

A large LNG carrier ship is shown from a high angle, sailing on the ocean at sunset. The sun is low on the horizon, creating a bright reflection on the water and illuminating the ship's white superstructure. The ship's deck and railings are visible in the foreground, and the ocean extends to the horizon under a cloudy sky.

SIGTTO

LNG Carriers Methane Emissions

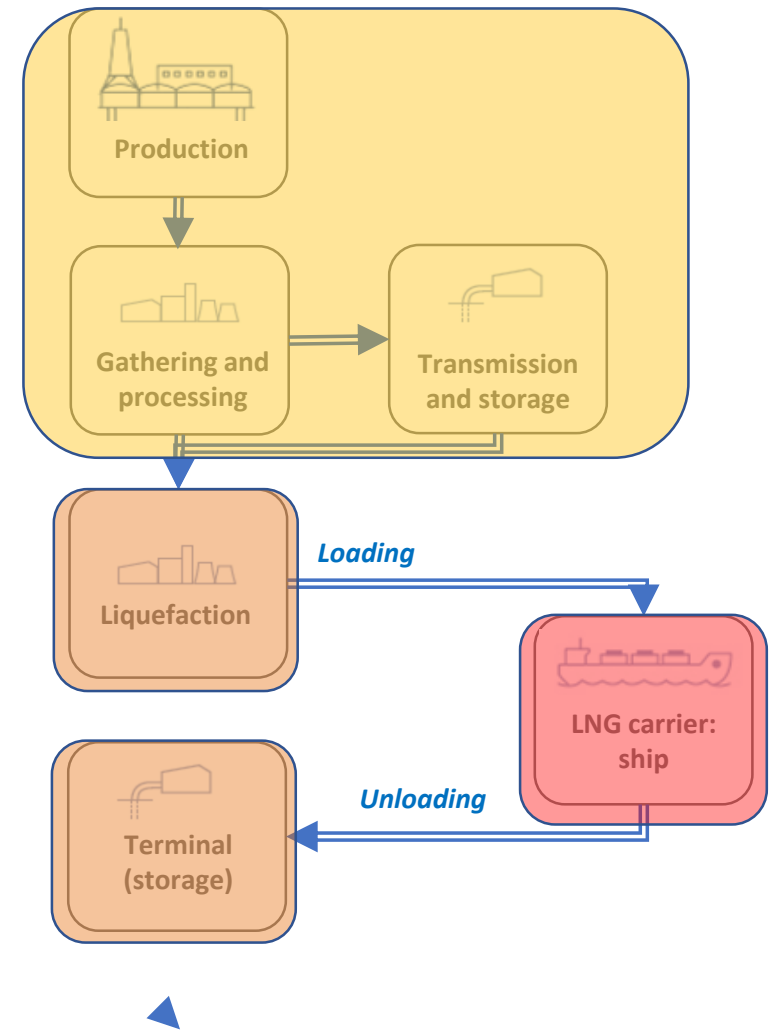
LNG Shipping Conference
London
1th September 2019

Introduction

- The credibility of natural gas and its role in decarbonising energy systems hinges on demonstrating transparency and reductions in methane emissions across the global gas supply chain.
- This project provides this with a unique academic-industrial collaboration to measure methane emissions, model the key factors and variations in emissions to determine minimisation targets via the most cost-effective emissions reduction solutions.
- The project is the first-of-a-kind covering LNG transport and its utilisation in the maritime sector.

Context: The LNG supply chain

- Regarding emissions, some supply chain stages have had more attention than others
- LNG in general has been less considered
- In particular there is a lack of data in LNG carriers; loading/unloading;
- Liquefaction and regasification terminals are already covered in the LNG Methane Emission Study (UN Environment and CCAC Methane Science Studies)



Aims & Scope



Project aims:

- **Fill data gap** by providing the **crucial measurement and modelling** required to determine the **climate impacts** of LNG transport.
- Determine **cost-effective methods of minimising potential emissions** across the supply chain
- **Drive the development of the role LNG** could play in energy systems and shipping, given climate targets
- This project is complimentary to the existing LNG Methane Emission Study (UN Environment Climate and CCAC Methane Studies), which covers liquefaction and regasification stages.

Project structure

- This is a first-of-a-kind study, measuring and modelling **all** emission sources across **all** phases of LNG shipping operations.
- To de-risk and reduce cost, first a **pilot study** will deliver a **proof-of-concept** by comprehensively measuring, modelling and assessing reduction opportunities for a single ship (LNG carrier). Two candidates for study are:
 - Brunei – Japan
 - Algeria – Barcelona
- Upon successful delivery and using learning from the pilot, a follow-on cost-optimal and comprehensive study will be developed to assess the variability of emissions and reduction-potential across the broad range of ships, technologies and routes. Additionally, loading/unloading terminals and LNG-fuelled ships and their bunkering will be included.

Work packages

- **WP1. Project set-up and design (4 months)**
 - Set-up IAG; develop preliminary emissions inventory; select ship/route; vessel visit; design measurement and data collection campaign.
- **WP2. Equipment procurement and manufacture (6 months)**
 - Informed by WP1; measurement equipment purchase; bespoke equipment manufacture for specific ship locations.
- **WP3. Measurement campaign (2 months)**
 - Emissions classification grid of potential sources and operational modes
 - Mixed-method approach, with direct source measurement and top-down corroboration
- **WP4. Modelling emissions and cost-effective reduction potential (6 months)**
 - Parameterised and probabilistic emission model; operation and technology variation; determine reduction potential; assess cost-effective reduction measures; reporting

Emissions measurement

- Emission sources: vents, exhaust, fugitives
- Different operational regimes
- Using mixed-method measurement, including passive sampling, flow monitoring and engine slip monitoring as well as periodic active monitoring
- Stack emission monitoring for exhausts and vents
- Fugitive Emission Detection System (FEDS) for fugitives
- Corroborated with walkabout surveys (infrared cameras and high flow samplers)

Emission Sources	Operations	Key parameters
<ul style="list-style-type: none">• Exhaust/s• Vent/s from fuel delivery system e.g. compressor room• Vent/s on storage tanks• Vent from boil-off management• Fugitives across all equipment/ processes	<ul style="list-style-type: none">• Cargo journey• Ballast journey• Port travel• Deep sea travel• Vessel loading• Vessel unloading• Gas free operation• Warm-up operation• Purging operation• Cargo venting operation• Over pressure safety valve release• Servicing/ maintenance	<ul style="list-style-type: none">• Vessel size• Vessel age• Vessel drive train (e.g. engine type)• LNG containment type• Re-liquefaction/boil-off management design• Journey length• Full journey operational profile (engine duty/ speed)• Storage/delivery operational pressures and temps• Port loading and unloading mechanisms• Weather/ ambient conditions

Modelling and reducing emissions

- Understanding what is going on whilst emissions are occurring is vital
- With help from operators, we will collect ancillary data on various aspects such as journey type, engine output, operational conditions (temps, press, flows), technologies used
- Linking operational data with emissions data via parametric and probabilistic modelling
- To understand the variations in emissions under different operations and using different technologies
- Analyse emission reduction potential via operational and technology change
- Assess technical and cost-potential for emissions reductions

Outputs

- A two-tier approach to maximise value to industrial partners and ensuring credibility and transparency through publication.
- Tier I: Confidential detailed emissions reports to owner/operator on a ship and facility level.
 - in-depth assessment of measurements, emissions models, and reduction potential
 - cost-effective emission mitigation assessment
 - benchmarked against other anonymised facilities.
- Tier II: Published academic papers from world leading, independent experts, that will provide the LNG supply chain and broader public with credible and independent data on current and potential contribution to the decarbonisation of the energy sector

Value

- Detailed emissions reports to each owner/operator on a ship and facility level
- To determine cost-effective strategies to reduce emissions and by how much.
- To prove and showcase the environmental credentials of LNG, its role in decarbonising energy systems and the potential for further reductions.
- To provide transparency and credibility to the industry.
- To enable robust revisions of emission intensities.

Governance

- Imperial College London are academic project lead
 - The Sustainable Gas Institute at Imperial specialises in methane emissions and supply chain systems modelling research
 - World-leading, independent academic body
- NPL are measurement lead
 - World-leading experts in emissions modelling, particularly methane measurement
 - UK national standards laboratory
- Industry Advisory Group (IAG) will provide key industry liaison
 - Project champions to industry, formed of key membership groups and industrial participants (including SIGTTO, Enagas, Shell, BP,)
 - Provide an effective route for industry delivery of expertise, site access and ancillary data

Industrial partners

- Enagás SA
 - Confirmed funder and leading partners in the development of this project, additionally providing expertise and industrial partner relationship development with LNG-fuelled ship owners and loading/unloading bay operators.
 - In addition discussing with CORE LNGas hive Partners coordinated by Enagás.
- SIGTTO
 - Proposal has been presented to the SIGTTO General Purposes Committee (members represent over 200 of the world LNG carriers) with a view to participation.
 - 3 Majors (OGCI leading members) have already confirmed interest to collaborate in-kind via site access, expertise and ancillary data
- In discussion with UN Environment Climate and CCAC Methane Science Studies (UNEP, EDF, OGCI) for funding.

Data and confidentiality

- The two-tiered output approach will give maximum value to participatory owner-operators and public-facing credibility, whilst maintaining confidentiality
- All source data will be managed by Imperial College and NPL, with many years of experience in this.
 - Full detailed breakdowns of an owner/operator's emissions, analysis and reduction potentials will be shared only with that owner/operator
 - Only aggregated and anonymised data will be shared across the group, to provide a baseline comparison
 - Only aggregated and anonymised data will be published, alongside estimates of the emissions-reduction potential, to provide the vital public-facing transparency

Indicative timeframe

- The pilot project is expected to run for 18 months
- But scope to reduce upstream campaign design phase time upon industry availability

Next steps

- Preliminary funding agreement between Enagas/ OGCI members/ Methane Science Studies
- Agree on ship/ route for pilot study
- Confirm industry collaborators and short-list ships/routes for full project
- Confirm IAG participants and prepare for kick-off



Thank you!