



Methane and Fugitive Emissions Management – Innovative Strategies for Methane Detection, Mitigation, and Cost-Effective Solutions

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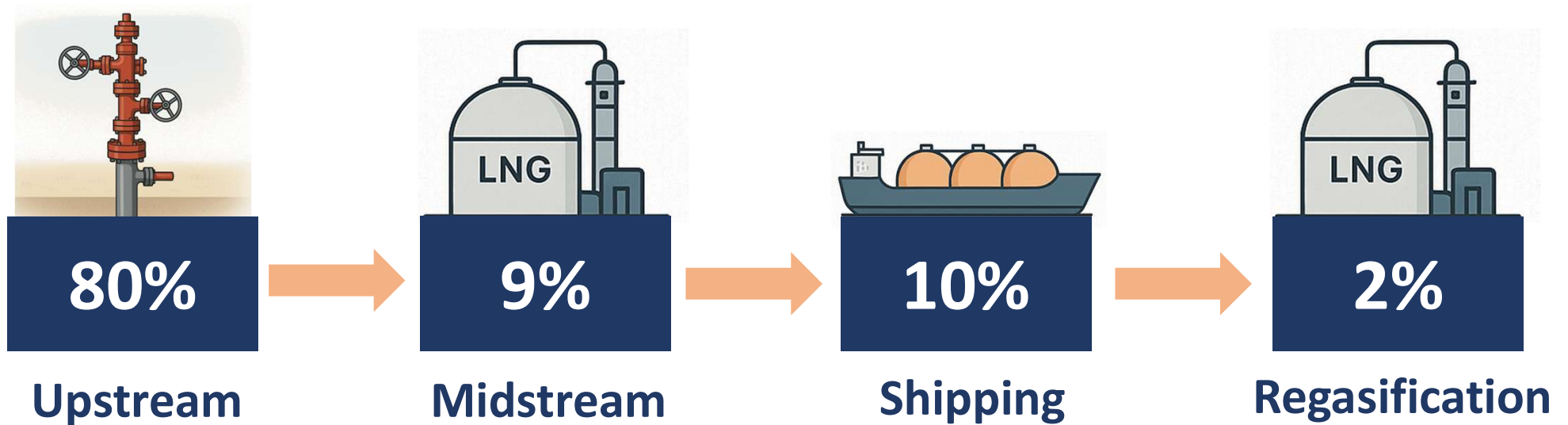
Efficient Quantification of LNG Supply Chain Methane Emissions Using Drones – Practical Examples and Best Practices

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LNG Supply Chain Emissions



* IEA report "Assessing Emissions from LNG Supply and Abatement Options"



The Challenge

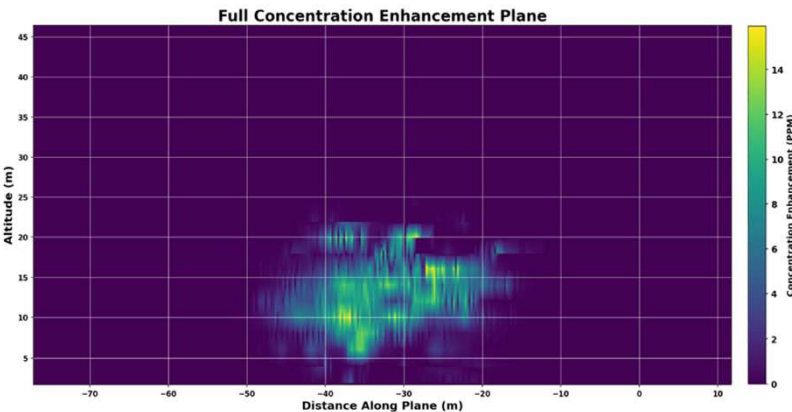


- Quantification of emissions is difficult!
- Global operation
- Many thousands of assets
- Many different operating environments
- Evolving, dynamic regulatory, technical, market and social requirements



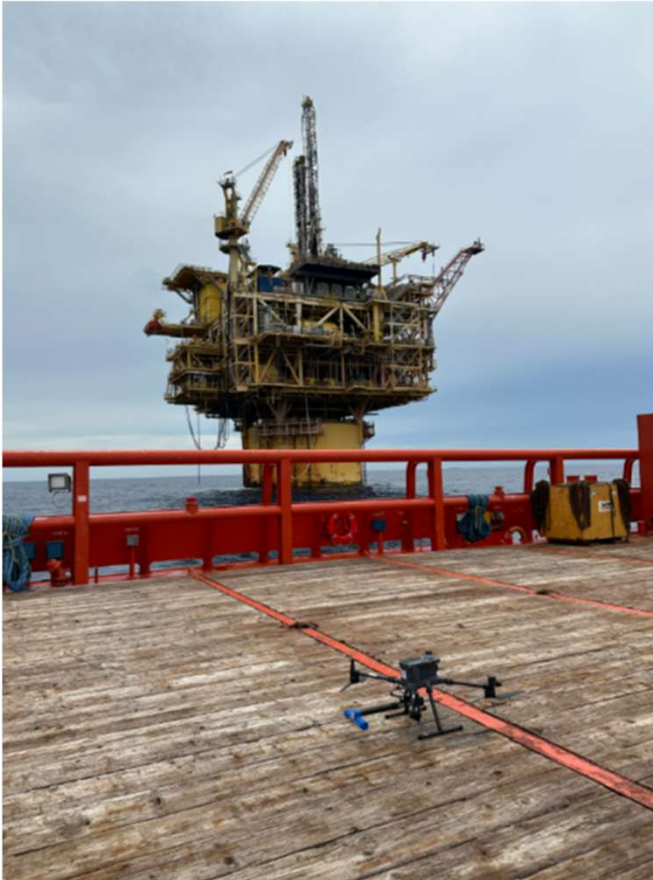


- Map methane plume cross-section
 - Fast, highly sensitive sensor (10 parts per billion)
 - Specific downwind flight path (“flux plane”)
 - Detailed concentration measurements along flight path
- Collect simultaneous on-site wind vectors
- Integrate concentration and wind to yield mass flow of methane.
- Identify and quantify individual plumes from equipment groups – e.g turbines, flares, vents etc





Upstream



- Production assets numbering in the thousands:
- A wide variety of operating environments
 - Onshore
 - Offshore
- Use of drones for emissions quantification:
 - Good quality drone services available globally
 - In-situ sensors immune to many environmental conditions
 - Efficient automated surveys allow quick assessment

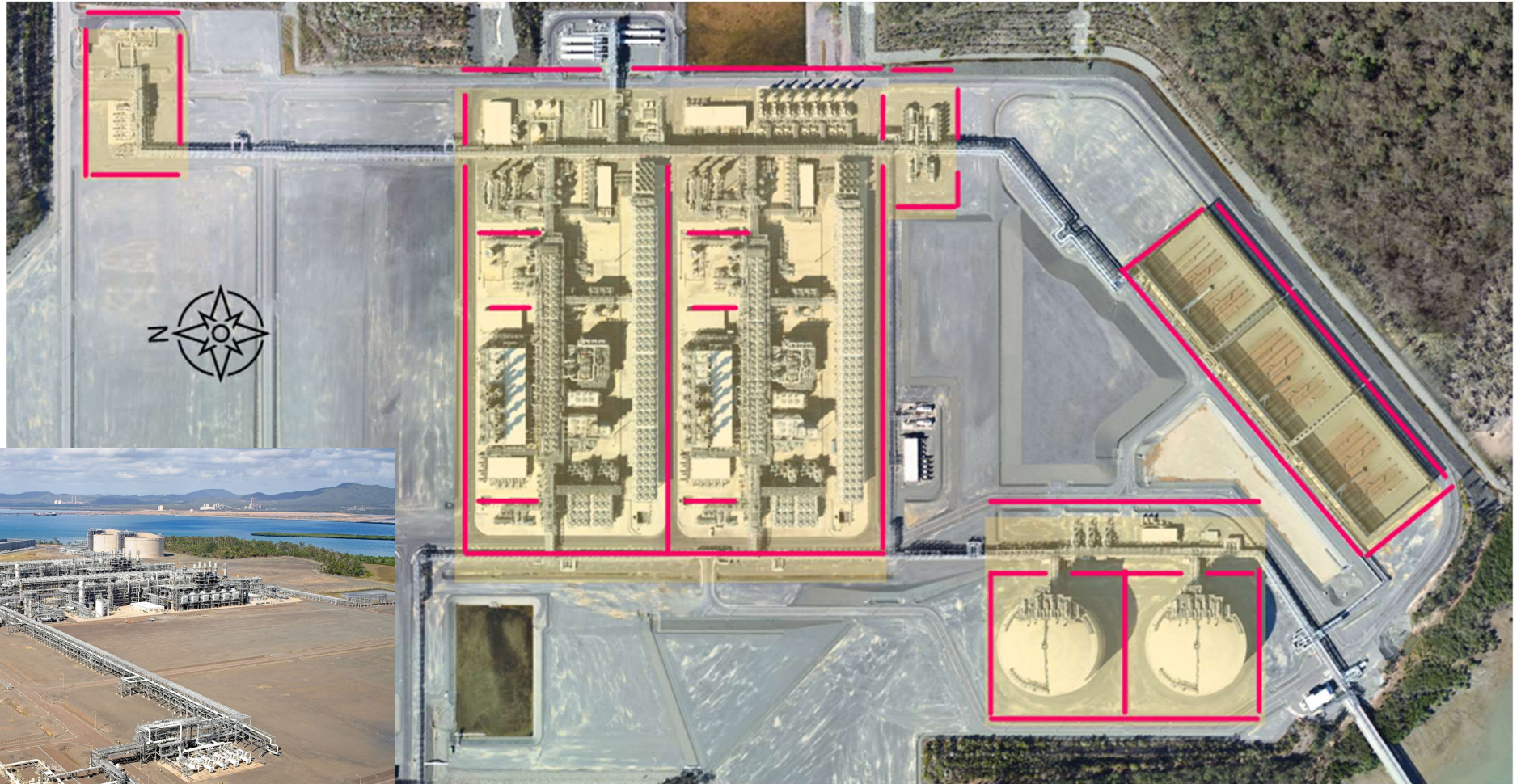


LNG Plants

- Complex plants spread over a large area
- Multiple equipment types
- Comprehensive operating rules
- Using drones to survey:
 - Rapidly survey site and equipment level
 - Access in 3 dimensions
 - Consistent across equipment
- Planning is key
 - Cooperation of plant personnel essential
 - Awareness of hazardous areas
 - Expect altitude high methane plumes
 - Use wind shifts



LNG Plants





Floating LNG



- Dense, complex plants
- Strict operating constraints
- Frequent SIMOPs
- Moves with the weather
- Substantial wind shadow/turbulence
- Using drones to survey:
 - Unobtrusive
 - Multiple standoff distances/directions
 - Orient under power if possible





LNG Carriers



- Emissions vary during loading
- Third parties often involved
- Limited optimum wind directions
- Sources close together
 - Vents
 - Loading arms
 - Vessel combustion
- Emissions from different vessels can vary substantially





Conclusion



- Drone-based emissions measurements have proven effective and versatile globally
- Future Developments
 - Improved standards
 - Beyond visual line of sight (BVLOS) operations



Questions and Discussion

