



#### **LOGISTICS & MARITIME FORUM**

European trends and regional perspectives

15-16 February 2017, Piacenza Expo

#### **ELECTRIC SHORE POWER or LNG**

to improve the quality of air in the port of Civitavecchia

Ing. Calogero Giuseppe BURGIO AdSP Mare Tirreno Centro Settentrionale Environmental & Energy Office, Director

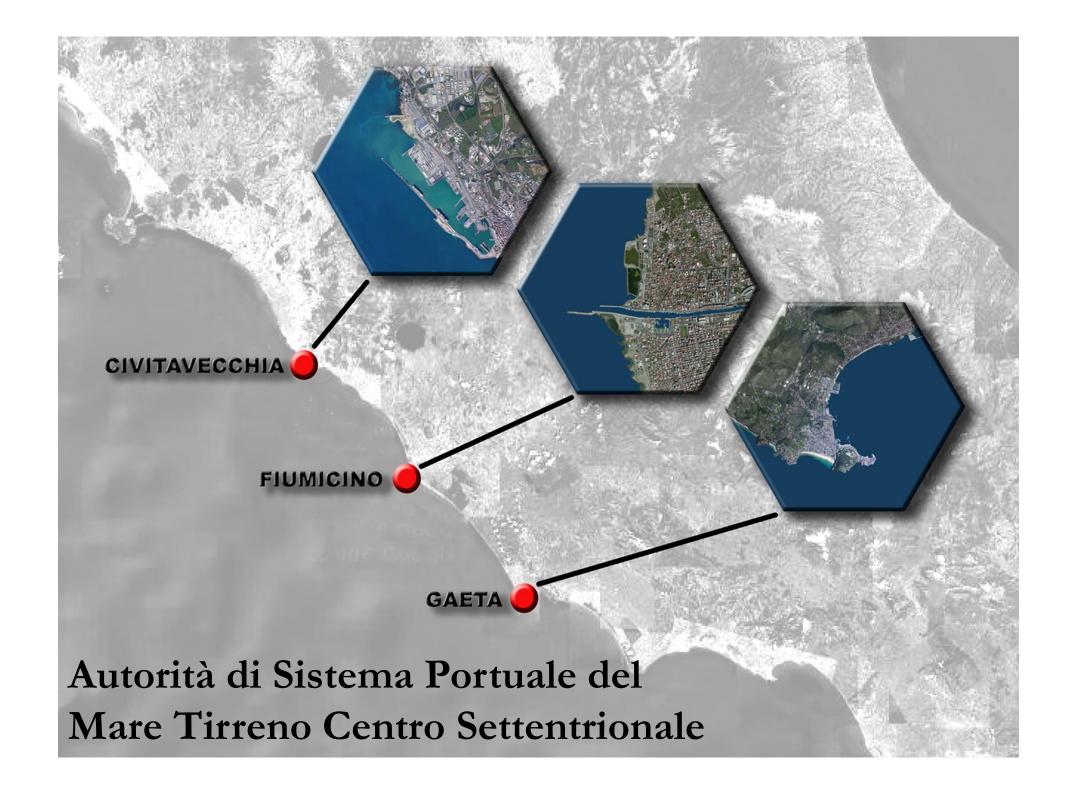
#### **ELECTRIC SHORE POWER or LNG**



AdSP del Mare Tirreno Centro Settentrionale has decided its energetic policy according with the three pillars of sustainability.

This consists of at least the economic, social, and environmental pillars. If any one pillar is weak then the system as a whole is unsustainable.

The investigation started on 2005 and it is continuously updated.







## Regulatory Framework on the deployment of alternative fuels infrastructure

#### Law 84/1994 Article 4bis

#### **Energetic Sustainability**

The planning of the port system must be respectful of energy and environmental sustainability criteria, consistent with the policies promoted by current EU directives.

The energetic/environmental planning document identifies actions to be implemented in order to attain objectives sighted, giving account for each of the prior assessment of technical and economic feasibility, including through CBA.



#### Legislative Decree 257/2016Article 4 - p. 7

## DIRECTIVE 2014/94/EU Article 4 - p. 5

#### **ELECTRIC SHORE POWER**

Member States shall ensure that the need for shore-side electricity supply for inland waterway vessels and seagoing ships in maritime and inland ports is assessed in their national policy frameworks.

Such shore-side electricity supply shall be installed as a priority in ports of the TEN-T Core Network, and in other ports, by 31 December 2025, unless there is no demand and the costs are disproportionate to the benefits, including environmental benefits.





#### Legislative Decree 257/2016 Article 6 – p. 1

## DIRECTIVE 2014/94/EU Article 6 - p. 1

#### LIQUEFIED NATURAL GAS

Member States shall ensure, by means of their national policy frameworks, that an appropriate number of refuelling points for LNG are put in place at maritime ports, to enable LNG inland waterway vessels or seagoing ships to circulate throughout the TEN-T Core Network by 31 December 2025.

Member States shall cooperate with neighbouring Member States where necessary to ensure adequate coverage of the TEN-T Core Network.





# VESSELS ENERGY NEEDS in Civitavecchia

## CALLS DATABASE (Harbour Master)

TIME AT BERTH
AND
MANOUVRING
TIME
(Harbour Master)



## SHIP TECHNICAL DATA

(On board interview by Port Authority)

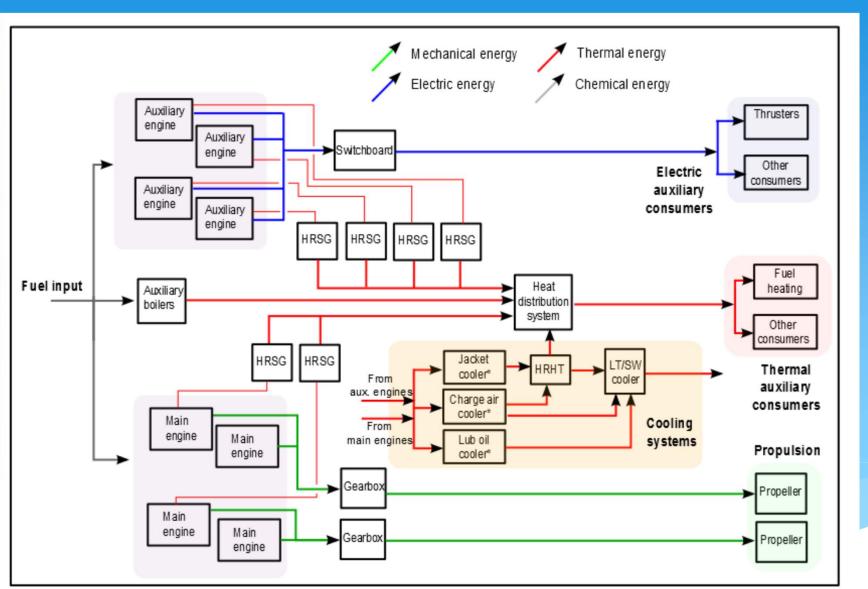
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ABSORBED POWER

(manouvring/hotelling)

ENERGY NEEDS

### schematic representation of ship energy systems



### average electricity need of FERRIES

Calls	(2013-2015)	Manouvring (2.5% S)	Hotelling (2.5-0.1% S)	Hotelling (0.1% S)	Total
Reliability	Time at berth (h)	Energy (kWh/y)	Energy (kWh/y)	Energy (kWh/y)	Energy (kWh/y)
Census	45.591	9.631.041	4.342.417	16.982.315	30.955.773
Sister	127	320.023	110.149	15.692	445.864
Estimated	2.053	742.470	480.521	1.022.599	2.245.589

#### ENERGY NEEDS RESUME (P<sub>Man</sub>=14.763kW - P<sub>Hot</sub>=1.365kW)

Calls	Hotelling (h/call)	Manouvring (kWh/call)	Hotelling (kWh/call)	Hotelling (kWh/call)	Total(kWh/call)
4.281	11h 10min	7.381	3.413	12.446	23.240

Average time to land and depart from the port is set 30 min Average time to switch from RO to MGO, and vice versa is set 2h30min

### average electricity need of CRUISES

Calls	(2013-2015)	Manouvring (2.5% S)	Hotelling (2.5-0.1% S)	Hotelling (0.1% S)	Total
Reliability	Time at berth (h)	Energy (kWh/y)	Energy (kWh/y)	Energy (kWh/y)	Energy (kWh/y)
Census	28.674	5.792.202	10.431.664	42.837.519	59.061.385
Sister	2.090	576.291	1.030.047	4.627.462	6.233.800
Estimated	2.911	499.312	902.458	3.489.852	4.891.623

#### ENERGY NEEDS RESUME (P<sub>Man</sub>=10.180kW - P<sub>Hot</sub>=5.499kW)

Calls	Hotelling (h/call)	Manouvring (kWh/call)	Hotelling (kWh/call)	Hotelling (kWh/call)	Total(kWh/call)
2.581	13h 03min	7.635	13.748	56.519	77.901

Average time to land and depart from the port is set 45 min Average time to switch from RO to MGO, and vice versa is set 2h30min

### average electricity need of CARGOES

Calls	(2013-2015)	Manouvring (2.5% S)	Hotelling (2.5-0.1% S)	Hotelling (0.1% S)	Total
Reliability	Time at berth (h)	Energy (kWh/y)	Energy (kWh/y)	Energy (kWh/y)	Energy (kWh/y)
Census	27.677	471.216	293.646	3.797.660	4.562.522
Sister	1.532	68.650	47.026	287.119	402.795
Estimated	57.316	587.875	305.945	5.985.785	6.879.605

#### ENERGY NEEDS RESUME (P<sub>Man</sub>=3.401kW - P<sub>Hot</sub>=390kW)

Calls	Hotelling (h/call)	Manouvring (kWh/call)	Hotelling (kWh/call)	Hotelling (kWh/call)	Total(kWh/call)
1.821	47h 31min	1.700	975	10.940	13.615

Average time to land and depart from the port is set 30 min Average time to switch from RO to MGO, and vice versa is set 2h30min

## average thermal energy need (boilers)

Some of the thermal energy need of ships (about 30% of the total energy need of vessels) is recovered by heat recovery devices. By utilizing heat of exhaust gases, for cruise and ferry vessels the amount of energy needed by the auxiliary boilers is about 7% of total energy need of the ship (for some tankers more, we consider for cargoes calling Civitavecchia equal to 10%).

In port stay mode this percentage is over 10%.

Ship	Manouvring (1.5/2.5%)	Hotelling (1.5/2.5-0.1%)	Hotelling (0.1%)	Sub-tot
Ferry	748.547	493.309	1.802.061	3.043.917
Cruise	480.746	1.236.417	5.095.483	6.812.647
Cargo	112.774	64.662	1.007.056	1.184.492
TOT	1.342.068	1.794.387	7.904.600	11.041.056

#### AVERAGE ANNUAL ENERGY NEEDS

(electricity and heat – large vessels)

Average annual energy needs of the ships calling Civitavecchia (referred to the period 01.01.2013 – 31.12.2015) are reported below.

Ship	Manouvring (1.5/2.5%)	Hotelling (1.5/2.5-0.1%)	Hotelling (0.1%)	Sub-tot
Ferry	10.693.534	4.933.087	18.020.605	33.647.226
Cruise	6.867.806	12.364.169	50.954.833	70.186.808
Cargo	1.127.742	646.617	10.070.564	11.844.923
Boilers	1.342.068	1.794.387	7.904.600	11.041.056
TOT	20.031.150	19.738.260	86.950.602	126.720.013

#### ANNUAL ENERGY NEEDS (2015)

# Calling ships Activity (kWh) Cruise 66.958.771 Ferry 34.709.654 Cargo 8.145.297 TOT 109.813.722

Resident ships		
Activity	(kWh)	
Tugs	1.587.505	
Barges	259.510	
Fisher-boats	374.431	
TOT	2.221.446	

The annual energy need of the port of Civitavecchia was about 137GWh.

Vehicles			
Activity	(kWh)		
Cruise	716.410		
Ferry	1.409.798		
Cargo	8.336.274		
Public transport	166.870		
Service vehicles	10.003		
Private vehicles	621.600		
TOT	11.260.955		

Buildi	ings
Activity	(kWh)
Yards	303.615
Cruise	5.763.810
Ferry	339.502
Cargo	53.343
Fisher-market	150.454
Services	6.986.179
TOT	13.966.930



#### QUALITY OF AIR IN CIVITAVECCHIA

(2013 - 2015)

ARPA LAZIO - Roma Agenzia Regionale per la Protezione Ambienta				atidi QUALI alle ore 01 A		31/12/20	
	CO mg/m3 293K Media M. 8 h Max	Q3 ugim3 293K Cmax Oraria	NO2 ugim3 293K Cmax Oraria	NO2 ug/m3 293K Num ore sup	PM10 ug/m3 Cmed 24 h	PM10 ug/m3 Num glorni sup anno	BENZENE ugim3 293K Media M. Annua §
D Lgs 1308/10 n.155 (Sogia Informazione		180					
D.Lgs 13/08/10 n.155 Sogla Alarme		240					
Limite + Tolleranza D.Lgs 13/06/10 n.155 n. max sup. Consentiti	10		200	200	50	50 35	5
010 Colleferro	0.9	19	45		33	28	
011 Colleferro	ore: 11	ore: 14	ore: 11		59.	See	
014 Allumiere		8	ore: 19		6	0	
015 Civitavecchia	0.5	ore: 20	ore: 11		12	1	
016 Guidonia	ore: 24	ore: 04	ore: 20	0	38	26	
016 Guidonia 045 Ciampino			ore: 19		20	32	1,4
060 Civitavecchia Porto			ore: 21		10		
		50	ore: 20		13	4	
083 Civitavecchia Villa Albani		ore: 03	ore: 20		13	•	
084 Civitavecc. Via Morandi		56 one: 02	100 ore: 11	0			
085 Civitaveochia Via Roma	0,7 ore: 17		89 ore: 10	3			
genda:  - Superamento limite Nazionale  N.V.  - media mobile come indicatione di lendi baservazioni:a stazione Civitavecchia via Roma alitali normativa vigente nell'arco de Cuiropa). Superamento del valore lin Obeletroro II (valia Europa) e Ciampi Obeletroro II (valia Europa) e Ciampi	è attiva dal gi l'anno del limi site giornaliero	aiore limite della orno 21/03/201 te giornaliero e	media annua  3. Superament del PM10 nella	stazione di C	olleferro 11 (	Viale	
Collaboratore Tecnico Professionale sott, F. Sacco		jente Responsat itiva Rete	de Unita		I Dirigente Res Servizio Aria dolf. 5 Ceradin		

				-	_	_	1
	CO maim3 293K	O3 upim3 293K	NO2 upim3 293K	NO2 ug/m3 293K	PM10	PM10 up/m3	BENZENE up/m3 2938
	mgim3 293K Media M. 8 h	ugim3 293K Crear Oraria	ugim3 293K Crear Oraria		ugim3		ug/m3 2938 Media M.
	Media M. 8 h Max		Creax Oraria	Num ore sup anno	Cmed 24 h	Num glomi sup anno	Media M. Annua §
D.Lgs 13/08/10 n.155 (Bogila Informazione		180					
D.Lgs 13/08/10 n.155 Gogla Alarme		240					
Limite + Tolleranza	10		200	200	50	50	5
D.Lgs 13/08/10 n.155 n. max sup. Consentti				18		35	
010 Colleferro	0,5	63	50	0	15	33	<del> </del>
011 Colleferro	pre: 24	ore: 14	ore: 21		32	49*	
	1		ore: 21		3350		
014 Allumiere		81 ore: 12	3 ore: DS	0	e	2	
015 Civitaveochia	0,3 ore: 01	74 ore: 14	12 ore: 01	0	18	4	
016 Guidonia	]	8	17 ore: 21	0	12	16	
045 Ciampino	]		54		31	27	1,4
060 Civitavecchia Porto	1		ore: 21	0	12	7	
083 Civitavecchia Villa Albani	i i	73	ore: 10		ND	,	
084 Civitavecc. Via Morandi	1	ore: 14	ore: 01	0	187080		
		ore: 14	ore: 01				
085 Civitavecchia Via Roma	0,3 ore: 01		21 ore: 12	3			
Lagenda:  - Superamento limite Nazionale N.V. 5 - media mobile come indicatore di lend Disservazioni: 1 valori dei parametri rilevati non evi		alore limite della	media annua	la normativa	vicente		

	e del Lazio		Da	alle ore 01 A	lle ore 24		
	co	03	NO2	NO2	PM10	PM10	BENZENE
	mg/m3 293K	ug/m3 293K	ug/m3 293K	ug/m3 293K	ug/m3	ug/m3	ug/m3 293K
	Media M. 8 h Max	Omax Oraria	Omax Oraria	Num ore sup anno	Cmed 24 h	Num giorni sup anno	Media M. Annua §
D.Lgs 13/08/10 n.155 (Bogila Informazione)		180					
D.Lgs 13/08/10 n.155 Sogila Allarme		240					
Limite + Tolleranza	10		200	200	50	50	5
D.Lgs 13/08/10 n.155 n. max sup. Consentti				18		35	
	ï						
010 Colleferro	1,8 ore: 23	23 ore 15	90 ore: 17	0	106 *	38*	
011 Colleferro	2.3.45		107	0	157 *	60*	
014 Allumiere		77	ore: 17	0	20	0	
015 Civitaveochia	1,0	ore: 16	ore: 17	0	40	0	
016 Guidonia	ore: 14	ore: 15	ore: 10		76*	26	
			ore: 17	ين ا			-
045 Ciampino			108 ore: 18		123 *	43*	1,5
060 Civitavecchia Porto			92 ore: 19	0	60+	1	
083 Civitavecchia Villa Albani		43 ore: 15	111 ore: 19	0	52.	4	
084 Civitavecc. Via Morandi		52 ore: 15	88 ore: 11	0	· ·		'
085 Civitaveochia Via Roma	1,4		130	-			
	ore: 24	J	ore: 09				
083 Civitaveochia Villa Albani 084 Civitaveoc. Via Morandi	1,4 ore:24	ore: 15	0re: 19 111 ore: 19 88 ore: 11	0			
	- non valido 🕴	N.D non dispor	ible				
Superamento limite Nazionale N.V.     media mobile come indicatore di fender							
aganda:  - Superamento limite Nazionale N.V.  - media mobile come indicatore di tender beservazione: Superamento del numero dei giorni ci "M10 nella stazioni di Colleferro 10, di Alta normativi vigente per il PM10 ni Liampino, Civitavecchia Porto e Civit	nza rispetto al v consentiti dall Colleferro 11 e relle stazioni C	aiore limite della la normativa vi e Ciampino. Si Colleferro 10 (v	media annua gente nell'arcc peramento de	l valore limite	giornaliero p	revisto	

According with data certified by Regional Agency for the Environmental Protection (ARPA Lazio), in the period 01.01.2013 – 31.12.2015 quality of air in Civitavecchia has been always in compliance with Decree 155/2010 (Directive 2008/50/CE).

Only few days in a year (less than allowed) PM10 is over the limit.

### Avaible emission factors (g/kWh)

All emission factors (except for LNG) are desumed from California Air Resourse Borard (**CARB**) document on May 2008, concerning with emissions of ocean-going vessels. Emission factor of PM<sub>10</sub> from LNG powered ships is assumed equal to 0.01 g/kWh.

VESSEL TYPE	GENERATOR	FUEL	PM10
ALL	Boiler	MGO 0.1	0.13
PASSENGERS	Boiler	RO 1.5	0.48
CARGO	Boiler	RO 2.5	0.80
ALL	Boiler	LNG	0.01
ALL	Main	MGO 0.1	0.25
PASSENGERS	Main	RO 1.5	0.90
CARGO	Main	RO 2.5	1.50
ALL	Main	LNG	0.01
ALL	Auxiliary	MGO 0.1	0.25
PASSENGERS	Auxiliary	RO 1.5	0.90
CARGO	Auxiliary	RO 2.5	1.50
ALL	Auxiliary	LNG	0.01

According with **DNV-GL** document on January 2014, concernign with LNG as fuel, compared to RO, LNG reduces particle emissions by 95% and more.

According with **WPCI** website compared to RO, LNG reduces particle emissions by 100%.

According with Norwegian Insitute for Air Research (**NILU**) document on June 2015, emission factor of PM<sub>10</sub> from LNG powered ships is equal to 0.00036 g/kWh.

#### AVERAGE ANNUAL PM 10 EMISSIONS

(Residual Oil and Marine Gas Oil)

According with p.8, of art.295 of D.lgs. 152/2006, ships at berth are obliged to use low sulphur fuels (<0.1%). Ships are allowed to switch from RO (1.5/2.5%) to MGO (0.1%) within 2 hr (Circolare MATTM 10023/2010). Emissions are expressed in ton.

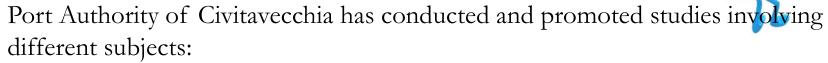
Ship	Manouvring (1.5/2.5%)	Hotelling (1.5/2.5-0.1%)	Hotelling (0.1%)	Sub-tot
Ferry	9,62	2,84	4,51	16,97
Cruise	6,18	7,11	12,74	26,03
Cargo	1,69	0,57	2,52	4,78
Boilers	0,54	0,37	1,03	1,94
TOT	18,03	10,88	20,79	49,71

Average annual production of PM<sub>10</sub>, using traditional fuels (RO or MGO), is estimated in **49,71 ton**.

## ELECTRIC SHORE POWER (HVSC) in Civitavecchia

## ELECRTIC SHORE POWER (HVSC) in Civitavecchia

#### **HVSC WORKING GROUP**



- ✓ Institutions (Ministero delle Infrastrutture e Trasporti, Ministero dell'Ambiente, Regione Lazio, GSE Spa);
- Electricity producers (Enel Produzione Spa);
- Electricity distributors (Enel Distribuzione Spa);
- ✓ Shipyards (Fincantieri Spa ed STX Europe AS);
- ✓ Electrical engineering components manufacturer (Nidec ASI Spa, ABB Spa, Siemens spa, Schneider Electric Spa, Eaton Industry Srl, Cavotec SA);
- ✓ Shipping companies (Carnival Corporation & PLC, Royal Caribbean Cruise Ltd., MSC Crociere Spa, Norwegian Cruise Line Ltd., Grimaldi Spa),
- ✓ Ports (Venezia, Genova, Bari, Savona, Barcellona, Nizza, Amsterdam, Goteborg).

## ELECRTIC SHORE POWER (HVSC) in Civitavecchia

#### PILOT PLANT FOR CRUISE VESSELS AT BERTH 12bis

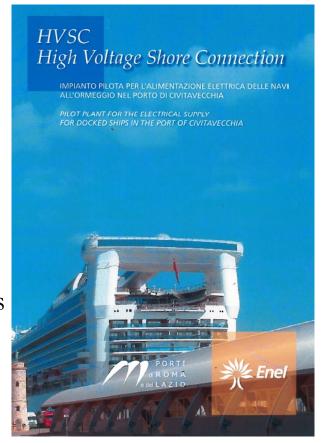
#### ENEL S.p.A., 29.01.2009.

First purchasing technical specification drawn up in Italy for a pilot plant, designed to provide 20MVA to one cruise ship moored at the dock 12bis.

Basic cost of the pilot plant (without connection to national grid):

- €.8.230.460,00 (system with static converter),
- €.9.431.440,00 (system with rotary converter).

The plant was designed to be used by ships belonging to different owners.



#### **ELECRTIC SHORE POWER (HVSC)**

in Civitavecchia

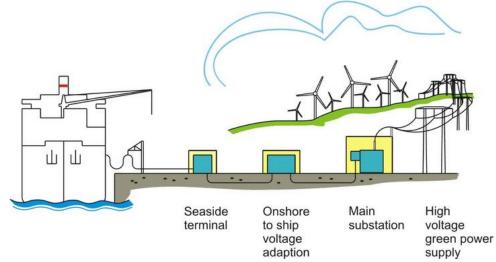
## SHORE POWER PLANT FOR ONE CRUISE AND ONE FERRY CALLING DARSENA SANT'EGIDIO

Basic cost for a system having a total power of 20MVA (16MVA for cruises + 4MVA for ferries) connected to the national grid, €.18.100.000,00:

- €.4.100.000,00: connection to national grid,
- €.14.000.000,00: system with static converter.

The plant was designed to be used by ships belonging to different owners.

Nota prot. assunta in data 14.12.2012 con n.17571



#### **ELECRTIC SHORE POWER (HVSC)**

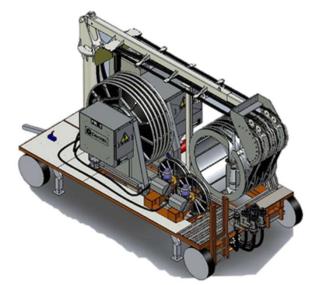
in Civitavecchia

## SHORE POWER PLANT FOR ONE FERRY CALLING DARSENA SANT'EGIDIO

Basic cost for a system having a power of 4MVA (only for ferries), without connection to the national grid, €.4.665.000,00:

- €.3.340.000,00: system with static converter,
- €.1.225.000,00: cables delivery system.

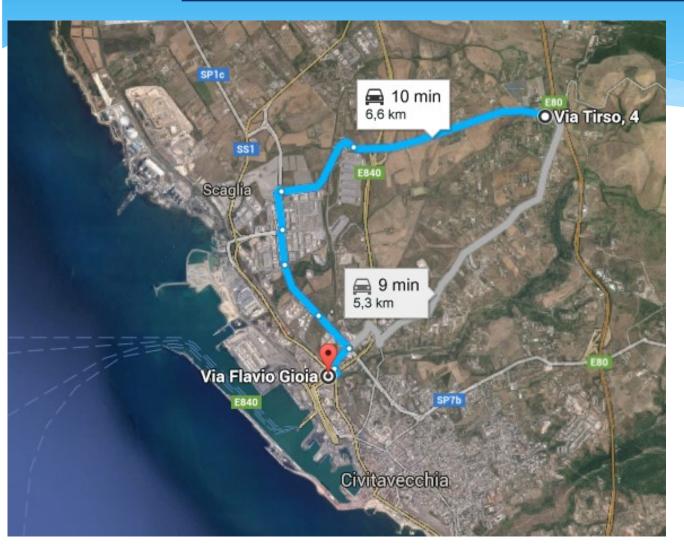
The plant was designed to be used by ships belonging to different owners.



Nota prot. assunta in data 08,09,2014 con n.11668

## ELECRTIC SHORE POWER (HVSC) in Civitavecchia

#### **CONNECTION TO NATIONAL GRID**



Point of connection to National Grid is located 6.6 km far from the point of delivery.

Connection could be realized in HV – 132kV (cost borne by P.A.), or MV – 20kV (cost borne by utility company).

### ANNUAL PM 10 EMISSIONS

(Electric Shore Power)

Connection/Disconnection operations take 45minutes (at least).

During the onshore connection (with engines and genset off) thermal energy needs (from boilers) is considered double.

According with p.9, of art.295 of D.lgs. 152/2006, ships using electric shore power are not obliged to use low suplhur fuels at berth.

Ship	Manouvring (1.5/2.5%)	Hotelling (1.5/2.5%)	Hotelling (HVSC)	Sub-tot
Cruise	9,62	0,85	0,00	10,47
Ferry	6,18	2,13	0,00	8,31
Cargo	1,69	0,17	0,00	1,86
Boilers	0,54	0,11	2,58	3,23
TOT	18,03	3,26	2,58	23,87

Average annual reduction of PM<sub>10</sub>, compared to the use of traditional fuels (RO or MGO), is estimated in **25,84 ton** (49,71 - 23,87 = 25,84): 52,0%.

#### RATES OF ELECTRICITY FROM NATIONAL GRID

(Power and Energy)



(Tariffe in vigore per l'anno 2015)

#### Tariffa per usi diversi MTA3

Questa tariffa si applica a forniture di energia elettrica in media tensione con **potenza disponibile superiore a 500 kW**, con contratto di durata annuale o inferiore all'anno.

Componenti della tariffa	Unità di misura	Prezzo
Quota fissa	€/anno	673,4177
Corrispettivo di potenza impegnata	€/kW/anno	28,8830
Prezzo dell'energia utilizzata	€/kWh	0,00693

La potenza impegnata è pari alla potenza prelevata massima in ciascun mese.

L'importo complessivo si calcola sommando le componenti della tariffa dopo averle moltiplicate per i fattori corrispondenti.

Ai prezzi della tabella vanno aggiunti: le componenti A, UC e MCT, i corrispettivi per l'energia reattiva e le imposte

www.eneldistribuzione.enel.it

The electricity tariff (energy component) in the port of Civitavecchia is 188,00 €/MWh.



(Tariffe in vigore per l'anno 2015)

#### Tariffe Usi diversi Alta

Questa tariffa si applica a forniture di energia elettrica in alta tensione con tensione fino a 220 kV

	Unità di misura	Prezzo
Quota fissa	€/anno	22.417,9133
Corrispettivo di potenza impegnata	€/kW/anno	18,3360
Prezzo dell'energia utilizzata	€/kW h	0,00126

L'importo complessivo si calcola sommando le componenti della tariffa dopo averle moltiplicate per i fattori corrispondenti.

Ai prezzi della tabella vanno aggiunte le componenti A, UC e MCT generali, i corrispettivi per l'energia reattiva e le imposte.

### Electric Shore Power system

	•
	large ships
Cost to provide Shore Power to the port (30 piers)	>€. 200.000.000,00
Regulation	IEC/ISO/IEEE 80005
Total power of the system (30 piers)	264MVA
Power of the system (12 cruises, 8 ferries, 2 cargoes)	185MWe
Annual cost (power, maintenance and personnel)	> 8.000.000,00 €./y
Energy delivered to ships	91.607 MWh/y
Electric energy tariff in the port of Civitavecchia	188,00 €./MWh
Cost of power, maintenance and personnel	> 87,00 €./MWh
Reduction of PM <sub>10</sub> emissions	52,0%

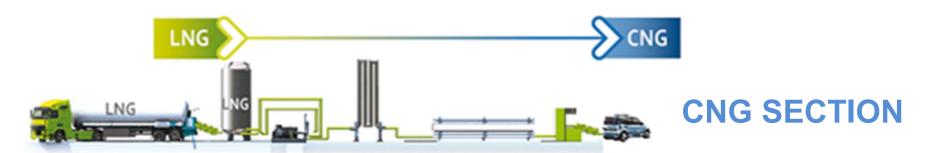
Cost are referred to infrastructures necessary to provide each berth of the port with a shore connection (total 264MVA, 50/60Hz, 6.6/11.0kV), and they also consider the connection cost to the national grid (185MWe, 50Hz, 20 or 132kV).

## LNG in Civitavecchia







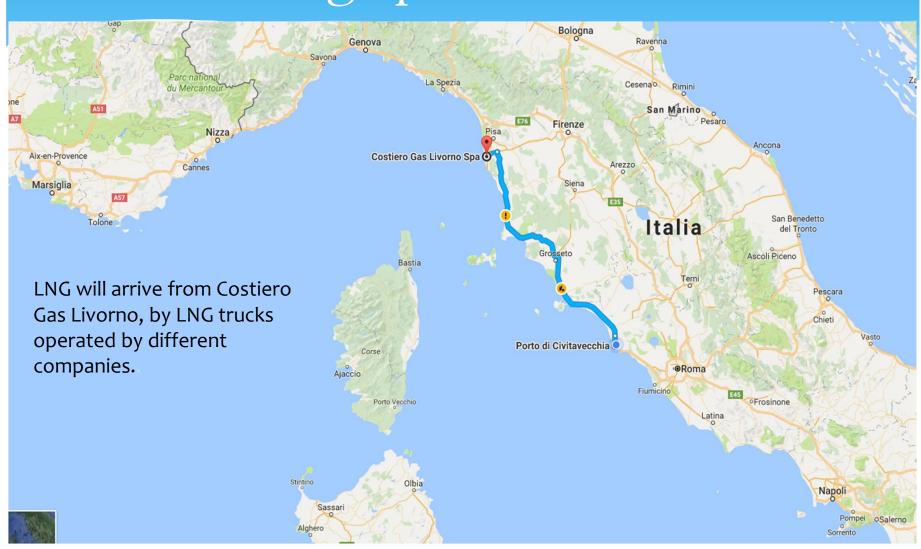


CNG FLOW: FROM 500 UP TO 20,000 NM3/H

## LNG station for road vehicles and fuelling (2018)

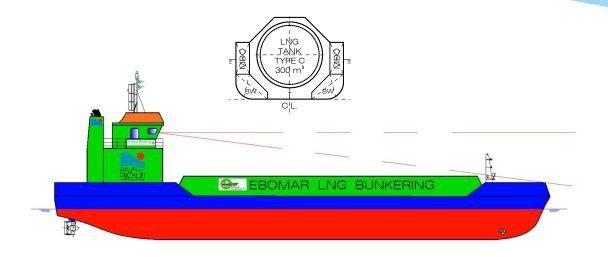
BUNKER STATION FOR CNG (COMPRESSED NATURAL GAS) ALSO SUITABLE FOR PRIVATE FLEETS WHO WANT TO SUPPLY THEIR OWN VEHICLES POWERED BY NATURAL GAS

## Logistic chain for road vehicles and fuelling operations (2018)





## EBOMAR ~ LNG BUNKERING BOAT FOR LARGE VESSELS (2023)



#### **LNG BUNKERING BOAT**

#### Principal dimensions:

$L_{oa}$	=	55.0 m
В	=	9.5 m
D	=	5.0 m
Т	=	3.5 m

#### Cargo Tanks:

LNG Tanks: 600 m<sup>3</sup> MDO/MGO: 500 m<sup>3</sup>

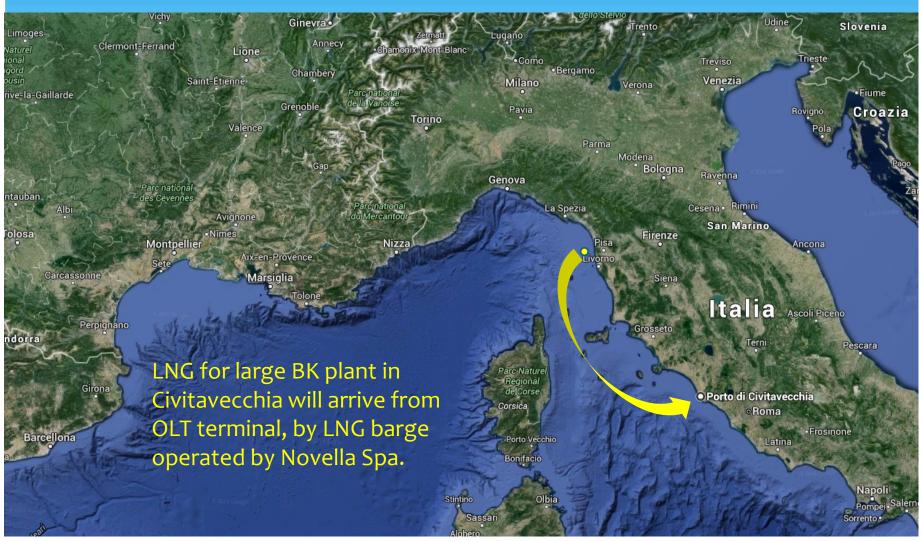
Service Speed: 10 knots







## Logistic chain for large LNG BK plant (2023)



#### ANNUAL PM 10 EMISSIONS

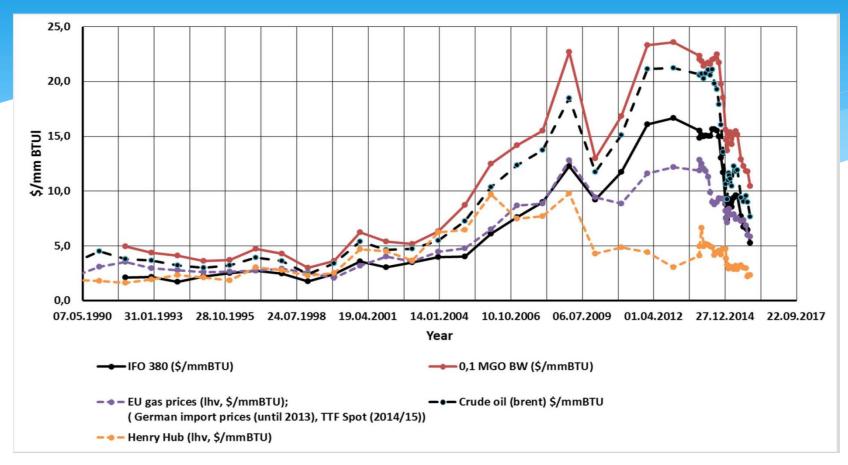
(Liquefied Natural Gas)

LNG can be used in each operational phase (navigation, manouvring and hotelling, to produce steam).

Ship	Manouvring (LNG)	Hotelling (LNG)	Hotelling (LNG)	Sub-tot
Ferry	0,11	0,05	0,18	0,34
Cruise	0,07	0,12	0,51	0,70
Cargo	0,01	0,01	0,10	0,12
Boilers	0,01	0,02	0,08	0,11
TOTALE	0,20	0,20	0,87	1,27

Average annual reduction of PM<sub>10</sub>, compared to the use of traditional fuels (RO or MGO), is estimated in **48,44 ton** (49,71 - 1,27 = 48,44): 97,4%.

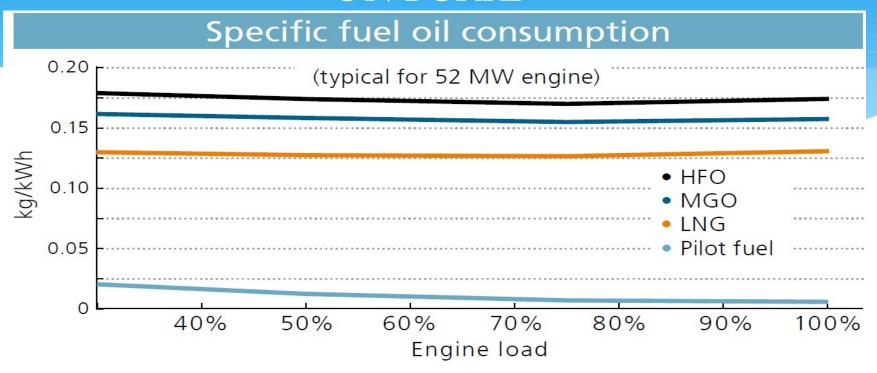
#### PRICE DEVELOPMENT OF MARINE FUELS



Data are referred to prices registred on 09th December 2015

MGO 0,1% S: 10,45 \$/mmBTU = 423 \$/t (384 €/t) IFO 180: 5,99 \$/mmBTU = 230 \$/t (209 €/t) LNG EU (Ihv): 5,87 \$/mmBTU = 272 \$/t (247 €/t) IFO 380: 5,25 \$/mmBTU = 202 \$/t (183 €/t)

## COST OF SELF-PRODUCTION OF ELECTRICITY ON BOARD



Cost of self-production is mainly given by (Price of fuel) x Sfc; specific fuel consumption (Sfc) changes according with different engine sizes, fuels and engine loads. At this cost must be added the cost of personnel, lubricant, maintenance, etc.

Average cost of fuel for self-production

MGO 0,1% S: 60 €/MWh IFO 180: 40 €/MWh LNG EU (lhv): 39 €/MWh IFO 380: 35 €/MWh

#### LNG Bunkering program

	2018 (small ships)	2021 (large ships)
Cost of the system (storage plant	€. 1.600.000,00	€. 50.000.000,00
with truck or barge)	(included cost of the truck)	(included cost of the barge)
Regulation	Circolare VV.F. 3819/13	D.lgs.152/06 – D.lgs.105/15
Storage volume (m <sup>3</sup> )	100	8.000
Surface of the storage plant (m <sup>2</sup> )	2.000	30.000
Boil off management	CNG for cars	CNG for cars
LNG pier	no	DEGM
Cryogenic pipeline	no	yes
Refilling of storage plant way	cryogenic truck	LNG carrier
Bunkering method	cryogenic truck	LNG bunker boat
Reduction of PM <sub>10</sub> emissions (%)	n.a.	97,4%

LNG bunkering program of Civitavecchia has been approved by Italian Ministry of Transport, and it has been included in the *PoseidonGainn* project.

## ELECTRIC SHORE POWER vs LNG in Civitavecchia

#### SUSTAINABILITY ANALYSIS

	HVSC	LNG
Basic cost of contruction for Port Authority (€.)	> 200.000.000,00	0,00
Cost of energy for ships	+ 300%	- 20%
Demand from ships	no	yes
Elegible for EU funding (CEF program)	no	yes
Economic sustainability	NO	YES
PM <sub>10</sub> reduction	52%	97%
Environmental sustainability	YES	YES
Social sustainability	YES	YES
SUSTAINABLE	NO	YES

According with this study, reduction of PM<sub>10</sub> emission from large vessels by HVSC is bearable, but only by LNG is sustainable.

### ENERGETIC POLICY

#### of the Port Authority of Civitavecchia

End User	Technology
Ferry	LNG
Cruise	LNG
Cargo	LNG
Pleasure boats and maxi-yacht	HVSC
Resident boats	LNG
Road/Heavy duty vehicles	LNG
Cars	CNG/electric
Energy from National Grid	Photovoltaic/Waves

