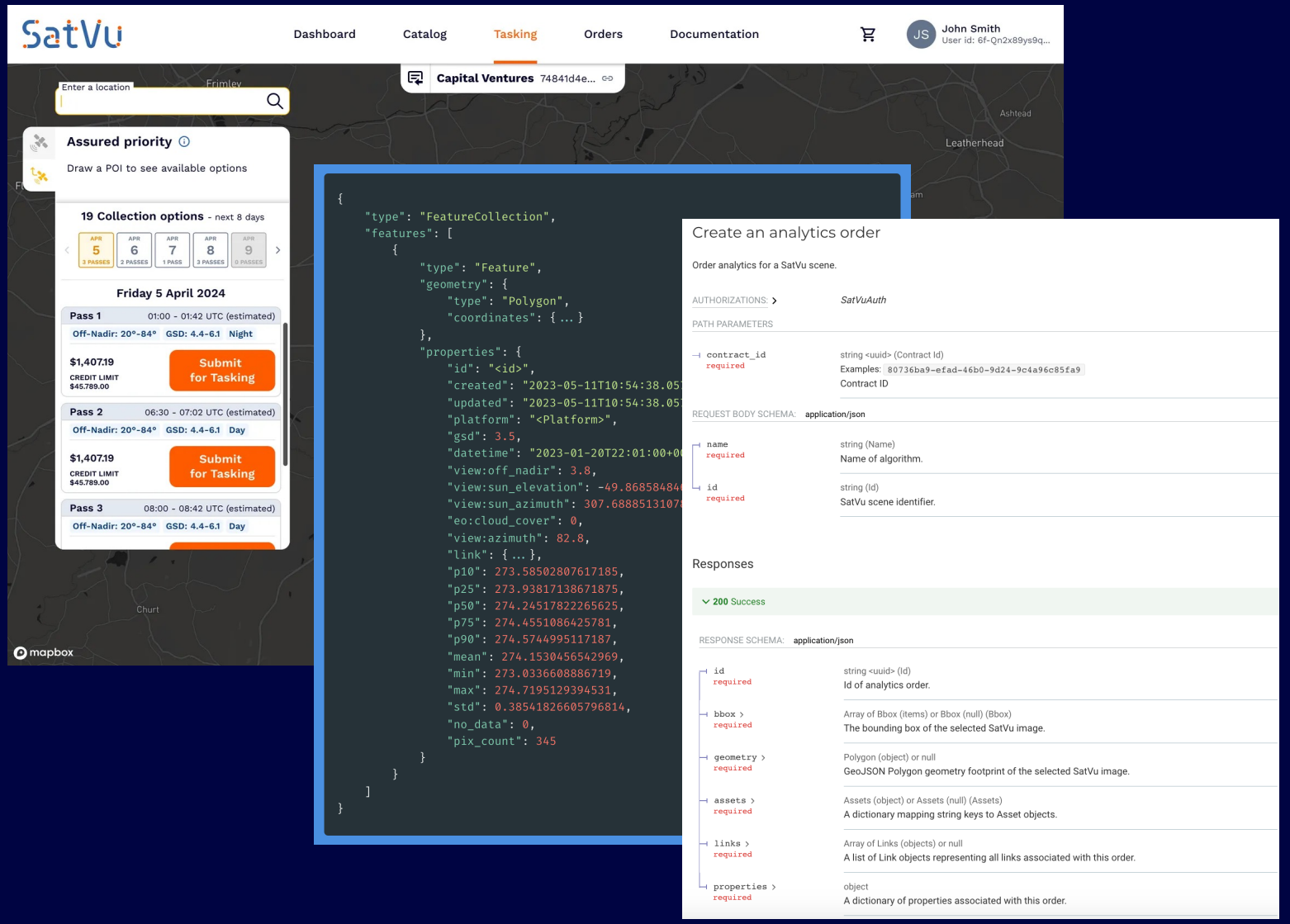
SatVu platform capabilities

SatVu platform comprises a **web application**, **Python SDK** and **RESTful API**, providing flexible access to satellite data for experts and newcomers alike.

It allows performing **satellite tasking** and accessing the **catalog** of previously collected data.

In addition, the platform has beta products for retrieving thermal statistics and running ML models.



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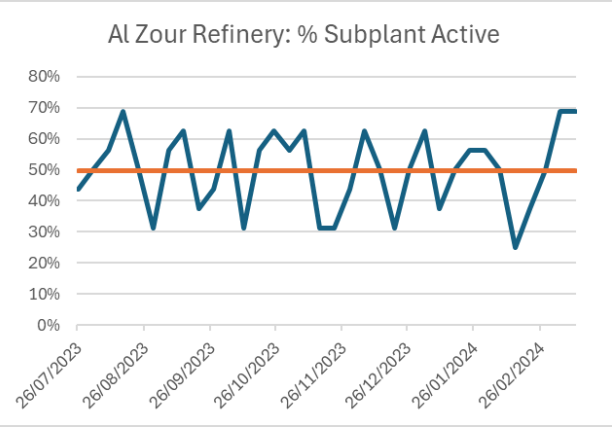
Integral platform concept discovery

Automated Tasking and Analytics capabilities enable the development of an integral platform that provides access to an individual oil refinery or storage facility.

With global coverage, high revisit and unique high-resolution thermal data collection, SatVu provides an opportunity for worldwide oil facilities monitoring.



Insights:

- Inferred activity levels
- Status change reports
- Aggregation of results at refinery and sub-plant level
- Time series trends & anomalies
- Alert triggers e.g. sub-plant activity falls below x%

Identifier	Refinery	Refinery		Change since prior observation	13/03/2024	06/03/2024	28/02/2024	21
AZKW001	Al Zour Refinery	Al Zour Refinery	% Plant Active	3	69%	69%	63%	
			Average % Plant Active		51%	51%	51%	
			Implied Production Level		422,813	422,813	384,375	

Identifier	Refinery	Sub-Plant Group		Change since prior observation	13/03/2024	06/03/2024	28/02/2024	21
AZKWHPU	Al Zour Refinery	Hydrogen Production Unit		1	75%	50%	75%	
AZKWSR1	Al Zour Refinery	Sulphur Recovery		2	50%	100%	100%	
AZKWFL1	Al Zour Refinery	Gas Flare Chimney		2	50%	75%	75%	
AZKWSWS2	Al Zour Refinery	Sour Water Stripper		2	50%	100%	0%	
AZKWST1	Al Zour Refinery	Storage Tank		1	100%	50%	50%	

Identifier	Sub-Plant Group	Sub-Plant	Sub-Plant Activity %	Change since prior observation	13/03/2024	06/03/2024	28/02/2024	21
AZKWHPU1	Hydrogen Production Unit	Hydrogen Production Unit 1	75%	3	1	1	1	
AZKWHPU2	Hydrogen Production Unit	Hydrogen Production Unit 2	75%	1	1	0	1	
AZKWHPU3	Hydrogen Production Unit	Hydrogen Production Unit 3	75%	2	0	1	1	
AZKWHPU4	Hydrogen Production Unit	Hydrogen Production Unit 4	75%	1	1	0	0	
AZKWSR1	Sulphur Recovery	Sulphur Recovery 1	50%	3	1	1	1	
AZKWSR2	Sulphur Recovery	Sulphur Recovery 2	50%	2	0	1	1	
AZKWFL1	Gas Flare Chimney	Gas Flare Chimney 1	50%	1	1	0	0	
AZKWFL2	Gas Flare Chimney	Gas Flare Chimney 2	50%	3	1	1	1	
AZKWFL3	Gas Flare Chimney	Gas Flare Chimney 3	50%	2	0	1	1	

Unique identifier scheme at the most granular level of observation is critical for useability & data management

0/1 signal indicates on/off for subplant on each date

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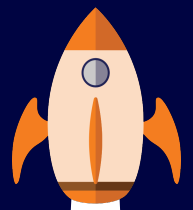
Our constellation

SatVu



2026
Funding to scale constellation to 9 satellites
10-20 revisits per day

Mid 2025
HotSat-3 launched
2+ revisits per day

Early 2025
HotSat-2 launched

2024
HotSat-2 and HotSat-3 in build
Product and feature development, including **assured priority tasking** and the ability to **withhold** imagery from the catalog

2023
HotSat-1 launched, but suffers failure in orbit after 6 months
Commercial operations begin

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Thank you!

mykola.kozyr@satellitevu.com

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