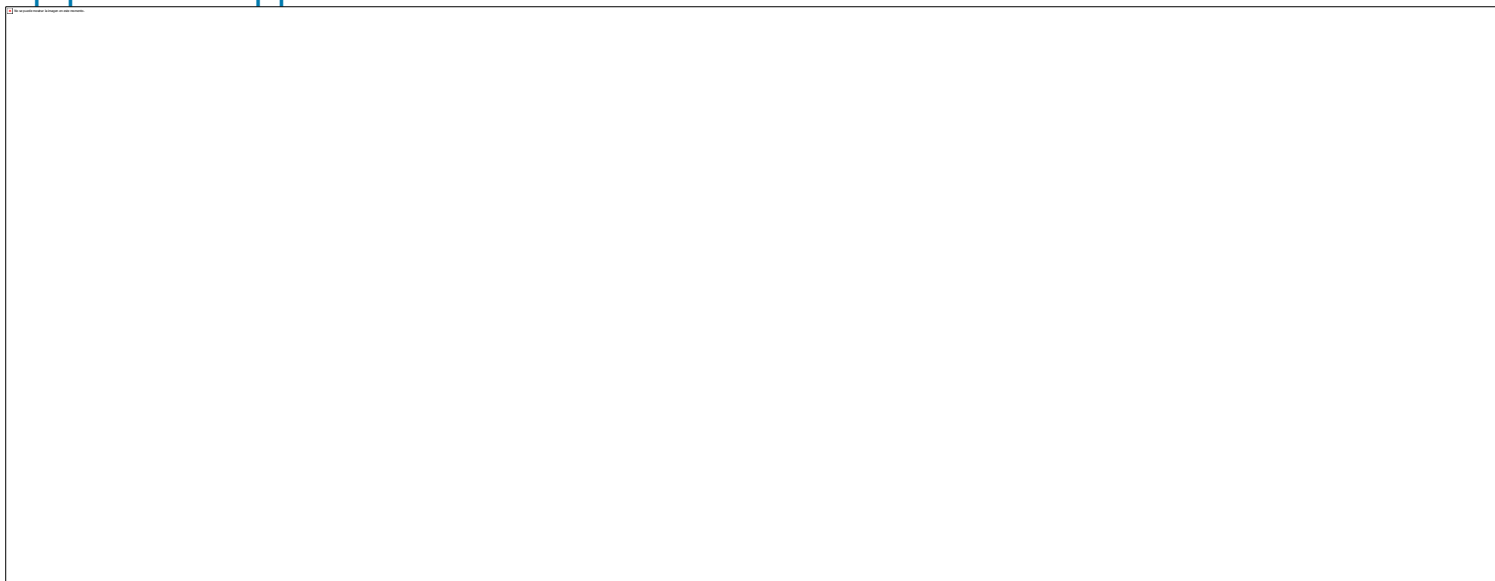


LNG TRUCKING *TECHNOLOGY AND MARKET.*

Fernando Impuesto Nogueras
Director of Commercial Operations and TPA.
January 12

0. GENERAL

Transporting LNG by road is a particularly useful alternative for supplying natural gas to sites where pipelines supplies are not available.



- ✓ **Industries:** that by the distance from the grids can not have natural gas in competition with other industries in the same activity as if they are connected, or those in which the natural gas technology represents an advantageous option.
- ✓ **Domestic distribution - commercial:** that advance gasification away from urban gas grid, and promote the development of gas infrastructure with lower levels of investment by connecting it by pipeline

0. GENERAL

In general terms, the possibility of distributing natural gas through satellite plants implies the availability of the following minimum:

- ✓ Having a LNG Terminal near
- ✓ Having a adequate land transport infrastructure
- ✓ Market needs that are consistent with the costs of LNG source and the necessary infrastructure to make a stable and efficient supply

Facilities

- + LNG Truck
- + LNG loading station
- + LNG satellite plant

Market

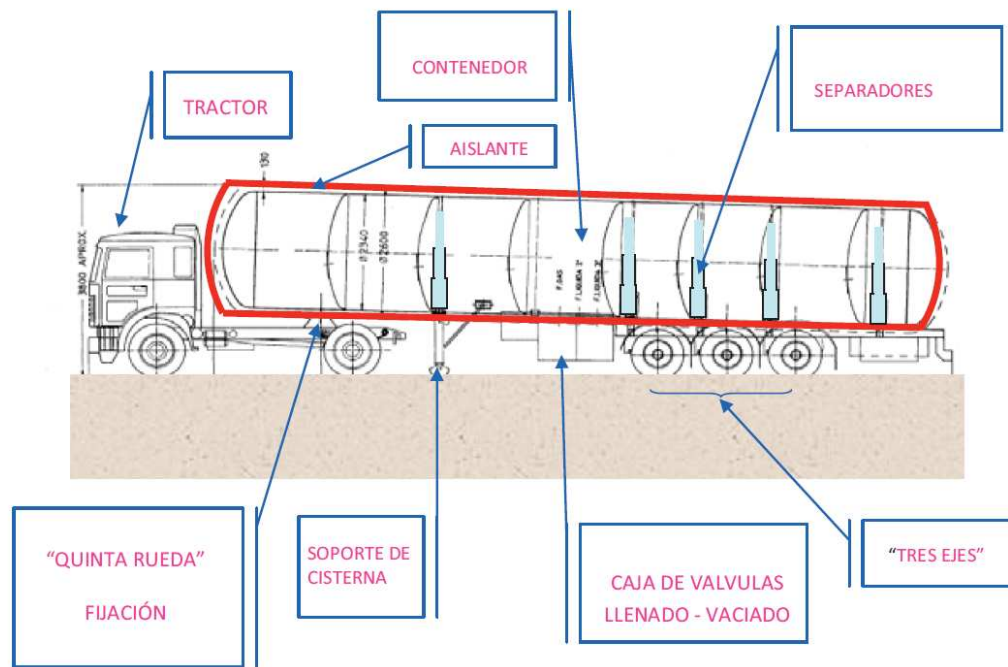
- + Players
- + Market

LNG TRUCKING TECHNOLOGY



1. FACILITIES: LNG TRUCK

- ✓ The truck can carry between 50 to 80 m³ of LNG depending on allowabel size of trucks in a specified country.
- ✓ These tanks are used for transportation of cryogenic liquids (N₂, O₂, ...) approved by the manufacturers for use with LNG.



- + Tractor empty weight: 11.2 tons
 - + Maximum Weight (Spain) 40 ton
 - + ADR as design pressure: 9.1 bar
 - + Maximum operating pressure: 7 barg
 - + Design temperature: ° C -198/50
 - + LNG Operating temperature: -160 ° C
- Trucks are expected to reach the terminal cold (less than -160 ° C)

LNG TRUCKING TECHNOLOGY

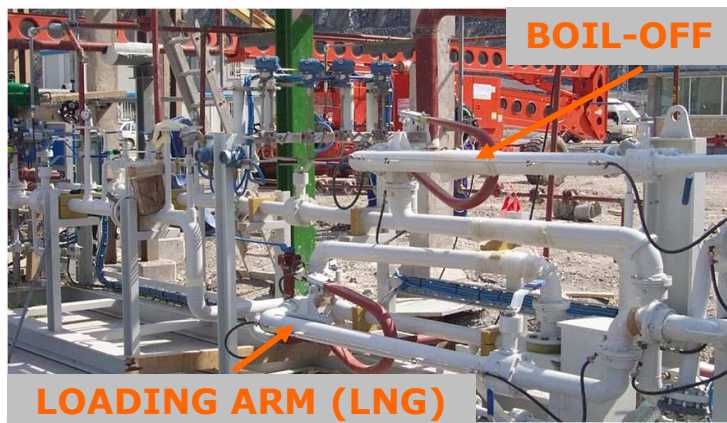


1. FACILITIES: LNG TRUCK

- ✓ The standard tank has a maximum capacity of 56 m³
- ✓ The maximum load of LNG is 47 m³ (84% of volume = approx. 22 tons) = 290,000 kWh
- ✓ Minimum capacity: for security reasons, the trucks must be kept cold with a remaining quantity of LNG to avoid excessive use of pressure relief valve due to an excessive increase in pressure inside the tank.



1. FACILITIES: LNG LOADING STATION

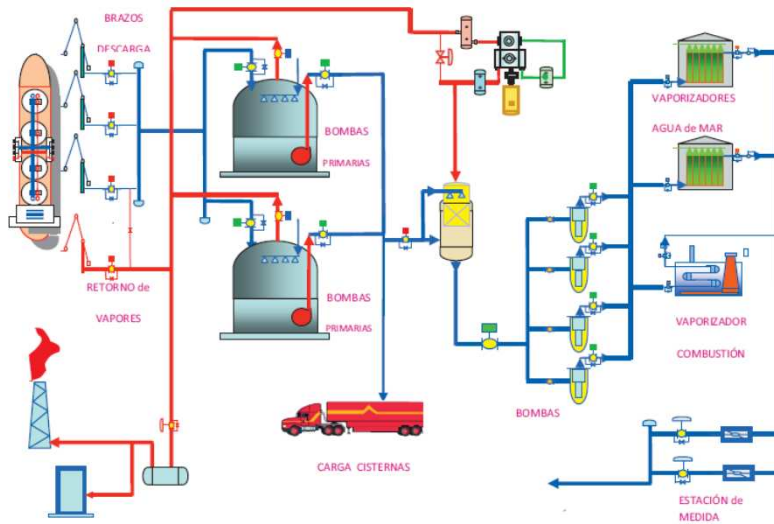


- ✓ Each filling station consists of:
 - Loading arm filling (LNG)
 - Vapor return lines
 - Weighbridge
 - Instrumentation:
 - flow measurement
 - computer system to weight and control (MONTREL)

LNG TRUCKING TECHNOLOGY



1. FACILITIES: LNG LOADING STATION



+ For send-out operation, two submerged in-tank pumps are installed. One pump is installed as a spare.

+ The pumps are installed in pump columns inside the tank and equipped with foot valves.

+ The send out lines to the truck filling station are permanently filled with LNG. A small circulation flow keeps the system at cryogenic temperatures.

+ The trucks are weighed prior to filling. Trucks are connected manually to the loading arm filling and vapor return lines.

+ The initial LNG into the "warm" tanks truck evaporates the resulting vapor returns to the storage tank. After cooling the truck tank, the filling rate increases to the maximum filling rate.

+ The flow meter stops the filling operation automatically via the automatic control valve at the loading station.

+ The truck leaves the plant via the weightbridge after disconnection from the loading arm.

1. FACILITIES: LNG LOADING STATION



- + The expected total time for filling a trailer is close to one hour, including time for connection and disconnection.

- + The actual filling time is 45 min, and 1 hour including signing of documents and safety procedures.

- + In Barcelona, Cartagena and Huelva Terminals capacity is designed to fill 50 trucks per day. The filling system consists of three filling stations in each terminal.



- + In operating conditions, two filling stations operate in parallel could fill more than fifty trailers every 24 hours.

- + Musel new terminal will have two loading station and capacity to fill 30 trucks per day.

1. FACILITIES: LNG LOADING STATION

✓ MONTREL is a Spanish company that has developed a system for automated control of filling station, this system is implemented in all the LNG terminals in Spain



The system responds to a complete solution for the different needs of the burden of LNG tankers on platform scales:

- + Import of online orders
- + Access Control, both the entry and exit, microwave identification of vehicles and people.
- + Checking compliance with all requirements and permits needed to transport
- + Automatic load control, monitoring the security levels required for the process.
- + Inclusion of actual data on the characteristics of the product through chromatographs.
- + Preparation of all documentation required for transport under ADR.
- + Export telematics actual data of each load, for billing and other treatment processes.

1. FACILITIES: LNG SATELLITE PLANT



A typical installation consists of:

- + Download tanks LNG storage tank + vertical or horizontal of Either configuration
- + Vaporizer - ambient or hot-water type type
- + Regulating the output pressure and odorization
- + Monitoring and recording parameters
- + Fire prevention and safety
- + Other: civil works, lighting, etc..

1. FACILITIES: LNG SATELLITE PLANT



LNG Storage tank:

Deposits jacketed metal, the stainless steel inner and outer carbon steel with an intermediate space in which a vacuum has been made and is filled with perlite.

+ Capacity between 60 m³ and 250 m³

+ Working pressure 5 barg

+ Design temperature: -196 ° C

+ Temperature: -162/-135 ° C

1. FACILITIES: LNG SATELLITE PLANT



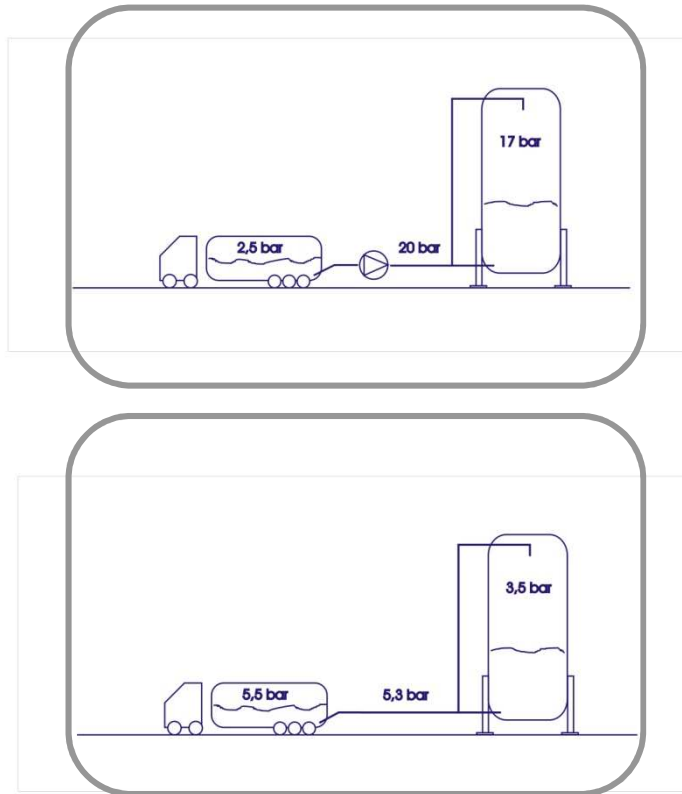
Vaporizers:

Ambient air vaporizers use heat transferred from ambient air to sub-cooled liquid. This process does not require the addition of other heat energy and hence, its operation is inexpensive.



Hot-water vaporizers use the energy exchange between hot water and the sub-cooled liquid. The water is typically heated by a gas-fired burner which consumes about 2% of the available natural gas for this activity. This type of vaporizers are thus more costly to operate, but may be required in when atmospheric conditions are severe.

1. FACILITIES: LNG SATELLITE PLANT



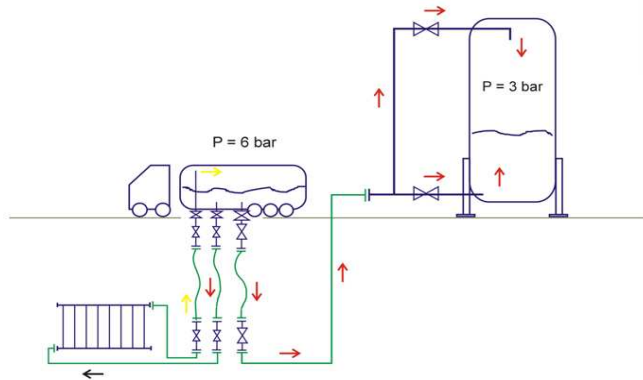
There are two main options to pump LNG from the truck to the tank.

1. By increasing the pressure in the tank of the truck
2. By pumping

The first option, to increase the pressure in the LNG tank of the truck, is slower but requires less equipment on the truck.

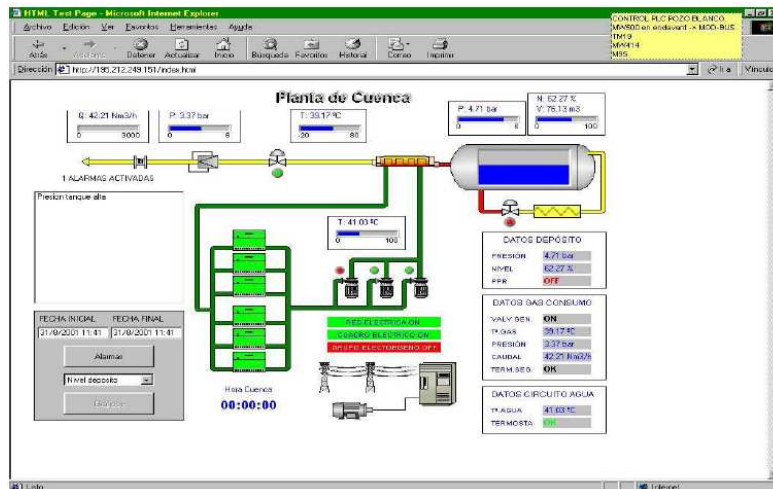
Pumping of LNG could be made with rather high transfer rate, though a typical hose size for LNG trucks is two to three inches.

1. FACILITIES: LNG SATELLITE PLANT



Download Procedure:

- + Connection to ground tank
- + Discharge hose connection
- + Balancing tanks and tank pressure (optional)
- + Pressurize the tank
- + LNG tank filled
- + Depressurization of the tank
- + Disconnect discharge hose
- + Disconnect ground clamp



120 m3 tank discharge data:

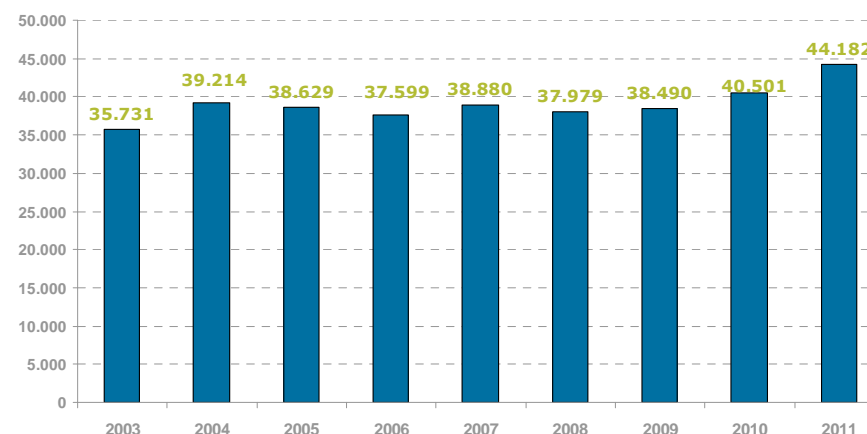
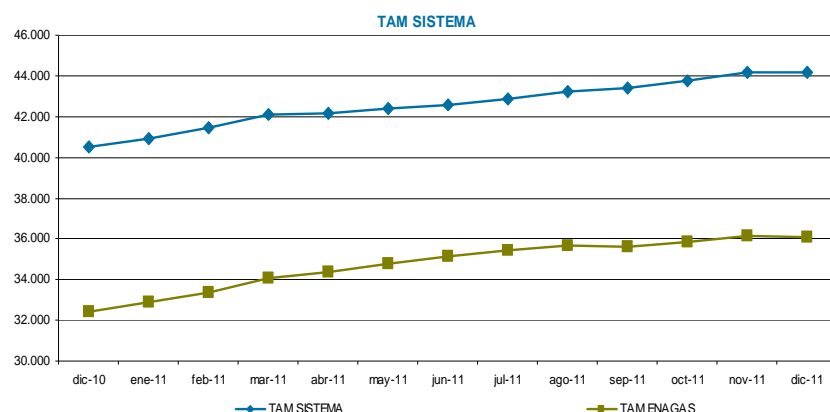
- + Download Total time: 1h 35 min
- + Tank filling time: 60 min
- + Initial tank pressure / minimum / final: 3.31 / 2.51 / 2.73 barg
- + Average flow discharge: 47 m³ / h

LNG TANK TRUCKS MARKET



3. MARKET: SPANISH SYSTEM.

✓ During the year **2011** has been **record-breaking** load of tanks in the Spanish gas system with a value of **44,182 tanks**, **82% were loads ENAGAS terminals**.



Market data in 2011:

**100 % Market
(44.182 LNG trucks)**

**82% ENAGAS
(36.075 LNG trucks)**

**18% OTHERS
(8.107 LNG trucks)**

**29% Barcelona
(10.511 LNG Trucks)**

**28% Cartagena
(10.102 LNG Trucks)**

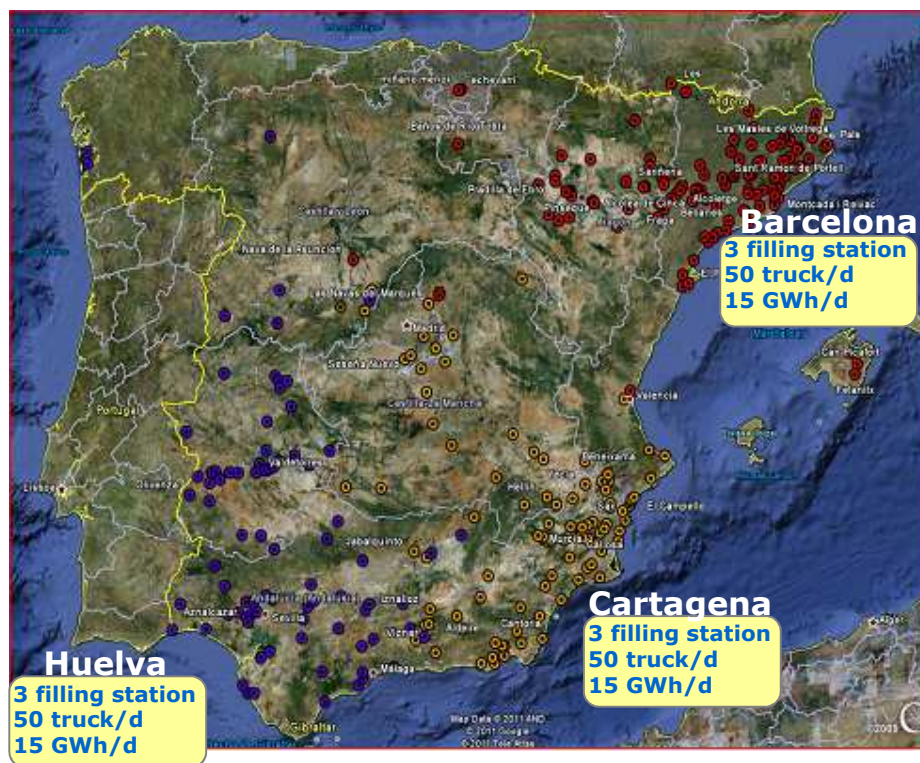
**43% Huelva
(15.462 LNG Trucks)**

LNG TANK TRUCKS MARKET



3. MARKET: ENAGAS

✓ Since Enagas terminals supplied a total of 388 LNG satellite plants



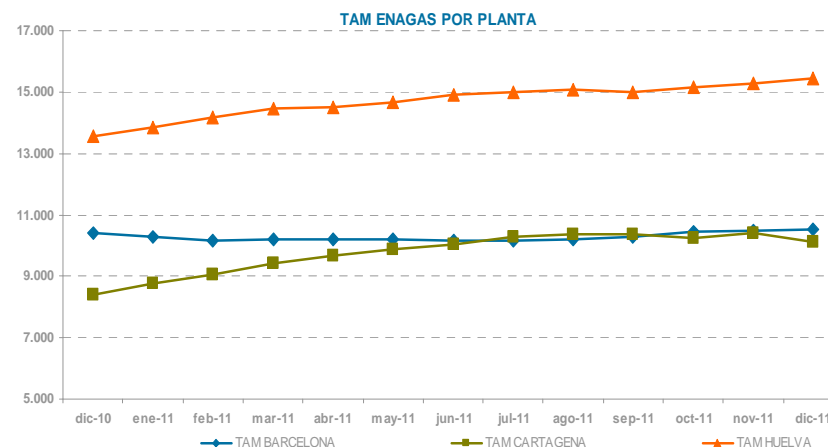
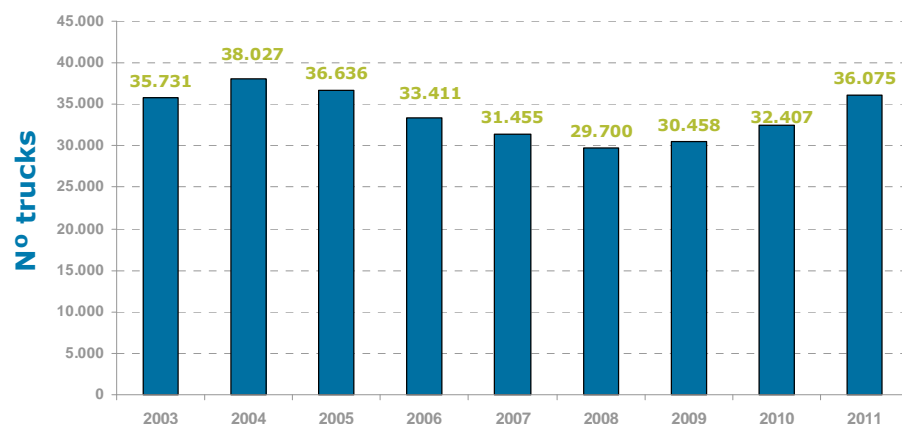
- BARCELONA Terminal: 128 LNG satellite plants
- CARTAGENA Terminal: 138 LNG satellite plants
- HUELVA Terminal: 122 LNG satellite plants

LNG TANK TRUCKS MARKET



3. MARKET: ENAGAS

✓ Since Enagas terminals supplied a total of 388 LNG satellite plants



Year 2011 = 36.075 trucks = 10.878 GWh = 12 LNG SHIPS

**100 % Market
(388 plants)**

**92% Industrial
(345 plants)**

**8% Distribution
(43 plants)**

**50% Cogeneration
(39 Plants)**

**15% Solar Thermal Power
(21 Plants)**

**45% Other
(285 Plants)**

LNG TANK TRUCKS MARKET

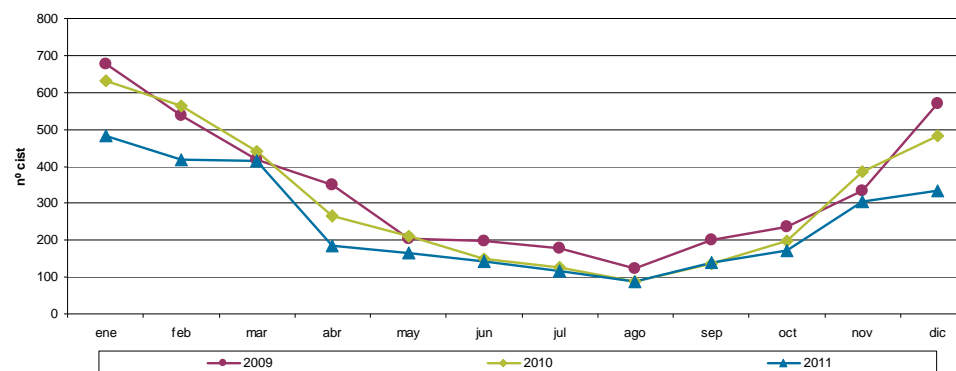


3. MARKET: DISTRIBUTION

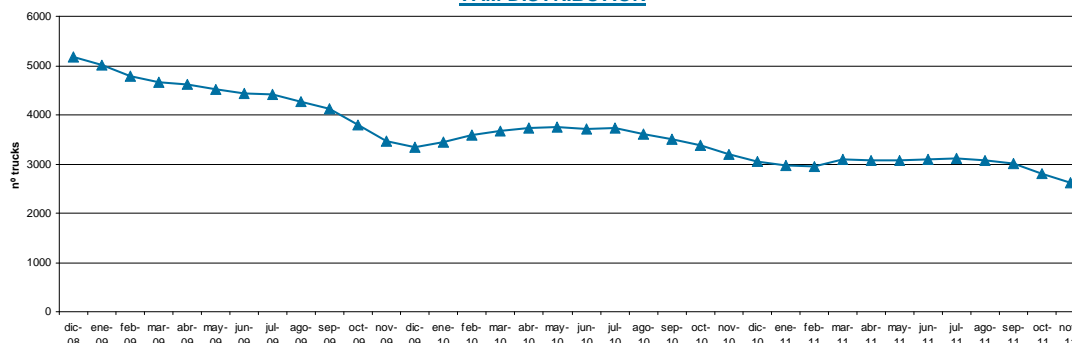
- ✓ Domestic distribution - commercial: that advance gasification away from urban gas grid, and promote the development of gas infrastructure with lower levels of investment by connecting it by pipeline

nº cist	DISTRIBUIDORAS			
	2008	2009	2010	2011
ene	976	678	631	483
feb	832	539	563	419
mar	772	418	439	413
abr	540	351	265	184
may	386	205	211	165
jun	319	196	149	141
jul	270	178	126	116
ago	206	123	89	88
sep	271	201	135	139
oct	331	238	197	172
nov	564	332	387	306
dic	676	569	481	334
TOTAL	6.143	4.028	3.673	2.960
GWh	1.843	1.208	1.102	888

DISTRIBUTION



TAM DISTRIBUTION



This type of consumption has a greater seasonality, higher consumption in winter and lower in summer

Decreased distribution market supplied by LNG trucks due to the development of new gas grid.

3. MARKET: DISTRIBUTION



- BARCELONA: 14 LNG Plants : 184 trucks/year
- CARTAGENA: 22 LNG Plants: 1.397 trucks/year
- HUELVA: 16 LNG Plants: 1.379 trucks/year

✓ Due to the high development of the gas network in Catalonia, the Barcelona plant is the plant that makes fewer loads for this market.

✓ Only 184 tanks, 2% of total loaded tanks.

✓ The Cartagena and Huelva plants have a very similar load level, around the 1,400 tankers years in Cartagena plant represents 14% of total loaded tanks, while in the Huelva plant 9%

Note the high consumption in some cities

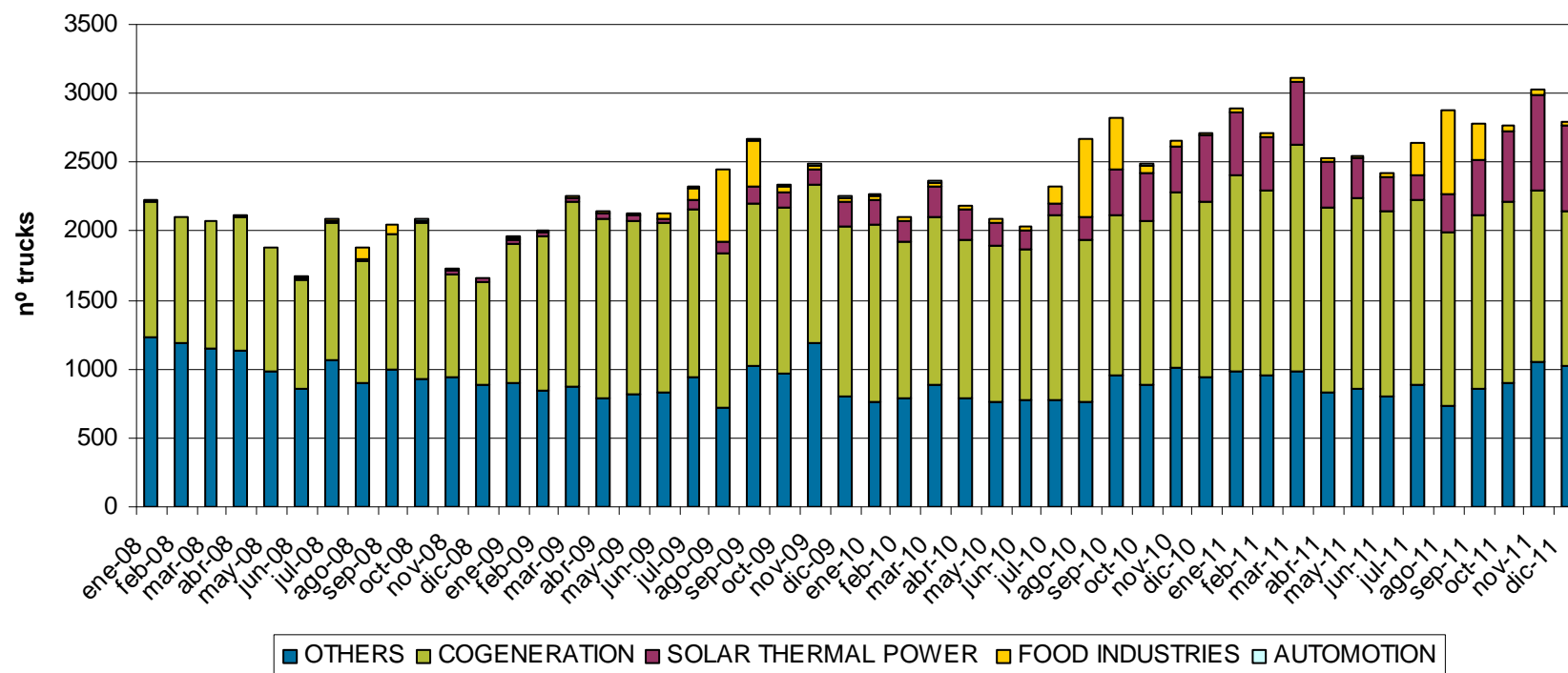
- **Ávila:** 839 trucks/year
- **Cádiz:** 307 trucks/year
- **Almería:** 187 trucks/year

LNG TANK TRUCKS MARKET



3. MARKET: INDUSTRIAL

INDUSTRIAL MARKET



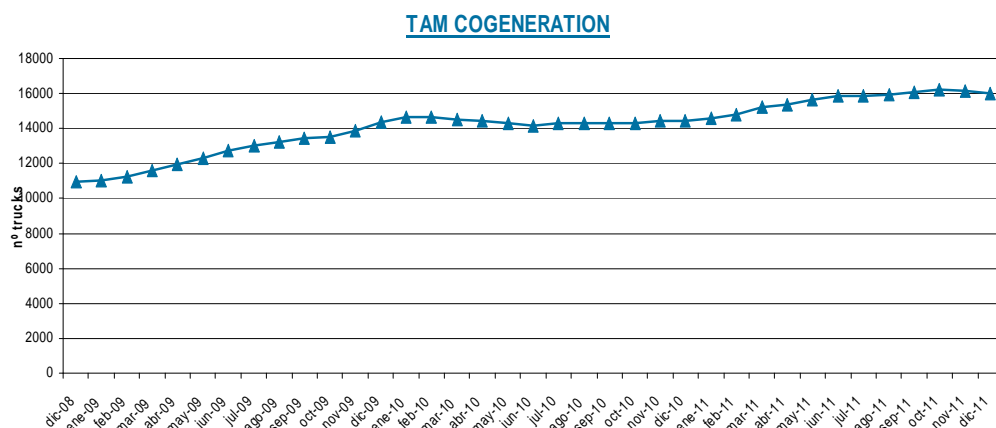
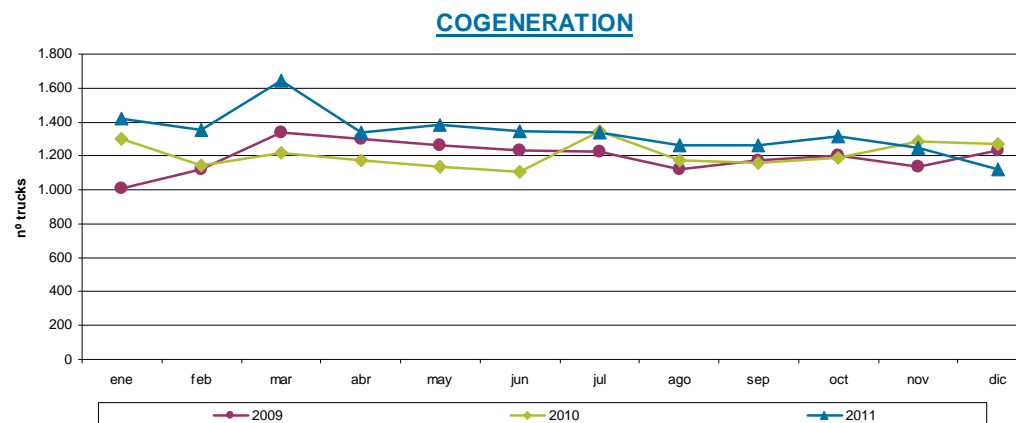
✓ It keeps track of 4 industrial markets to highlight their influence on the loading racks supplied from Enagas terminals.

LNG TANK TRUCKS MARKET



3. INDUSTRIAL MARKET: COGENERATION

nº trucks	COGENERATION			
	2008	2009	2010	2011
ene	993	1.007	1.296	1.418
feb	916	1.122	1.140	1.349
mar	933	1.340	1.215	1.644
abr	963	1.296	1.174	1.335
may	892	1.264	1.132	1.384
jun	790	1.231	1.103	1.348
jul	1.003	1.226	1.341	1.338
ago	887	1.122	1.172	1.261
sep	978	1.171	1.157	1.262
oct	1.134	1.203	1.188	1.311
nov	748	1.139	1.281	1.245
dic	753	1.236	1.267	1.117
TOTAL	10.990	14.357	14.466	16.012
GWh	3.297	4.307	4.340	4.804



This market has a very flat profile throughout the year

Satellite plants that supply cogeneration processes account for 50% of total charges made for the industrial market

LNG TANK TRUCKS MARKET



3. INDUSTRIAL MARKET: COGENERATION



● BARCELONA

● CARTAGENA

● HUELVA

✓ This market is divided between the three plants.

✓ The highest consumption is concentrated in Cataluña and Andalucía.

✓ Other destinations cogeneration 5 loaded more than 1,000 tanks located 2 in Lleida and Barcelona 1(plants to reduce the environmental impact of the pork livestock and generate electricity) and 1 in Jaén (plant to reduce the environmental impact of olive waste and generate electricity)

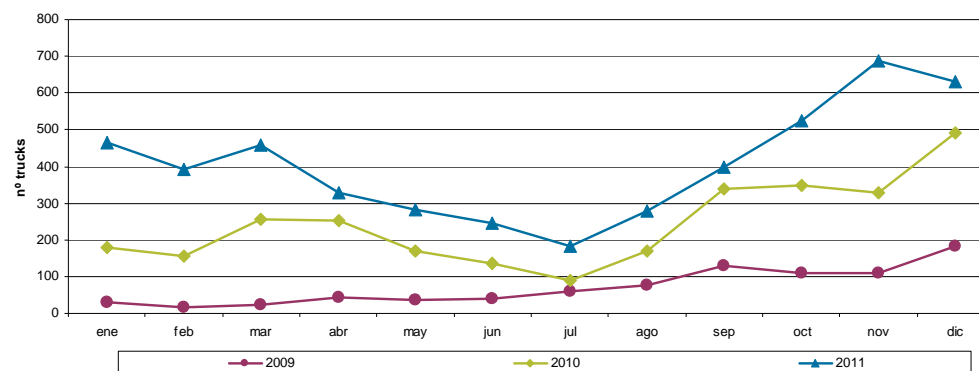
LNG TANK TRUCKS MARKET



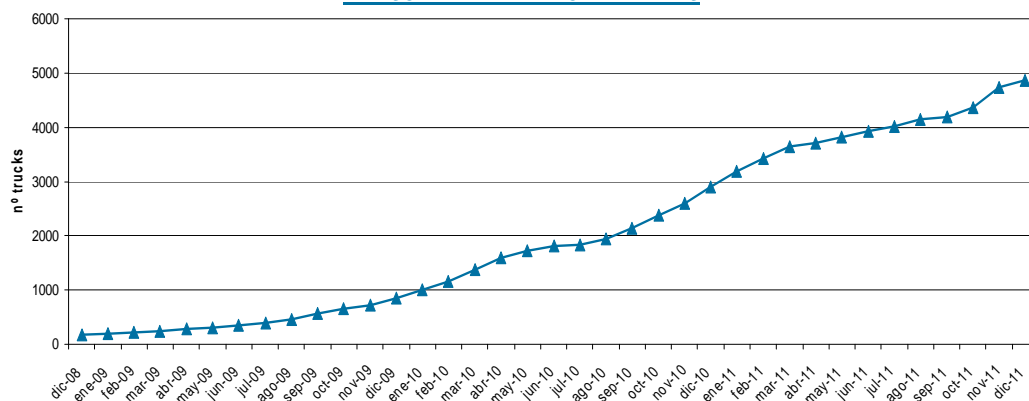
3. INDUSTRIAL MARKET: SOLAR THERMAL POWER PLANTS

nº cist	SOLAR THERMAL POWER PLANTS			
	2008	2009	2010	2011
ene	0	29	180	464
feb	0	15	155	393
mar	0	24	254	459
abr	3	43	252	327
may	0	36	168	282
jun	4	39	135	244
jul	7	61	90	183
ago	4	75	169	279
sep	11	131	338	398
oct	15	110	348	523
nov	18	111	328	686
dic	24	181	490	630
TOTAL	86	855	2.907	4.868
GWh	26	257	872	1.460

SOLAR THERMAL POWER PLANTS



TAM SOLAR THERMAL POWER PLANTS



✓ The market for LNG tanks to supply solar thermal plants is the fastest growing. Over the last few years, reaching 4,900 in 2011 loaded tanks.

✓ In solar thermal plants use the gas to keep warm thermal fluids used in the process of heat exchange.

LNG TANK TRUCKS MARKET



3. INDUSTRIAL MARKET: SOLAR THERMAL POWER PLANTS



✓ This market is concentrated in Andalucía and Extremadura.

✓ Most of the plants are supplied from the Huelva plant, where this market represents one third of the charges made.

✓ Sanlúcar la Mayor in a town near Seville are 5 satellite plants, consuming more than 1000 tanks/year.

● DESTINOS DE BARCELONA ● DESTINOS DE CARTAGENA ● DESTINOS DE HUELVA

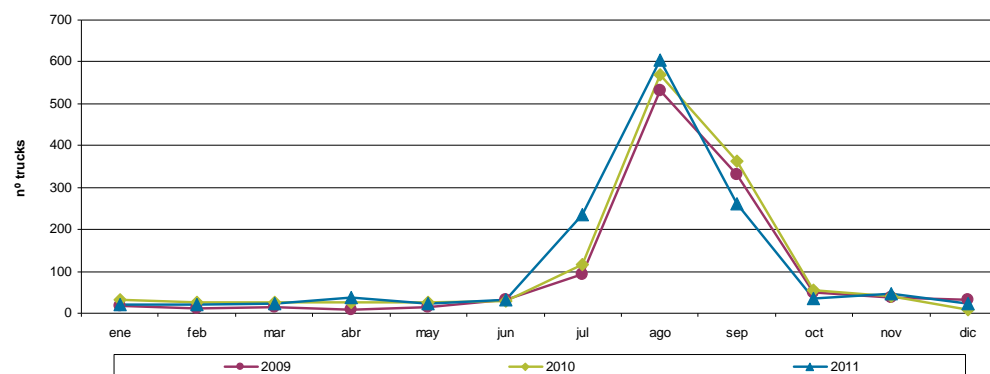
LNG TANK TRUCKS MARKET



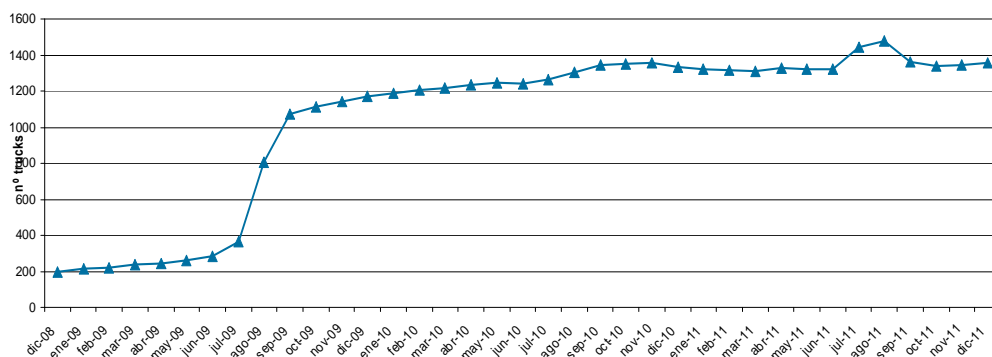
3. INDUSTRIAL MARKET: FOOD INDUSTRIES

nº trucks	FOOD INDUSTRIES			
	2008	2009	2010	2011
ene	0	16	31	19
feb	0	11	26	20
mar	1	14	26	23
abr	0	9	26	38
may	0	15	26	24
jun	6	31	29	31
jul	16	94	116	235
ago	87	531	568	605
sep	64	332	362	261
oct	10	50	56	34
nov	9	38	42	47
dic	3	32	9	22
TOTAL	196	1.173	1.317	1.359
GWh	59	352	395	408

FOOD INDUSTRIES



TAM FOOD INDUSTRIES



✓ Some food industries (vegetables) have a high seasonal consumption during the summer months (July, August and September).

3. INDUSTRIAL MARKET: FOOD INDUSTRIES



● DESTINOS DE BARCELONA ● DESTINOS DE CARTAGENA ● DESTINOS DE HUELVA

✓ The whole market is supplied from the Huelva plant.

✓ Most destinations are located in Extremadura, highlighting 3 destinations Miajadas (Cáceres) and 2 in Santa Amalia (Badajoz)

✓ Its use is concentrated in the months of July, August and September.

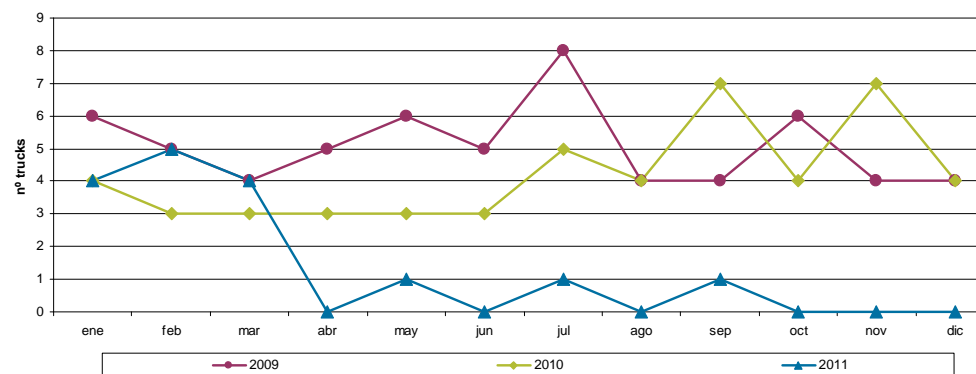
LNG TANK TRUCKS MARKET



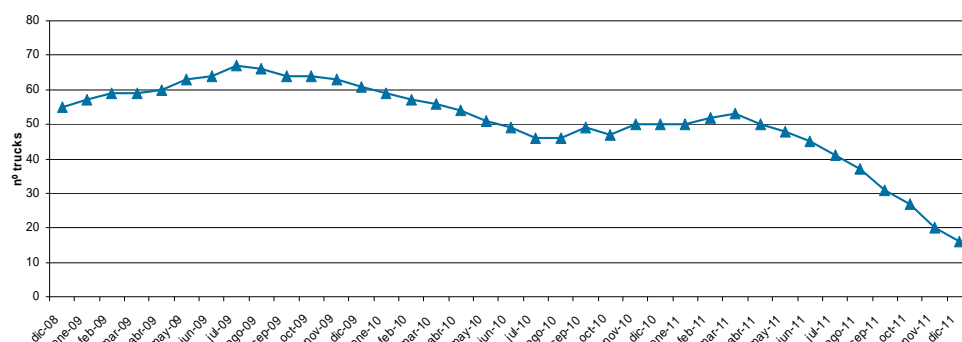
3. INDUSTRIAL: LNG FUELLING STATION

nº trucks	LNG FUELLING STATION			
	2008	2009	2010	2011
ene	4	6	4	4
feb	3	5	3	5
mar	4	4	3	4
abr	4	5	3	0
may	3	6	3	1
jun	4	5	3	0
jul	5	8	5	1
ago	5	4	4	0
sep	6	4	7	1
oct	6	6	4	0
nov	5	4	7	0
dic	6	4	4	0
TOTAL	55	61	50	16
GWh	11	13	2	2

LNG FUELLING STATION



TAM LNG FUELLING STATION

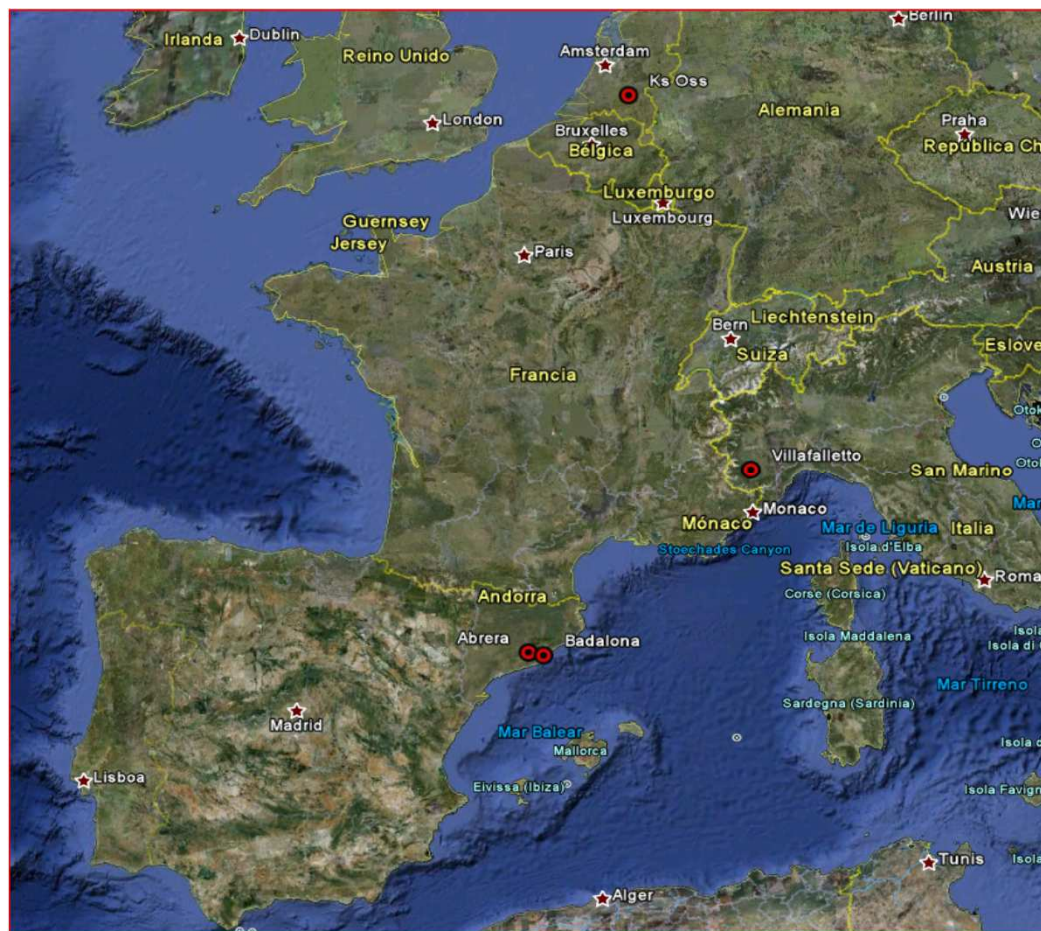


✓ The use of natural gas as fuel has resulted in the development of new markets for LNG. By LNG trucks can deliver these new stations

LNG TANK TRUCKS MARKET



3. INDUSTRIAL MARKET: FUELLING STATION



● DESTINOS DE BARCELONA

✓ This market is supplied entirely from Barcelona.

✓ During 2010 there have been two high international destinations, one for the Netherlands and one for Italy.

3. INDUSTRIAL MARKET: FUELLING STATION

LNG + L-CNG STATION



✓ Natural gas is also finding increased usage as an alternative vehicle fuel. The impetus for this application is improved environmental ecology.

✓ The use as vehicle fuel has been known for several years and mainly as compressed gas (CNG). However, improvements in on-board LNG storage vessels and vaporizer systems have opened new opportunities for the use of liquid and also offered advantages enhanced safety and vehicle travel range.

Source: RosRoca

✓ LNG is use more for large distribution fleets, buses and garbage trucks. Filling station can be equipped to dispense both LNG and CNG, thus improving their effectiveness.

3. INDUSTRIAL MARKET: BUNKERING

BUNKERING



Source: Gasnor

- ✓ Today there are several ships operating with LNG as fuel, and there are constructed several LNG terminal with the purpose of supplying ships with this fuel.
- ✓ LNG can be transported either by small LNG ships or by truck from regional LNG production and/or storage terminals.
- ✓ LNG can be store at a smaller buffer tank dedicated for the ship in question, and that this buffer tank is supplied with truck from the main terminal