



**Liquefied Natural Gas as a Sustainable
Alternative maritime fuel:
a techno-economic comparison of biological
and chemical synthesis routes
(LNG-SEA)**



- Different alternatives are being evaluated to substitute conventional marine fuels with renewable and cleaner options



- The maritime sector is responsible to **1.5 billion** tons of CO_{2,eq} (roughly **3%**) of total annual GHG emissions
- These emissions need to be **reduced by at least 50%** in absolute value by **2050**, to comply with the objectives of the International Maritime Organization (IMO)

- **BIOFUELS**
- **AMMONIA**
- **METHANOL**
- **LNG**

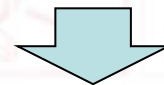
- **Liquefied Natural Gas (LNG)** as fuel can significantly improve the environmental footprint of a vessel:
 - ❖ Up to **23%** reduction in **GHG emissions**
 - ❖ Up to **80%** reduction in **NO_x emissions**
 - ❖ Almost eliminates **SO_x**, particulate matter (**PM**)

FINCANTIERI VARA LA SUA PRIMA NAVE DA CROCIERA A LNG "SUN PRINCESS"

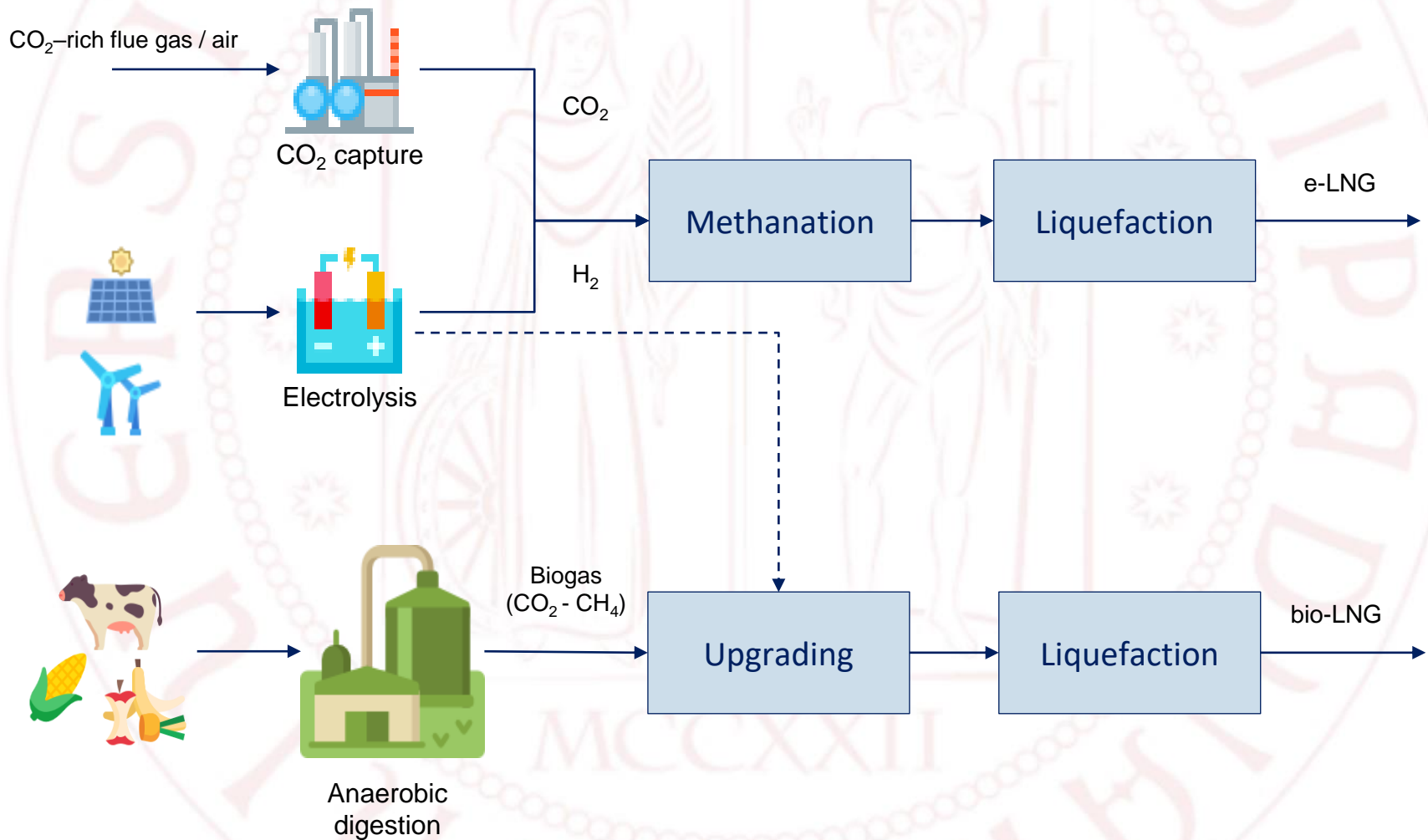
Con 175.500 tonnellate di stazza lorda è anche la nave più grande finora costruita in Italia

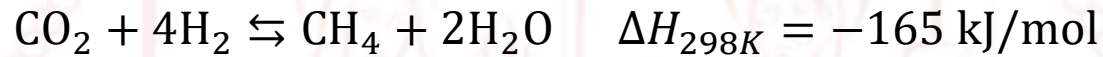
08 MARZO 2023

Trieste, 8 marzo 2023 – Si è svolto a Monfalcone il varo di "Sun Princess", la prima di due navi da crociera a LNG (gas naturale liquefatto) per Princess Cruises.



**RENEWABLE
LNG**

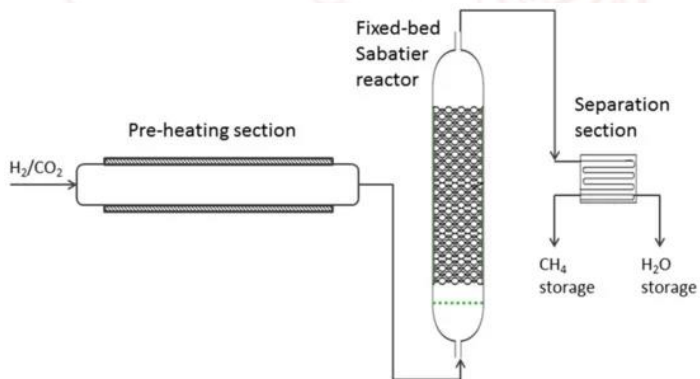




CHEMICAL

Catalytic reaction (Ni/Ru catalysts)

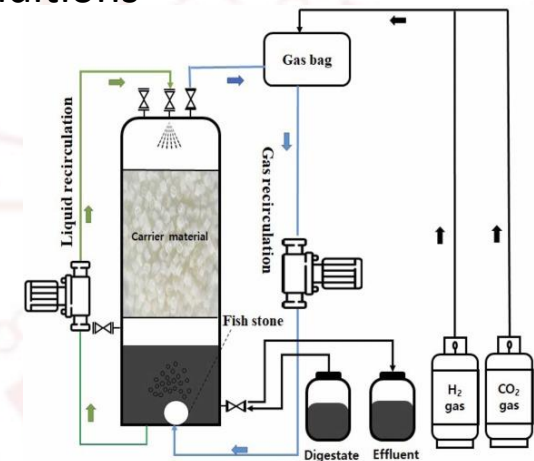
300°C, 5-20 MPa



BIOLOGICAL

Hydrogenotrophic methanogens

Anaerobic conditions



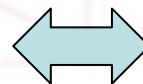
PROJECT OBJECTIVES

1. Collect **experimental data** of biomethanation process at different operating conditions, to develop a **kinetic model** of the bioprocess
2. Develop a **techno-economic analysis** of different renewable LNG synthesis routes, comprising both chemical and biological processes, to quantify their **energetic, economic, and environmental** performances, and provide **quantitative indicators** that can aid decision-makers in the transition.



TECHNO-ECONOMIC ANALYSIS

Elena Barbera, Fabrizio Bezzo
(DII)



BIOMETHANATION EXPERIMENTS

Laura Treu
(DiBio)





**CENTRO STUDI DI ECONOMIA E
TECNICA DELL'ENERGIA
"GIORGIO LEVI CASES"**



**UNIVERSITÀ
DEGLI STUDI
DI PADOVA**

**THANK YOU
FOR YOUR ATTENTION**

elena.barbera@unipd.it