dunkerque LNG
fluxys

75th TSG Meeting
WG related to CO2 emissions

MAY 2024

Questionnaire Preliminary Findings Scope 1

- Questionnaire submitted on May 13th.
- **12 replies received** : Asia (6), Europe (4), America (2)
- **7 members shared their full emissions results**. Great gap in results reflecting the differences between our installations and their use.
- **For 8 members, CO2 represents more than 50% of total scope 1 emissions.**
- For 2 members, CH4 is responsible for the majority of scope 1 emissions
- **Scope 1 CO2 emissions : Ratio of 280 between highest and lowest declarations.**
- 1st emitter : SCV (4) / 2nd emitter : Fugitives emissions (3) , Flare (3)
- **8 members have already implemented CO2 reductions actions and all members are studying reduction actions.**
- **7 members are ready to share their experience** in a dedicated report.

Scope 1 reduction actions mentioned

- **On SCV:**
  - Use of solar panels to reduce consumption
  - Burner efficiency / Study : H2 green as burner fuel
  - Review testing
- **On Flare:**
  - Switch of sweep gas and flare header blanketing from gas to nitrogen
  - Green H2 as pilot
  - Study : switch to low consumption pilot or on a pilot on demand system
- **On fugitive emissions :**
  - LDAR campaign
- **Others** : site electrical vehicles, solar PV on roofs for electrical production

Questionnaire Preliminary Findings Scope 2

- Less replies for scope 2
- Great variability on ratio vs scope 1 : From 0% (green electricity supply) to 291% (low emission terminal)
- 7 members have implemented or are studying scope 2 reduction actions.
- 3 members only are ready to share experience

- Scope 2 reduction actions mentioned:
  - Installations of VFD on LPP, HPP, SWP
  - Turboexpander
  - LED lighting on site
  - Green electricity supply contract

Draft Table of Content

- **For discussions following survey**
- Scope 1/2/3 to be covered ?
  Limit to Scope 1 only ?
  Cancel Scope 3
- Minimum number of case studies for the final report ?
  Several cases still under study.
  Initiative database vs formal report ?
- Sufficient real cases existing for the time being ?
- Case study presentation might follow the same template used for terminal and PP integration

Introduction

> General context
> Source of main CO2 emissions inside a regasification terminal
> Extent of CO2 emissions per main equipement and scope

I-Ways to reduce CO2 emissions

1.1)Scope 1 emissions

> Flaring	> H2 pilot flare > Pilot on demand flare retrofit >…
> Maintenance flaring	> Rental of temporary Pipeline Compressors >…
> Vaporizers (SCV, S&T, IFV..)	> ORV installations in "cold" sea water area > Solar panels to warm SW > H2 burners > Carbon Capture from SCV Flue gas > FSRU : Warm SW from steam condenser, NG Trim heaters,… >…
> Other scope 1 emission (to be listed)	>…

1.2) Scope 2 emissions

> VSD installations
> BOG / HP LNG Exchanger
> Operation adjustement during peak hours
> Renewable energy facilities on terminal
> Smart building and lighting management system (LED, AC…)
> Others (recent examples of thermal integration)

1.3) Scope 3 emissions

> Site electricle vehicles for O&M personnel
> Others

II-LNG terminal concrete examples

Case Study #1
Case Study #2
Case Study #3
…

Case Study Presentation

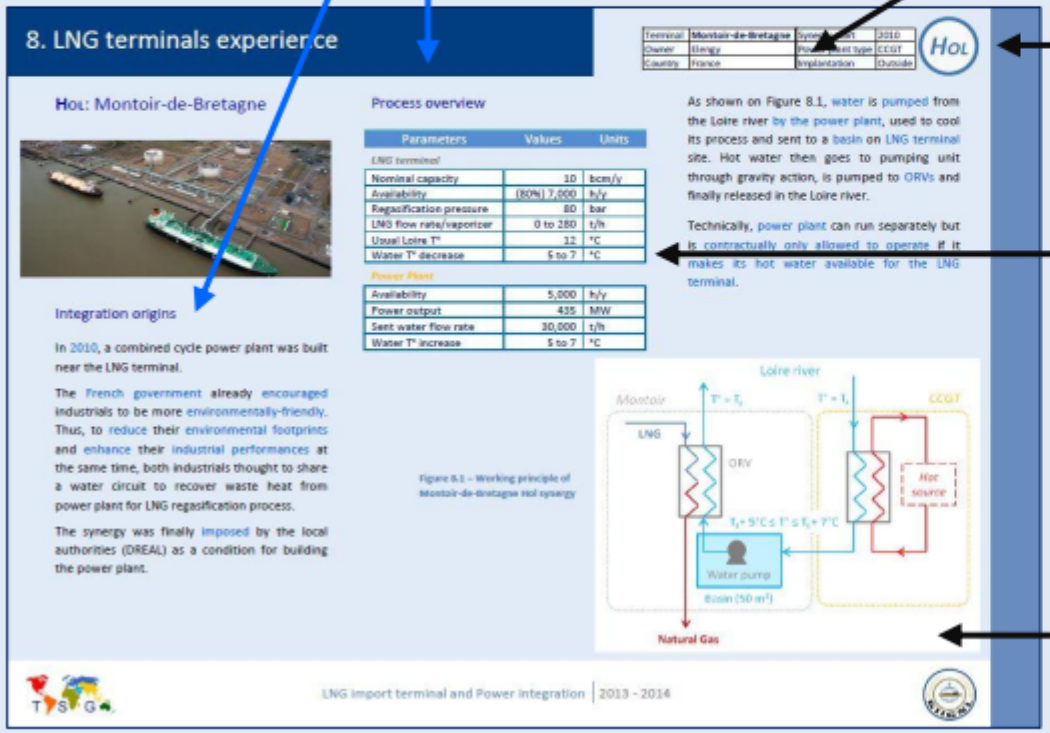
When information was obtained, integration origins, process overview, some elements of costs, generated benefits and return of experience are provided.

Recap table: LNG terminal & synergy

Logotype of the synergy
Same as in 6th part

Operating parameters: LNG terminal & synergy

Scheme of working principle: for both LNG terminal and power plant, only necessary to understand the synergy principle units are represented.



Way forward

- Pursue questionnaire for 1 month ?
- Diffusion of questionnaire results.

- Collect more precise emissions declarations to support MRV ?

- Submit Case study presentation forms to volunteers.

“

Shaping together a bright energy future

SPARE SLIDES

Recent study from CRIGEN

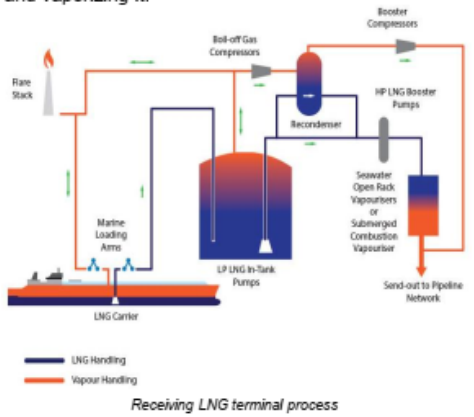
LNG VAPORIZATION: LNG COLD UTILIZATION TO REDUCE TERMINALS CARBON EMISSION

DETOURNAY Clémence, Green gases R&D engineer
HUBERT Audrey, R&D project manager

LNG 2023 VANCOUVER 10-13 JULY
PRESENTED BY IGU GTI ENERGY HOSTED BY IIF IIR CGI

Receiving LNG terminal

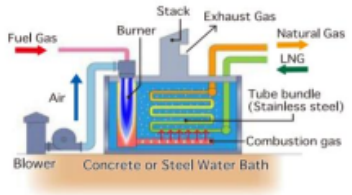
Receiving LNG terminals aim at temporarily storing the LNG, pressurizing it between 40 to 100 bara and vaporizing it.



Receiving LNG terminal process

Regasification technologies

- **Open Rack Vaporizers (ORV):** Heat is provided by sea water.
- **Submerged Combustion Vaporizers (SCV):** LNG is vaporized in a warm water bath heated by Natural Gas combustion (about 1,5% of terminal production).



Submerged combustion vaporizer unit

Scan me!

SCV's zoom

- SCV are often used as main system or for back-up. SCV is one of the main source of carbon emission on terminals.
- Assuming a classic NG combustion, a typical CO_2 content of stak gas is $8\%_{mol\ dry}$.

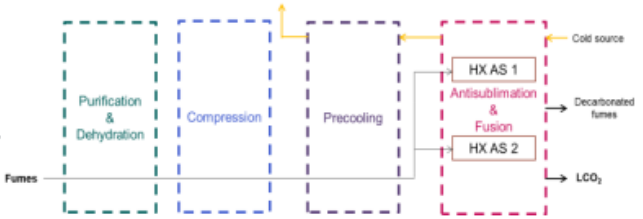
Example of SCV mass balance

Fuel gas (NG) flow rate	960 kg/h
Stack gas flow rate	35 000 kg/h
Released CO_2	**4 161 kg/h**
LNG flow rate	80 000 kg/h

Objectives: Studying cryogenic carbon capture solution for SCV's emissions and assessing its symbiosis with LNG regasification.

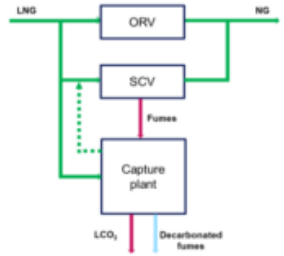
Cryogenic carbon capture

Among all cryogenic carbon capture technologies, carbon capture by anti-sublimation (AS) is the most compatble with LNG vaporization temperatures. LNG is used as refrigerant for carbon capture system.



Carbon capture by anti-sublimation principle

Application to SCV



Carbon capture integration in regasification system

Technical results

- **AS temperatures:** from -102°C to -121°C.
- **LNG mass flow required:** 4,3 kg_{LNG}/kg_{CO2}.
- **Energy consumption:** 0.18 kWh/kg_{CO2} (instead of 0.33 kWh without LNG cold *(Pan, Clodic, & Toubassy, 2012)*).
- **NG saved:** 62 kg/h (944 kWh).

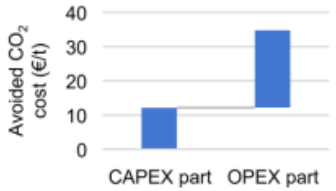
➡ 3 772 kg/h of CO_2 is avoided (91%)

Economic analysis

CAPEX of cryogenic carbon capture for one SCV values 4,56 M€.
Carbon price in European Union approaching the symbolic threshold of 100 €/t.
Considering follwing economic assumptions, avoided CO_2 cost is 35€/t, which is far below 100€/t.

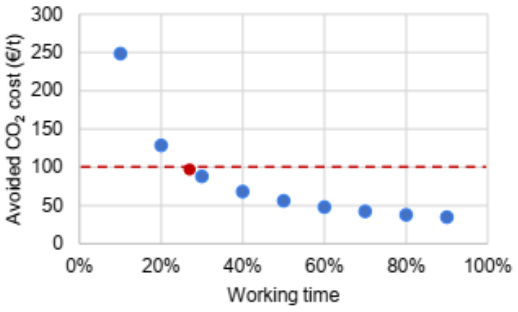
Economic assumptions

Electricity price	75€/MWh
NG price	-20€/MWh
Plant lifetime	20 years
SCV's working time	90%
Inflation rate	1%
Fixed OPEX	$4\%_{CAPEX}$
Tax rate	35%
Actualization rate	10%



SCV working time

To reach a CO_2 capture price below 100€/t, it requires a minimum SCV's working time of 27%.

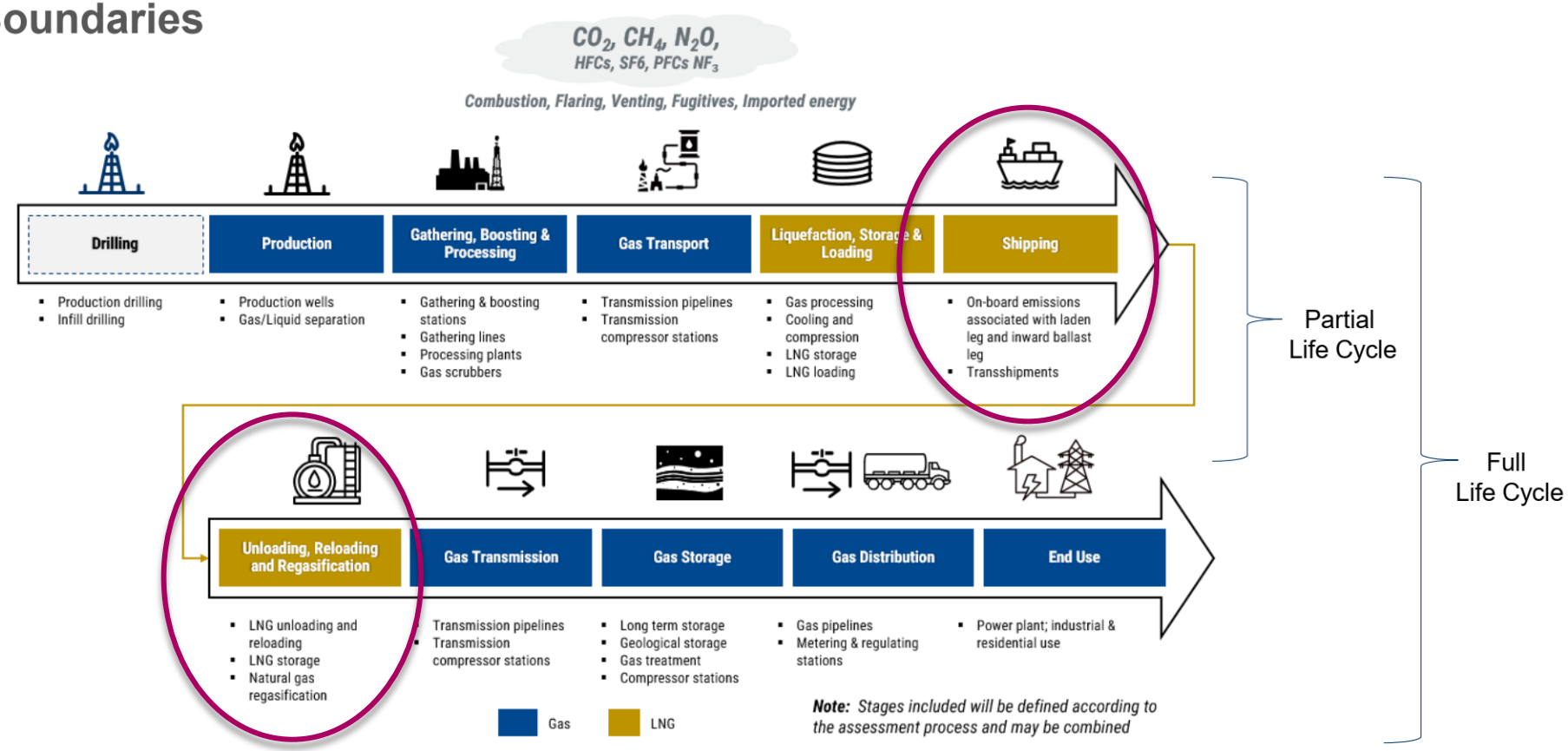


Status

- Draft questionnaire not submitted yet…
- Comments from last TSG:
  - Confusion between questionnaire and central office activities about MRV
  - Confusion between scope limits, especially for emissions related to scope 3.
- Scope 3 related questions:
  - *Q1: Did you consider the emissions related to the transport of gas upstream and downstream the LNG regasification terminal battery limits in your SCOPE 3 emissions ?*
  - *Q2: Did you consider the LNGC emissions while unloading/reloading at your terminal in your scope 3 emissions ?*
  - *Q3: Did you consider Port services mobilized during LNGC call at your terminal in your scope 3 emissions (eg : Tugboats, Pilot port boat, Linesmen boat…) ?*

Status

Boundaries



- When does finish the Shipping step and start the unloading one ?
- Does LNG unloading include Ship ?

- Any « official » rule on GIIGNL ?
- Avoid double accouting and guarantee proper scope allocation

From previous TSG Meeting

Decisions were as follows:

- Shell joins the Task Force on CO_2 Emissions from LNG terminals. The Task Force members are: Dunkerque LNG (Task Force Leader), Enagas, Engie, Sempra Infrastructure, Shell and TotalEnergies.
- The Task Force on CO2 Emissions from LNG terminals will collect examples from GIIGNL members, set-up a questionnaire and submit it. Mr Planteline (Task Force Leader) will make a presentation at next TSG meeting for sharing the results.
- A Task Force is constituted on LCO2 terminalling with the following members: Singapore LNG (Task Force Leader), Dunkerque LNG, Elengy, Engie, Equinor, Fluxys LNG, Osaka Gas, Sempra, Shell and TotalEnergies.
- Mrs. Ang (Task Force Leader) will prepare a scope of work on LCO2 terminalling and will present it at next TSG meeting.

Questionnaire objectives

- Draft questionnaire divided in 6 parts:
- Part 1 is related to methodology. Purpose is to assess where do we stand collectively as of today in carbon accounting and to look at specific points we all face when starting this assessment.
- Part 2 is related to Reporting. Purpose is to assess what are general reporting obligations LNG terminals are facing as of today.
- Part 3 is related to reduction Action Plan which follows usually the carbon footprint assessment. Purpose is to assess where do we stand collectively.
- Part 4 / 5 / 6 are respectively related to Scope 1 / 2 / 3 emissions. Purpose is to assess the share of each scope in terminal global emissions and the reduction actions identified or already conducted. Goal is to identify which members are already ready to share return of experience of some reduction actions conducted in their terminal.

WG members

Company	Name	Email
DUNKERQUE LNG	Sylvain PLANTELINE	s.planteline@dunkerquelng.com
ENAGAS		
ENGIE		
SEMPRA INFRASTRUCTURES		
SHELL		
TOTALENERGIES		

Any recent initiatives to share ?

- On Dunkerque LNG side,
- **Action #1:** Reduce fugitive emissions. LDAR campaign carried out on full site
- **Action #2:** Feasibility study initiated to stop flare pilot and switch to a « pilot on demand system ». Flare pilot represented 23% of our scope#1 emissions in 2021.
- **Action #3:** Switch road lights to LED
- **Action #4:** Feasibility study initiated to supply shore power to the Stand-by tug on duty during unloading operations.