The Port of Venice Case Study: voluntary agreements to reduce air pollution from cruise ships.

Giovanni Terranova (giovanni.terranova@port.venice.it), Marta Citron (marta.citron@port.venice.it), Alberta Parolin (alberta.parolin@port.venice.it)

Abstract

Ships and harbour emissions are currently increasing, due to the increase of tourism with potential impact on air pollution.
In April 2015 a new voluntary agreement (Venice Blue Flag) has been subscribed by Cruise companies, VPA, Venice Harbor master and the Municipality to have the engines of cruise vessels shift to 0,1 % S fuel as they approach the Lido Inlet.
With the Venice Blue Flags a special "green zone" has been created, with a very tight limit to the emissions.
The 0.1% target actually goes one better than the 3.5% sulphur limit currently acceptable in ports that will be reduced to 0.5% by 2020.
The effects of using green fuel in navigation have been estimated during 2013 cruise season by ARPAV (Veneto Region Environmental Agency): considering emissions arising from maneuvering phase there is a reduction of 60% of PM, and 96% for SO2. Balancing emissions rising both from maneuvering and mooring phase the reduction estimated are of 46% for PM and 91% for SO2.
Venice as a case study of how voluntary agreement could be effective in reducing the impact of shipping on local air quality in coastal areas, in comparison to other kind of tools (scrubbers).

1. Introduction

Ships and harbour emissions are currently increasing, due to the increase of tourism and trade, with potential impact on global air pollution. At local scale, “in-port” ship emissions influence air quality in coastal areas, potentially impacting both on health of coastal communities and environment. International legislations to reduce ship emissions, both at Worldwide and European levels, are mainly based on the use of low-sulphur content fuel. In Venice since 2007, some voluntary agreements have been signed between local authorities and cruise companies in order to use green fuel within the Venice Lagoon.

In this work an analysis of voluntary agreement effects at local scale will be reported.

2. The contest: Venice port location and characteristic

The Port of Venice is situated in the Venice lagoon in the northern part of the Adriatic sea. As shown in the above figure, the Port is divided in two different operative areas:

1) the commercial terminals and ferry area which is located in Porto Marghera zone (the area underlined with a circle on the left), in the hinterland
2) the cruise/passenger terminals area (Marittima), located in the historical center (underlined with a smaller circle on the right).

Picture 1: Port of Venice: commercial terminals/ferry area (Porto Marghera) and cruise terminals area (Marittima)

The two main port areas have their own separate access: the Malamocco inlet serves cargo ships (commercial/industrial traffic) and ferries, while the Lido port mouth serves passengers ships (cruise ships, fast ships and yachts).

Venice is not only an ideal an unique setting for a cruise for its natural environment and cultural heritage, it is also a major port, equipped with the most modern facilities: Venice Passenger terminal surface is more than 260.000 squared meters; there are more than 3.000 linear meters of piers, 10 multifunctional terminals and 7 quays.

Over the period 1997-2014, 25 million passengers from all over the world travelled through the port of Venice facilities. Thanks also to its accessibility from hinterland and to the good connection to rail, highway network and the international airport “Marco Polo”, in 2014, Venezia Terminal Passeggeri S.p.A. welcomed 1.733.839 cruisers from over 170 countries, thus reconfirming its prominent position among the best worldwide homeports.

3. Venice port Authority and the environment

Venice is a unique city where history and culture come in different shapes, offering an exciting array of discovering experiences, but it is also located an unique and delicate ecosystem to be preserved. Venice and its Lagoon are both part of the UNESCO World Heritage List: *Venice and its*

lagoon form an inseparable whole of which the city of Venice is the pulsating historic heart and a unique artistic achievement.

The goal of Venice Port Authority (VPA) by law is to maintain harbor activities and to develop traffics, but it is clear that these goals could be achieved only preserving the lagoon environment and the cultural heritage of the UNESCO site: Venice and its lagoon, thanks to their unique characteristics, are the driving elements that attract tourists.

VPA, according on its institutional role and its function works to safeguard artistic, architectonical and environmental heritage and it is especially involved into the preservation of the cultural, economic and social Venetian identity, operating in accordance to the principle of safeguard.
This is the reason why VPA, since 2007 has adopted a proactive strategy to improve air quality that involves both compliance with existing regulations and undertaking voluntary endorsements to reduce air emissions.

4. Venice blue flag voluntary agreements measured effects

In April 27, 2007, the first "Venice Blue Flag", a voluntary agreement between VPA, Harbour Master, Venice Municipality and cruise companies on using fuel with increasing lower level of sulphur and engine rules during mooring in Venice Port. This agreement brought forward by more than three years the objective of improving the quality of fuel set by the national regulations.

The shipping companies that endorsed the first Venice Blue Flag in 2007 committed themselves to using for the 2007 cruise season fuel oil with a sulphur content lower than 2,5% by weight, with an occasional margin of 0.5% to be reported on the Harbor Office each time. This should be seen in relation to the international standards set by the MARPOL convention of the IMO, which provides in Annex VI for a maximum level of sulphur in fuels of 4.5% by weight, reduced to 1.5% for the ships passing through special emission control areas.
This agreement has been renewed in following years, continuing with the voluntary use of cleaner fuels and bringing the maximum content of sulfur for the seasons 2008-2009 to 2.0% in navigation and 1.5% at berth. In 2010 national low entered in force, with the implementation of 2005/33/EC/Directive and the obligation for using 0.1 % sulfur content fuel when mooring.

Through some measurement stations located around the Marittima Passenger Terminal (*Contini D, Gambaro A. et alia 2011)* VPA had also the opportunity to assess the effectiveness of the Venice Blue Flag initiative, in which the Port of Venice acted as forerunner of the legislation at that time in force. Over the years, different campaigns of measurement were carried out to assess the direct influence of the transit of ships on the air quality in the urban area of Venice (historical center).

Results (http://www.medmaritimeprojects.eu/section/poseidon) showed a decrease of primary contribution of PM2.5 from 7% in 2007 to 5% in 2009 and to 3.5% in 2012. The meteorological conditions of the campaigns were similar, while tourist ship traffic during measurement campaigns increased, in terms of gross tonnage, of about 25.4% from 2007 to 2009 and of 17.6% from 2009 to 2012. This means that if the calculated contributions are normalised by the average gross tonnage of ship traffic, the decrease from 2007 to 2009 and 2012 is even more accentuated.
Therefore, the decrease in the observed contribution is likely related to the mitigation strategies implemented for the reduction of ships SO2 emissions. Specifically, the voluntary agreement

enforced between 2007 and 2009 and, successively, the implementation (starting from 01/01/2010) of the 2005/33/EC Directive (*Contini D, Gambaro A. et alia 2015)*.

Taking into account results arising from local studies and measurements, in 2013 and then, again, in 2015 voluntary agreements (Venice Blue Flag 2) to have the engines of cruise shift to fuel with a lower content of sulfur (0,1%) as they approach the Lido Inlet.
With the Venice Blue Flags II a special "green zone", a kind of ECA area, has been created in the Venice Lagoon: the 0.1% is actually inferior to the indications of the European Union that they have fixed to the 3,5 percentage of sulfur accepted in the ports, that it will be reduced to the 0.5% within 2020.

YEAR	IN FORCE LEGISLATION	% S NAVIGATION/MANEUVERING	% S AT BERTH
2005	MARPOL - IMO – ANNEX VI	4.5%	4.5%
2007	VENICE BLUE FLAG	2.5% (+ 0.5%)	2.5% (+ 0.5%)
2008	VENICE BLUE FLAG	2.0 % (+ 0.5%)	1.5% + (0.25 %)
2009	VENICE BLUE FLAG	2.0 %	1.5%
2010	MARPOL - IMO – ANNEX VI and 2005/33/CE Directive	4.5% + 1.5% (passenger ships operating on regular services to or from any Community port)	0.1%
2012	MARPOL - IMO – ANNEX VI (as amended) 2005/33/CE Directive	3.5% + 1.5% (passenger ships operating on regular services to or from any Community port)	0.1%
2013	VENICE BLUE FLAG 2 2005/33/CE Directive	0.1% Passenger ships within the Port of Venice	0.1%
2015	VENICE BLUE FLAG 2 2005/33/CE Directive	0.1% Passenger ships within the Port of Venice	0.1%

Table 1

Effects of Venice Blue Flag 2 on air quality have been calculated, starting from emission inventory, by ARPAV (Regional Environmental Protection Agency).
Emissions estimation have been obtained using Tier 3 EMEP/EEA (EEA 2009 – March 2011) methodology. The methodology distinguishes between different emission factors depending on:

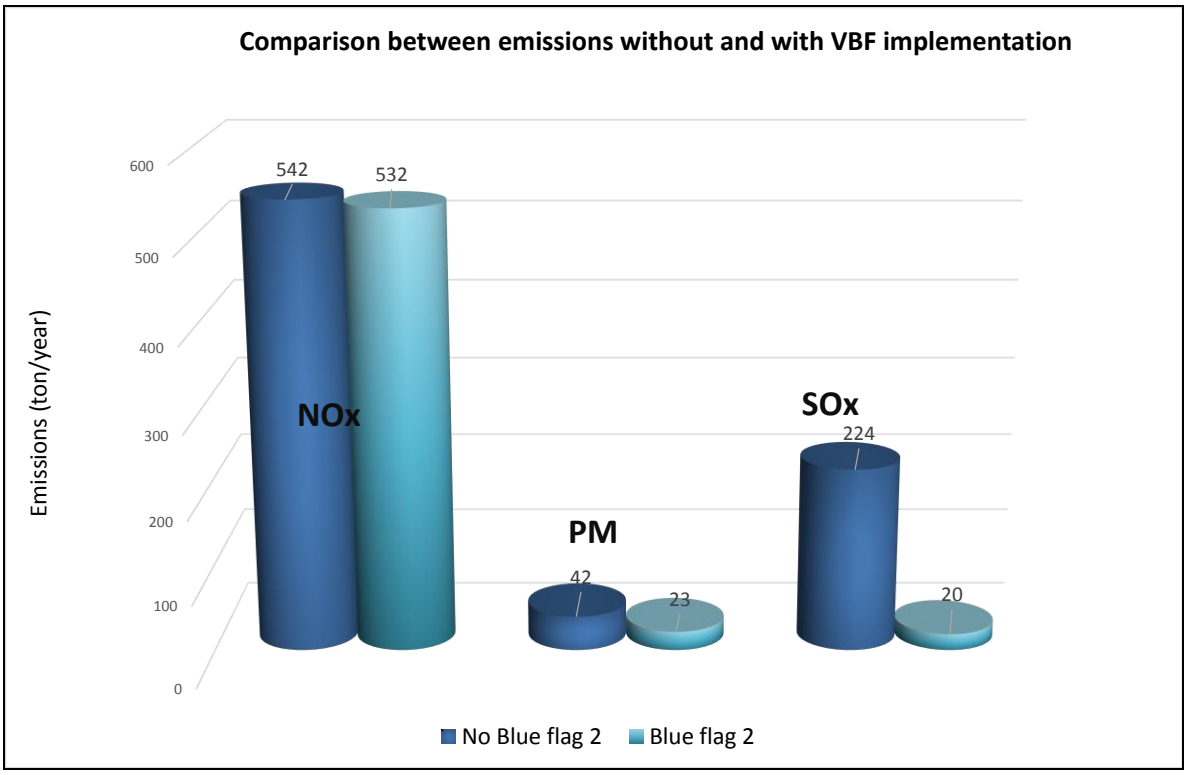
- different vessels,
- different engines,
- different fuel: MDO/MGO (Marine Diesel Oil/Marine Gas Oil) with a 0.1% of sulphur content and BFO (Bunker Fuel Oil) with a medium value of 2.7% of sulphur content.
- different navigation phase.

In the Venice case, only two navigation phases are considered: hoteling and manoeuvring, because, since the entering in the lagoon through the Lido inlet, navigation speed are limited by local Harbour Master decree to 6 knots.
In the hypothesis of VBF implementation all vessels committed themselves to using only fuel with 0.1% of sulphur both during manoeuvring and hoteling phase. In the other case, vessels could use BFO during manoeuvring.

The estimated effect of Venice Blue Flag implementation is a strong reduction of both SOx (-91%) and of PM (-46%), and a slight reduction of NOx emissions. Data obtained through the methodology application are the following.

	Annual emission for cruise sector in Venice (ton/year) - Data 2011 referred to vessels with GT > 40.000 ton								
	NOX			PM			SOx		
	No Blue flag 2	Blue flag 2	Reduction %	No Blue flag 2	Blue flag 2	Reduction %	No Blue flag 2	Blue flag 2	Reduction %
Hotelling	336			10			12		
Manouvering	206	196	-5%	32	13	-60%	213	8	-96%
Tugs	47			4			24		
Hotelling and manouvering	542	532	-2%	42	23	-46%	224	20	-91%
Hotelling and manouvering and tugs	589	579	-2%	46	27	-41%	248	44	-82%

Table 2



Graph 1

5. Cost/benefit analysis of Venice Blue Flag implementation

Port activities give rise to environmental impacts, but the costs of these effects are not fully known. The so called external costs evaluation should be part of the decision making process trying to find out short term solution, balancing economic and feasibility aspects, to reduce environmental impacts of shipping activities.

For maritime transport, the air pollution effects have in the recent years become an important policy issue. In the NEEDS project, specific damage cost values for all major pollutants have been calculated for all European sea regions using the EcoSense model. Table below reports these values, updated to the price level of 2010 (Source*: Update of the Handbook on External Costs of Transport - Final Report January 2014*).

Sea Region	NOx	PM2.5	SO2
Baltic Sea	4700	13800	5250
Black Sea	4200	22550	7950
Mediterranean Sea	1850	18500	6700
North Sea	5950	25800	7600
Remaining North-East Atlantic	2250	5550	2900

Table 3: Damage costs of main pollutants in sea areas, in € per tonne (2010)

Considering data referred to 2013 calendar, starting from emission inventory and using the same calculation methodology, it is possible to evaluate both fuel consumption and emissions data with and without Venice Blue Flag implementation, in order to evaluate cost benefit of VBF implementation.

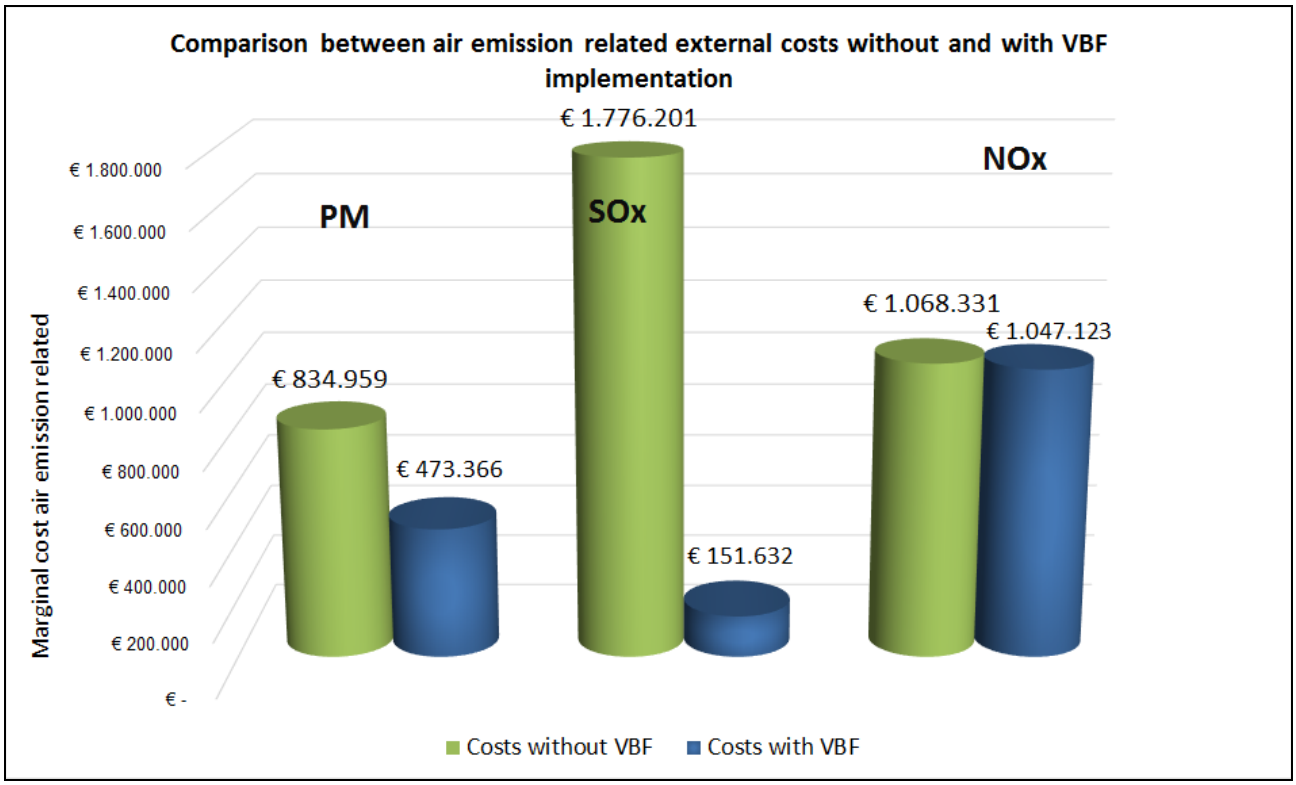
Scenario (2013 calendar)	Emission NOx ton	Emission PM10 - PM2,5 ton	Emission SOx ton	Fuel consumption manouvering phase (ton)	Fuel consumption hotelling phase (ton)	Total fuel consumption (ton)
With VBF	566,01	25,59	22,63	4506,73	6809,08	11315,82
Without VBF	577,48	45,13	265,10	4657,16	6809,08	11466,24
Reduction %	-43%	-91%	-2%			

Table 4

Applying unitary marginal costs reported in the previous table to calculated emissions, it is possible to evaluate the reduction of the marginal external costs related to VBF implementation.

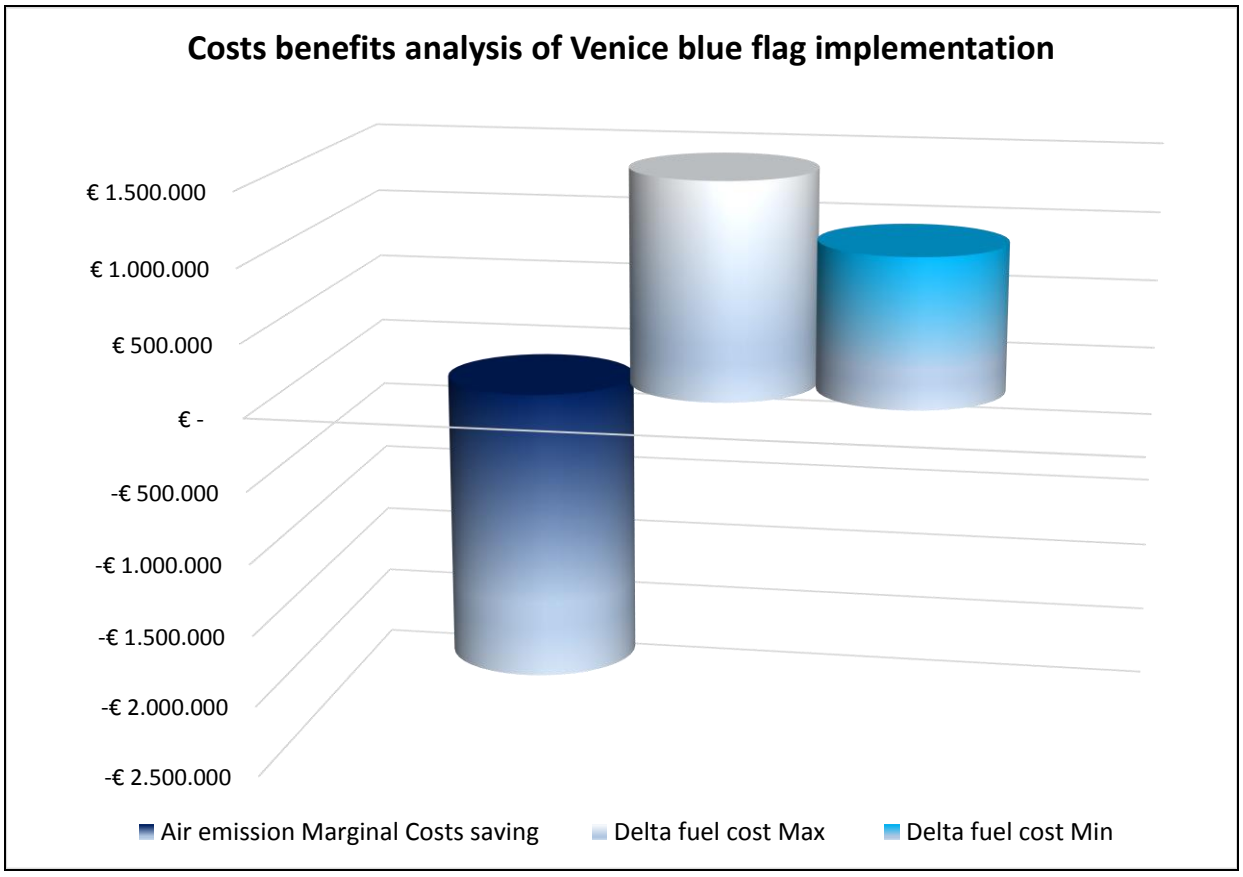
Costs	PM2,5	SOx	NOx
Marginal External costs of emissions (€/ton) in sea area	€ 18.500	€ 6.700	€ 1.850
Costs with VBF	€ 473.366	€ 151.632	€ 1.047.123
Costs without VBF	€ 834.959	€ 1.776.201	€ 1.068.331
Different costs with VBF	-€ 361.593	-€ 1.624.569	-€ 21.208

Table 5



Graph 2

In order to evaluate costs and benefits balance of VBF agreement, it could be taken in consideration gap between MDO/MGO and BFO costs: even if fuel prices are quite variable, the differential between BFO and MGO/MDO could be considered around 250/300 € per tons.
Major costs related to the use of low sulfur content fuel, during both maneuvering and mooring phase, for the entire cruise season (calendar 2013), could range between 1.100.000 € and 1.500.000 € depending on fuel costs difference.



Graph 3

6. Conclusions

By analyzing possible measures to adopt in order to reduce port activities emissions in Venice, different researches conducted both in the framework of EU project and by ARPAV (local environmental protection agency) pointed out that these voluntary agreements are a good short term solution.

With this work, cost benefits analysis has been implemented, taking into account marginal external costs emissions related. The net benefit of VBF is very clear: even if there is an incrementation of costs related to distillate fuel consumption, the reduction in term of marginal external costs is definitely higher, thus confirming that the voluntary agreement could be the best solution balancing environmental, economic and feasibility aspects.

Bibliography and Websites

- Venice Port Authority Programmatic Documents (POT 2008-2011 and 2012-2015)
- ARPAV Air quality Regional Report 2011
- ARPAV Air quality Regional Report 2012
- Venice Municipality Air quality annual report 2011
- Venice Municipality Air quality annual report 2012
- External costs of Transportation Case study: maritime transport (European Commission Joint Research Centre 2009)
- Institute for Environment and Sustainability
- The direct influence of ship traffic on atmospheric PM2.5, PM10 and PAH in Venice - *Contini D., Gambaro A. et alia Journal of Environmental Management 2011;*
- Inter-annual trend of the primary contribution of ship emissions to PM2.5 concentrations in Venice (Italy): Efficiency of emissions mitigation strategies - *Contini D., Gambaro A. et alia Atmospheric Environment 2015*
- *To Venice By the Sea - Marsilio Editori 2012*
- *http://www.lngbunkering.org/lng/business-case/cost-and-benefits-for-ship-owners*
- *Update of the Handbook on External Costs of Transport - Final Report (January 2014)*

- http://www.port.venice.it/it
- http://www.apice-project.eu/
- http://www.arpa.veneto.it/
- http://www.ccpv.it/