Quantification of methane emissions

MARCOGAZ Assessment and development of the CEN Technical Report”.

Marcogaz Results

LNG	4,700 ton CH_4 0.002 % compared to the EU28 sales 0.003% of anthropogenic CO_{2eq}
UGS	38,000 ton CH_4 0.01% compared to the EU28 sales 0.02% of anthropogenic CO_{2eq}
TSO	133,000 ton CH_4 0.05% compared to the EU28 sales 0.08% of anthropogenic CO_{2eq}
DSO	339,000* ton CH_4 0.12% compared to the EU28 sales 0.21% of anthropogenic CO_{2eq}

Remarks

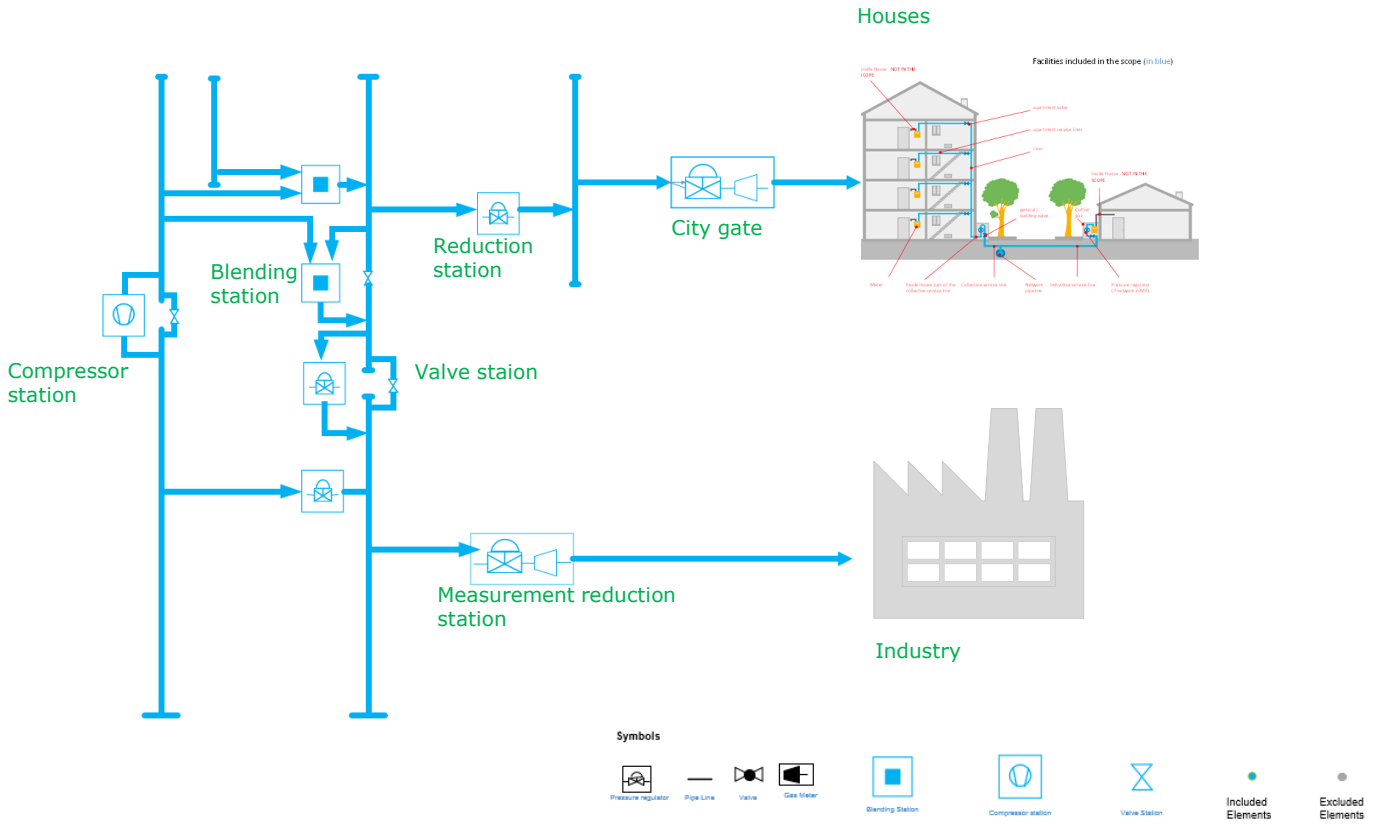
- ✓ Results valid at global European level and not for an individual country.
- ✓ (*) 553,000 with 95% confidence level as mentioned in the report.

Marcogaz Framework Assessment report (includes ones of the actions identified)

- Prescription of identification of methane emission sources
- Quantification strategy
  - Gives an overview of available measurement methods
  - Prescription of estimation and calculation methods
- Reporting
- Verification according existing standards
- Uncertainty assessment

- Bottom-up approach based on Tier III approach.
- Definitions from available CEN / ISO standard are used
- Further work has to be done to establish a knowledge base with emission factors

Primary Scope: EU DSOs and TSOs network



Types of emissions

Methane emissions			
Types of emissions			**Examples**
Fugitives	**Leaks due to connexions**		Tightness failure
	Permeation		
Vented	**Operational emissions**	**Purging/venting for works, commissioning and decommissioning**	Works, maintenance
		Regular emissions of technical devices	Pneumatic emissions actuators, flow control valves, …
		Starts & stops	Emissions from start and stops of compressors, …
	Incidents		Third party, corrosion, construction defect/material failure, ground movement, failure of installation
Incomplete combustion			Unburned methane in exhaust gases from combustion installations.

Structure of the report

marcogaz TECHNICAL ASSOCIATION OF THE EUROPEAN NATURAL GAS INDUSTRY		Types of emissions						
		Fugitives		Vented				
				Operational emissions			Incidents	Incomplete combustion
		Permeation	Leaks due to connections	Purging/venting for works, commissioning and de-commissioning	Regular emissions of technical devices (e.g. pneumatic)	Start & Stop		
Groups of assets	Main lines & service lines	§ 6.4.1	§ 6.4.2	§ 6.5.2.1			§ 6.6	
	Connections (flanges, seals, joints)		§ 6.4.2					
	Measurement devices (chromatographs, analysers ...)		§ 6.4.2		§ 6.5.2.2			
	Valves[2] (regul. stations, blending stations, compressor stations, block valve stations)		§ 6.4.2	§ 6.5.2.1	§ 6.5.2.2			
	Pressure / Flow regulators		§ 6.4.2		§ 6.5.2.2			
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	Combustion devices (turbines, engines, boilers...)		§ 6.4.2	§ 6.5.2.1		§ 6.5.2.3		§ 6.7
	Compressors & compressor seals		§ 6.4.2	§ 6.5.2.1	§ 6.5.2.2	§ 6.5.2.3	§ 6.6	
	Flares					§ 6.5.2.3		§ 6.7

Identification

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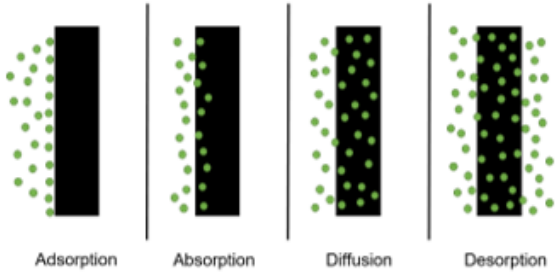
Fugitive emissions: Permeation



$$q_V = PC_{CH4} \cdot \pi \cdot SDR \cdot p_{CH4}$$

Permeation Coefficient (original)		Unit
Value	Material, temperature	
0.019	PE100, 20°C	$cm^3_{CH4}/(m \cdot bar \cdot d)$
0.056	HDPE, 20°C	$cm^3_{CH4}/(m \cdot bar \cdot d)$
34.1	PE100, 20°C	$(ml \cdot mm)/(m^2 \cdot bar \cdot d)$
1.11E-09	PE80, 8°C	$cm^2_{CH4}/(bar \cdot s)$
0.006	PE100, 8°C	$cm^3_{CH4}/(m \cdot bar \cdot d)$
0.29	Plastic, 8°C	$m^3_{CH4}/(km \cdot bar \cdot yr)$

Identification

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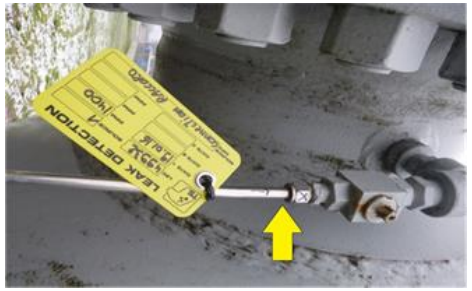
Fugitive emissions: Connection

e.g. flanges, equipment, joints, seals

Methods applied

- Direct measurement



- Emission factors
  - estimate of average emission flowrate via surveys
  - average duration
  - number of leaks

Identification

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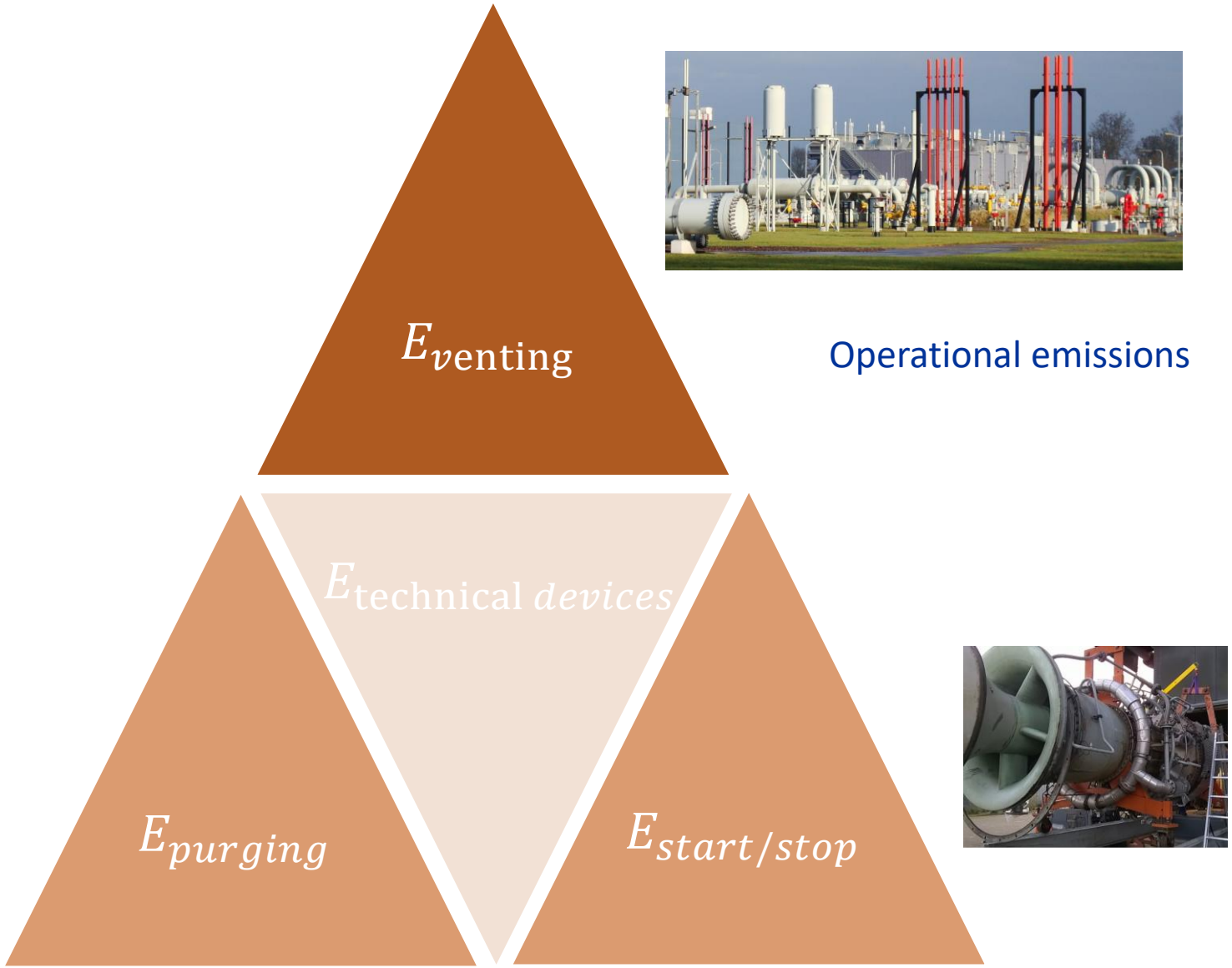
Vented emissions: Operational emissions



Operational emissions

Identification

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Emissions from incidents

Incident causes

- External interference (i.e. third-party damage)
- Corrosion
- Construction defect / material failure
- Hot tap made by error
- Ground movements
- Venting caused by system failure

TSO Individual based

- Volume
  - Diameter
  - Length
  - pressure
- Duration
- Geometry of leak

DSO Grouping

- Average flow rate
- Average duration
- Average number of incidents

Identification

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Measurement / Detectors

- The operation is based on the ionization of the detected gas in the hydrogen flame that is generated inside the FID. It enables to detect the methane concentrations from very low levels, but reacts not only to methane, but to other hydrocarbons as well.

Flame ionisation detection

- In the presence of the detected gas, the semiconductor's resistance decreases due to the oxidation, or reduction, of the gas on the metal oxide surface. *Optical gas imaging*

Semiconductor based detection

- OGI infrared cameras are equipped with sensors to detect hydrocarbons. The equipment may be hand-held or remotely operated from ground-mounted installations or through mobile deployment (vehicular & aerial). Hand-held units are a recommended solution for a broad range of components.

Optical gas imaging

- Acoustic leak detectors capture the acoustic signal of pressurized gas escaping from a valve plug or gate that is not tightly sealed. They can detect either low or high frequency audio signals and are useful for detecting internal through valve leaks or ultrasonic signals from blowdown valves and pressure

Acoustic leak detection

- A popular detector is the Remote Methane Leak Detector (RMLD), which uses a tunable diode-infrared laser that is tuned to a frequency which is specifically absorbed by methane. As the laser beam from an RMLD device passes through a gas plume (and is reflected back to the camera) it will detect if methane is present in the beam path by comparing the strength of the outgoing and reflected beams.

Laser leak detection

- When gas that is aimed to be detected goes through the catalyst it is combusted what heats up the catalyst and changes the resistance, which subsequently enables detecting of the searched gas. The catalyst poisoning may be an issue decreasing its reliability.

Combustible gas detection

- Gas leak rate is estimated based on the size of the cloud observed from thermograms. The amount of gas released depends of the upstream pressures and leak sizes.

Thermal dispersion

- Electrochemical detectors use the porous membrane through which the detected gas goes to the electrode on which it is either oxidized or reduced, resulting in the change of the electric current.

Electrochemical detection

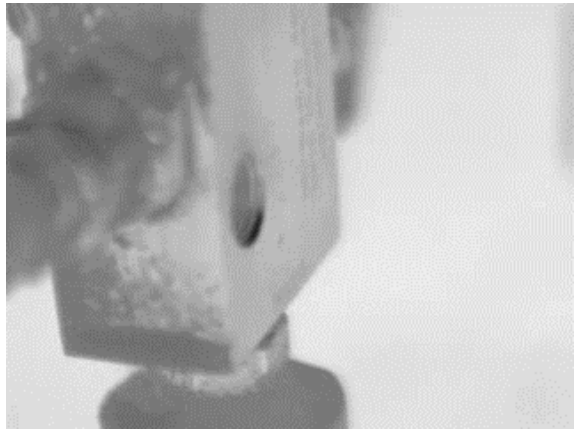
- It is easy, quick and low cost to detect leaks with a soap solution. Soap bubble screening consists to spray all the junctions with a mixture of water and soap (or with a specific commercial foaming product). All the junctions (even the junctions inserted in a coating) are targeted (the actuator of the valves, flanges, fitting, caps, insulating joints,

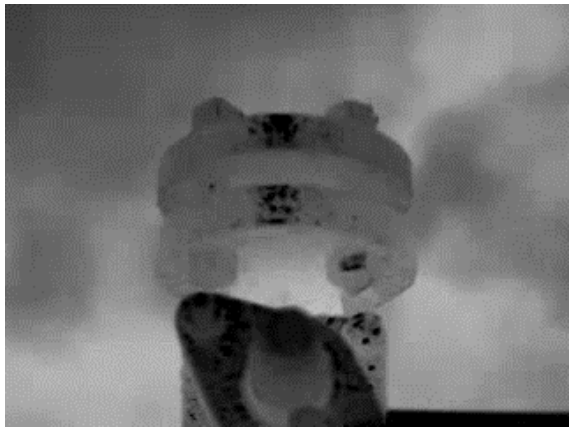
Soap Bubble Screening

Detection

Optical Gas Imaging and IR Camera

InfraRed Camera





- ✓ **Operator can scan a wide potential emission area in real time.**
- ✓ **It is probably the fastest way to detect methane emissions**
- ✓ **Detection threshold is dependent on atmospheric conditions.**

Detection

Optical Gas Imaging and IR Camera

Systematic leakage search on distribution grid (GRDF example)

- ✓ The gas distribution network is monitored throughout the year by a systematic leakage search, divided into two distinct methods, Pedestrian and Vehicular (depending on the accessibility of the area).
- ✓ ~100 000 km checked every year
- ✓ Measurements are taken at ground level by sampling tubes mounted on a suction ramp. The vehicle, equipped with a GPS, transmits to an embedded software the necessary information to track the detected leaks.
- ✓ Every leak detected is reported and considered in GRDF methane emission quantification.
- ✓ If immediate action is needed, the emergency security office sends a specialized team for intervention. For the other leaks (lower severity) a repair program is set.

Detection

Soap Bubble Screening

Soap bubble screening

- ✓ **This technology can be used for an efficient and fast leak detection and repair campaign, operational team are familiar with that well know historical methodology.**
- ✓ **Not effective on large openings.**
- ✓ **Accessibility can be an issue**

Uncertainty calculation

$$E = \sum_{i}^{n} E_i$$ Basic formula to evaluate

To calculate uncertainty is difficult.

MARCOGAZ proposes to use some simpel equations to derive uncertainty:

Therefore:

- ✓ Quadratic model is used or Monte Carlo simulation
- ✓ Standard deviation E_i must be knowm

Using ref JCGM-100. Evaluation of measurement data - Guide to the expression of uncertainty in measurement. s.l. : Committee for Guides in Metrology (JCGM/WG 1), 2008.

JGCM-101. Evaluation of measurement data — Supplement 1 to the "Guide to the expression of uncertainty in measurement" Propagation of distributions using a Monte Carlo method. s.l. : JCGM, 2008.

CEN

TC234 : WG14

CEN TC234 WG14 Technical Report

- Creation of CEN TC234 WG14 “Methane Emissions” 09/2020,
  - ✓ 26 committee members, 12 member states
- Adoption of a New Work Item for a CEN Technical Report :
  “TC234 WI 00234094 Assessment of methane emissions for gas transmission and distribution systems”
- 1st Draft based on the MARCOGAZ assessment document (equivalent scope, limited to TSO and DSO)
- Existing Liaison with IOGP and MARCOGAZ
- LNG and storage Operator experts to be included in the WG
- Comments on 1st Draft adressed, 2nd Draft was issued in December 2020 :
  - ✓ with a scope enlarged to LNG and Storage
  - ✓ with reference to the OGMP2.0 Frame Work (level 4)
- Final document to be proposed for formal vote next June, to be available 3rd Q 2021

Status CEN TC234/WG14 Methane (01-03-2021)

- 2nd working draft

- Two request that will require decisions from CEN/TC 234.

  - Title and scope: extend the title and scope from transmission and distribution to UGS and LNG terminals.
    - new title: Methodology for methane emissions quantification for gas transmission, distribution and storage systems and LNG terminals

    - New scope: This document describes a methodology to identify different types of methane emissions from the gas infrastructure and it explains, step by step, how to quantify each type of emission in a gas transmission, distribution and/or storage system and in an LNG terminal. Gas is considered any product with a high methane content that is in gaseous form inside the respective gas infrastructure (e.g. natural gas, biogas or mixtures thereof with each other or with hydrogen). Methane emission from utilisation, CNG/LNG fuelling stations, biomethane production and upgrading plants and LNG liquefaction and transport are not covered in this document, except if they are inside the covered asset (see Annex I on granularity).
  - Type of deliverable : CEN/TR to CEN/TS (we asked for a decision on the plenary meeting of 22nd April 2021)

OGMP 2.0 allows companies to categorize asset-level reporting by 5 categories

Level 1	**Venture/Asset Reporting** • Single, consolidated emissions number • Only applicable where company has very limited information sharing
Level 2	**Emissions Category** • Report emissions based on 5 IOGP emissions categories • Estimates based on emissions factors
Level 3	**Emission Source Level** • Emissions allocated to individual source types • Estimates based on emissions factors
Level 4	**Emission Source Level** • Emissions allocated to individual source types • Estimates based on specific EFs and direct measurement
Level 5	**Site Level** • Emissions allocated to individual source types • Reporting based on site-level measurements to reconcile source and site level emission estimates

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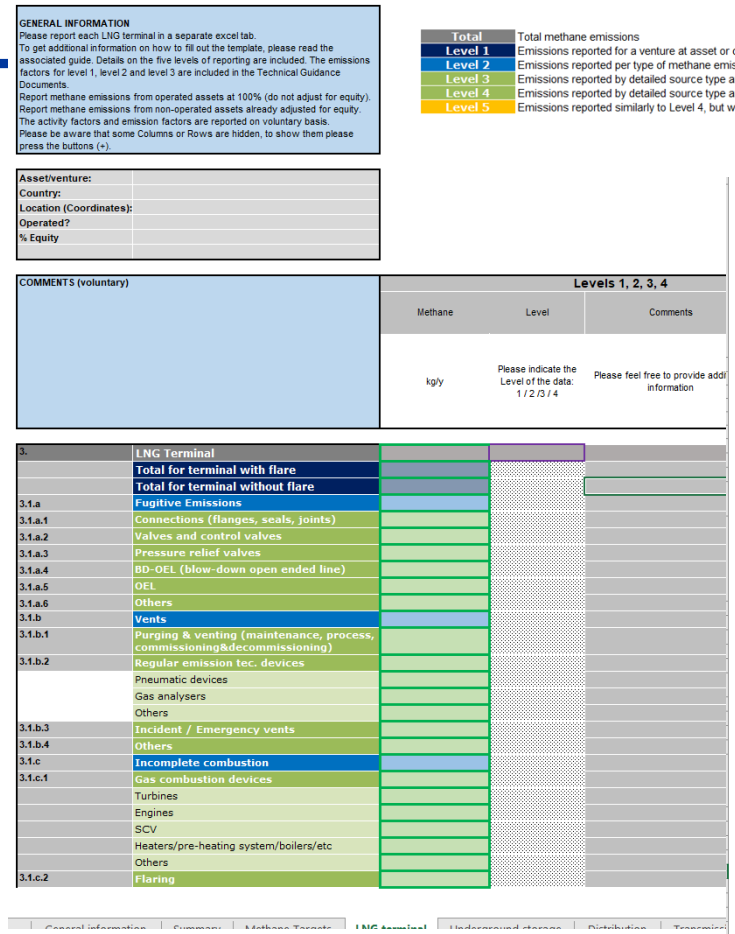
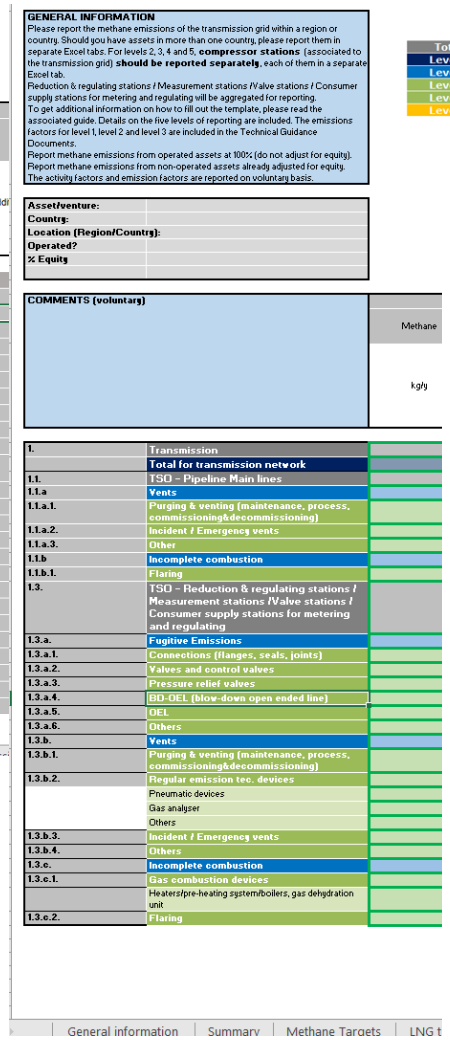
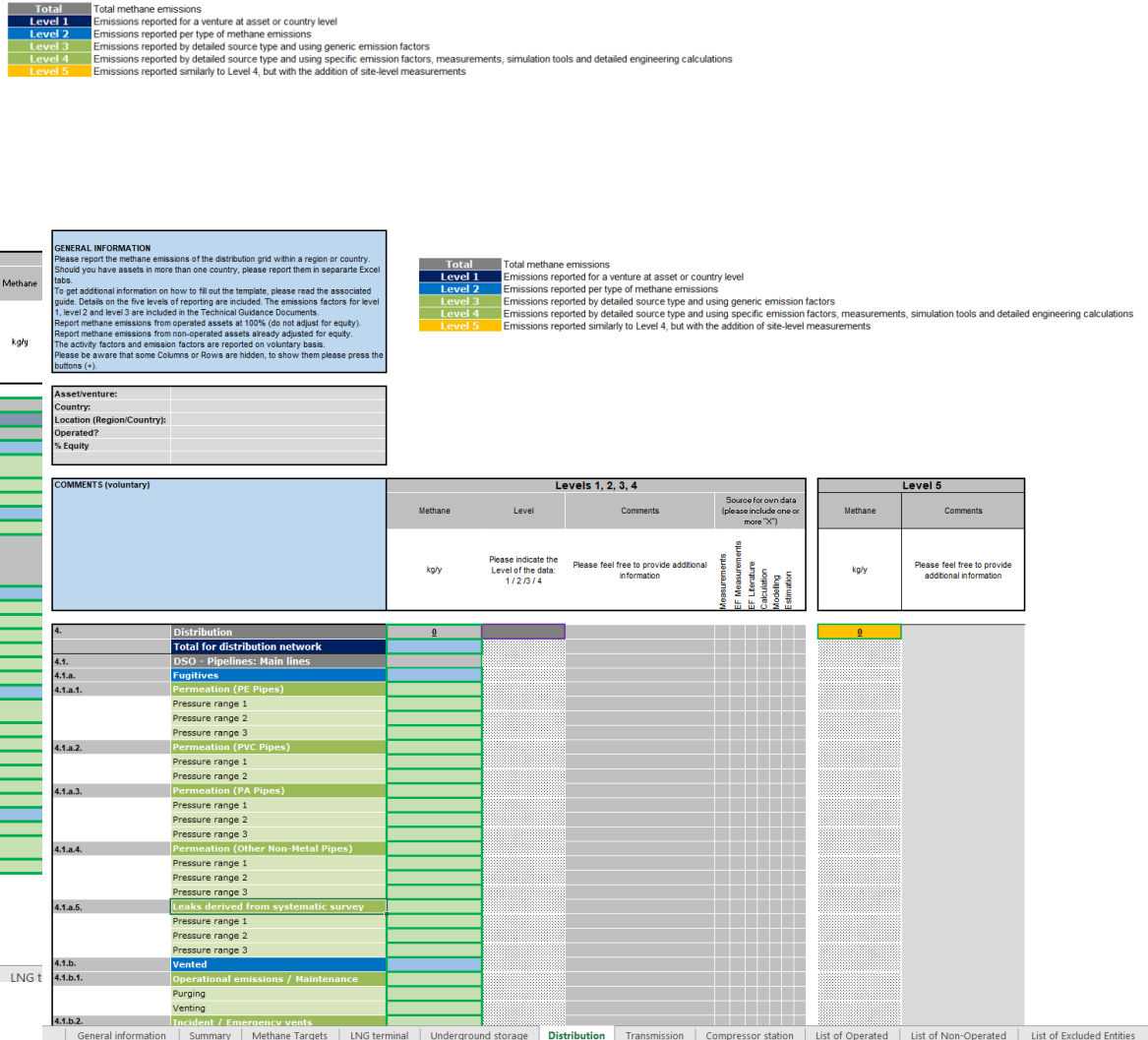
2nd draft CEN and OGMP template DSO,TSO,LNG UGS







2nd Draft
with scope enlarged to LNG and Storage
with reference to the OGMP2.0 Frame Work (level 4)

End of presentation.

Questions?