Plan Overview

A Data Management Plan created using DMPonline

Title: Clean FLNG Power: Integrating LNG Cryogenic Liquefaction and Hydrogen Reforming

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Template: DCC Template

Project abstract:

Global carbon emissions are driving the maritime industry toward cleaner fuels, with LNG already established as a transitional option that reduces SOx, NOx, and particulate emissions compared to conventional marine fuels, aligning with decarbonisation strategies. This research aimed to explore the transition of offshore and marine platforms from conventional marine fuels to cleaner alternatives, with Liquefied Natural Gas (LNG) emerging as the principal transitional fuel. Subsequently, Floating Liquefied Natural Gas (FLNG) platforms are increasingly being deployed to harness offshore gas resources, yet they face critical challenges related to weight, space, and energy efficiency.

In alignment with the IMO's 2018 strategy, which targets a 40% reduction in CO_2 emissions by 2030 and 70% by 2050, the adoption of LNG is accelerating. However, unresolved issues, such as methane slip and unburned hydrocarbon emissions, limit its long-term sustainability. This research develops a roadmap that advances the Clean Energy Hypothesis by modelling integrated fuel-use scenarios across three interlinked domains: fuel combustion, carbon emissions, and thermodynamic performance. The hypothesis stated that to avoid using hydrocarbons as a raw material, any hydrocarbon should be converted into a clean fuel for use.

The study proposes pathways for transitioning FLNG energy systems from LNG to zero-carbon fuels such as hydrogen, derived directly from LNG resources. Emphasis is placed on LNG liquefaction, boil-off gas (BOG) management, and fuel supply optimisation under the unique operational constraints of FLNG units. The work unifies the independent domains of LNG process thermodynamics, hydrogen generation from boil-off gas (BOG) and reforming systems, and hydrogen–LNG co-firing gas turbine performance within an environment, linking Aspen HYSYS, MATLAB, and ANSYS Fluent.

Aspen Hysys thermodynamic modelling was used to evaluate LNG process cycles, and comparative analyses were conducted on liquefaction technologies, including the Brayton (single- and dual-nitrogen expander), SMR-PRICO, and Dual Mixed Refrigerant (DMR) cycles, highlighting trade-offs among efficiency, cost, and thermodynamic optimisation. Results show that while DMR offers enhanced flexibility through refrigerant composition tuning, modular SMR systems achieve efficiency gains through pressure-ratio control and exergy recovery in throttle valves and heat exchangers.

In parallel, the research investigates the conversion of BOG into hydrogen (high specific energy) for use in FLNG power generation. A novel integration of small-scale Brayton refrigeration cycles with clean fuel production, BOG utilisation, and hydrogen reforming is proposed to validate this concept. Hydrogen gas turbines are examined in dual-fuel configurations, including CFD-based flame stability analysis, demonstrating the feasibility of applying complex combustion processes in gas turbines for FLNG power systems.

Gas turbine performance for a 50 MW unit was modelled in Aspen Hysys to focus on the process of 0-100% hydrogen blends. Parameters analysed included air-fuel ratio (AFR),

Wobbe index, turbine inlet temperature, and other parameters, with a sensitivity analysis to quantify the effects of pressure ratio, equivalence ratio, and hydrogen fraction on efficiency, stability margins, and performance. The integrated methodology bridges chemical process simulation and gas turbine performance to provide a transferable framework for fuel-flexible turbine optimisation for hydrogen blending, AFR calibration, and NOx reduction, aiming to mitigate issues in next-generation offshore turbines. The analysis was validated using Gasturb software.

This research develops a comprehensive modelling and validation framework for the FLNG platform through the hydrogen-enriched gas turbine power system. Overall, this work not only supports the IMO's decarbonisation goals but also delivers a technology framework that unifies LNG liquefaction, clean fuel generation, and advanced Gas turbine combustion. The findings contribute to the next generation of sustainable FLNG operations and to a clean energy framework that integrates LNG liquefaction, hydrogen generation, and gas turbine co-firing, providing a transferable model for clean power generation across a broad spectrum of floating maritime platforms.

ID: 190832

Start date: 02-11-2020

End date: 05-04-2027

Last modified: 21-01-2026

Copyright information:

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Data Collection

What data will you collect or create?

1. Existing data in the literature for LNG and hydrogen-related fuel

2. Existing information from the public domain on the clean energy fuel/ Marine Power generation technology and its application

How will the data be collected or created?

1. Theoretical Simulation results, design and optimisation of the Hydrogen gas turbine for FLNG power generation to achieve the Marine Green Energy development

1. Literature review, industry contact/interview, industrial partner search
2. Literature review, feasibility study
3. Using commercial software as a tool to perform simulation, design and optimisation of the LNG Cryogenic Liquefaction and Hydrogen Reforming to get the Gas turbine model

Documentation and Metadata

What documentation and metadata will accompany the data?

1. Written in the feasibility report and preliminary planning design
2. A study protocol will be held in the folder with the data, describing the methodology and contact details for the principal investigator.
3. Another document will explain acronyms in the dataset (for example, full questionnaire names and references), units of measurement, and so on.

Ethics and Legal Compliance

How will you manage any ethical issues?

1. All data would be unclassified
2. Data will be presented in the feasibility study report and preliminary design planning documentation that will be authored accordingly

How will you manage copyright and Intellectual Property Rights (IPR) issues?

1. The consent process will inform the originator of how their data may be used (e.g. presentation at a conference, written up in a journal) and will comply with the existing university guidance on data preservation, sharing, and storage.

Storage and Backup

How will the data be stored and backed up during the research?

1. Date will be stored on Newcastle University computers and the network drive.
2. The university has a regular backup schedule on network drives.

How will you manage access and security?

A spare copy of the data will be stored on USB hard drives that will be updated daily. Also, plan a backup program to synchronise every day between the portable hard drive and the main data storage.

Selection and Preservation

Which data are of long-term value and should be retained, shared, and/or preserved?

All the data should be retained on the university service for ten years, and the principal investigator will be working towards a PhD for the next seven years and will conceivably revisit the data for reanalysis during this time and after.

What is the long-term preservation plan for the dataset?

For long-term storage of the data, restore it effectively in the NAS home cloud and on an additional hard drive for use. Also, plan to discuss with a storage company about long-term data storage. However, I haven't planned to use NAS since the cost is high, and I only plan to use the university's OneDrive.

Data Sharing

How will you share the data?

Raw data relevant to cooperative work will be shared only among collaborators. Date sharing for the public will be done through the publication of the feasibility report and papers/articles. Preliminary design planning is confidential.

Are any restrictions on data sharing required?

Only preliminary design planning will be confidential and shared among the collaborators.

Responsibilities and Resources

Who will be responsible for data management?

The principal investigator on each side

What resources will you require to deliver your plan?

USB portable hard drive, backup software