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Project confinancè parle Fonds Eurôèen de Dèveloppement Règional
Project co-finnaced by the European Regional Development Fund

APICE

Local Adaptation Plans (LAPs) for the Port-Cities of APICE project (WP5.5)

This report was edited by Elena Gissi, PhD (University Iuav of Venice, Dept. of Design and Planning in Complex Environments) on behalf of Regione del Veneto, 28th of February 2013

Local Adaptation Plans for the Port Cities of the APICE project

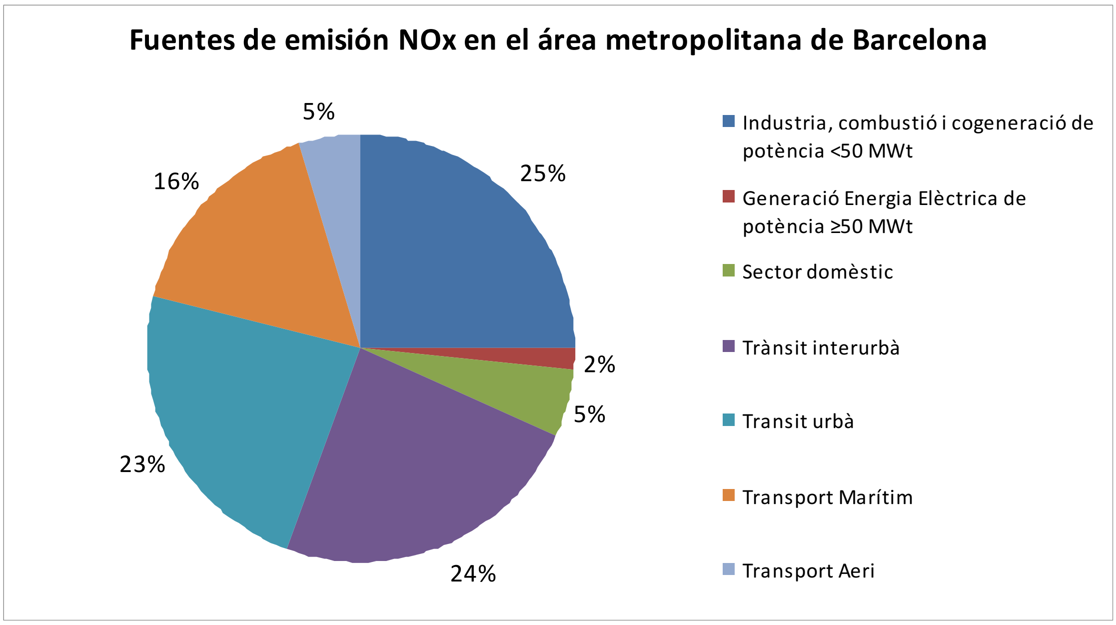
Final report

Local Adaptation Plan for Barcelona

By Pedro Fernández Bautista and Carolina Pérez (EUCC Mediterranean Centre) with contributions from CSIC – IDÆA and University of Murcia

1. Introduction

Barcelona port and the maritime and terrestrial transport linked to it are the origin of an important share of air pollution in the metropolitan area. The Catalan Government emissions inventory of 2008, illustrated in the figure, assigns to the port 23% of PM_{10} and 16% of NO_x emissions at the area affected by the Air Quality Improvement Plan. The project APICE has analysed those emissions derived from maritime and port traffic, identifying the sources and calculating emissions for each of them. The horizon 2015 emissions have been moreover estimated according to the current trend.



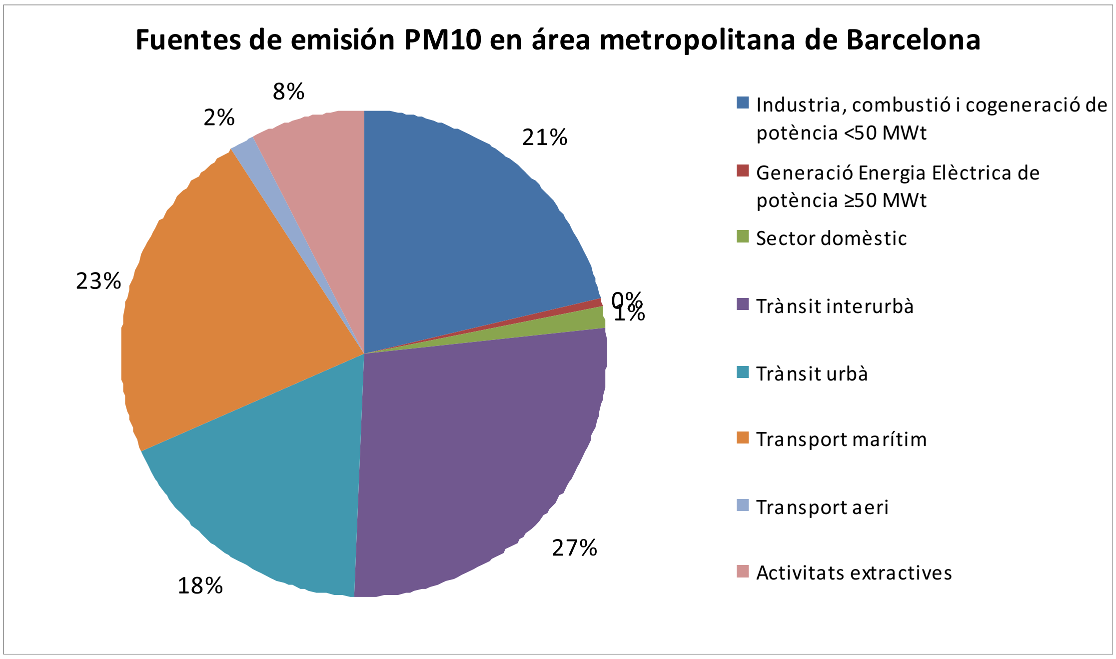
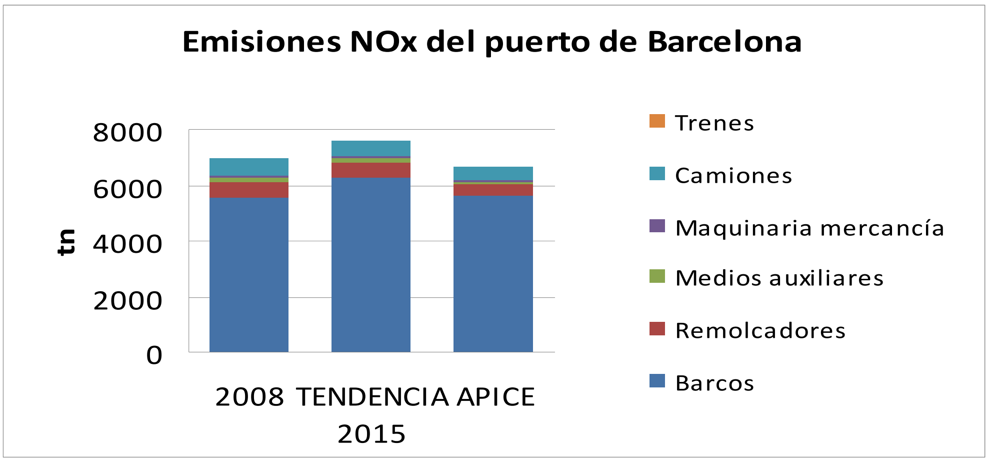


Figure 1.1. and 1.2: Emissions sources for the Metropolitan Area of Barcelona (NOx and PM10).

Should mitigation measures not be undertaken, NO_x emissions at the port - a critical pollutant in Barcelona- will increase. A decreasing trend is nevertheless expected for SO_x and PM_{10} as a result of the entry into force of stricter regulations for fuel of vessels. It is important to emphasise the contribution of vessels as compared to other maritime transport and port activity sources.



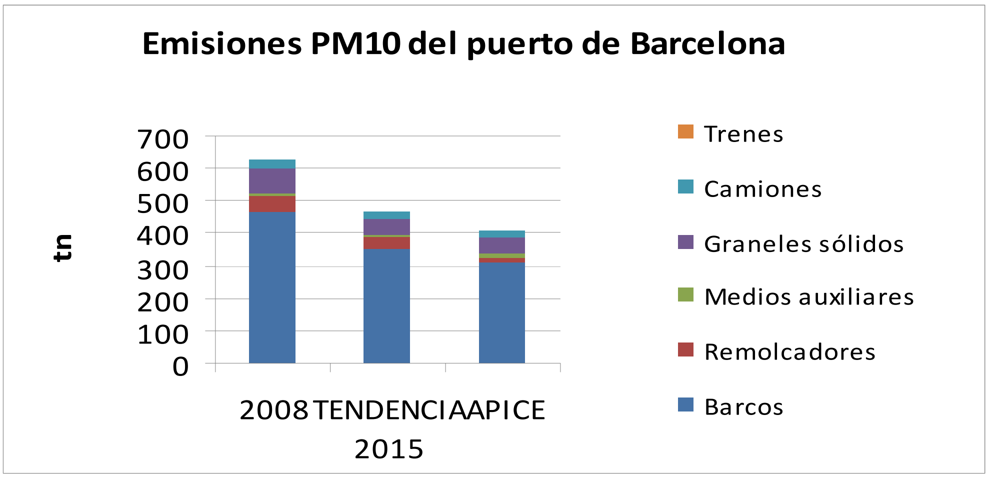


Figure 1.3 and 1.4: Emissions of NOx and PM10 of the Barcelona Port

Following the analysis of emission sources and in view of the urgency to abate emissions, measures have been identified addressing each of the sources. The implementation of the APICE Plan would result on a 12% NO_x and PM_{10} emission abatement as compared to the 2015 trend scenario.

2. Apice plan Barcelona: description of measures

2.1. Ship and vessels activity

International ship emissions thresholds are set by the International Maritime Organization (IMO). The European Union establishes further requirements for vessels within its ports. While SOx emissions are controlled through fuel sulphur content, NOx emissions are ruled according to the ships construction year. In order to fulfil these requirements, vessels will have to change the type of fuel or adapt their engines.

Measure 1.1. LNG promotion as fuel for vessels

Several stakeholders have expressed readiness to develop liquefied natural gas (LNG) at the port of Barcelona as the fuel for the future, and thus it is proposed as the most important action to adequate maritime traffic to international emissions standards.
According to reports of the DNV classification society, LNG is currently an interesting fuel for maritime traffic commercially and offers reductions of around 25% CO2, full elimination of SOx and nearly 90% of NOx. However, there are still barriers to overcome in order to facilitate LNG being a widely use fuel. APICE proposes to work in three aspects:

Development of normative framework for ships propelled by LNG
Nowadays, there is not international non-national regulations for the use of LNG in vessels other than ships that transport gas, which is a barrier for introducing this fuel. However, international rules are being developed (IGF code and ISO TC 67/WG 10). At national level, the Merchant Navy General Directorate should play an important role to promote LNG within IMO framework.

Implementation of infrastructure and logistic for LNG supply
Setting up a basic infrastructure, as a pilot project, is necessary to use LNG in the Mediterranean and to foster this fuel like it has been done in North Europe. Considering current commercial relations, it would be convenient to dedicate this pilot project in West Mediterranean to Short Sea Shipping. Ports that could make part of this network are: Valencia, Barcelona, Palma de Mallorca, Marseilles-Fos, Bastia, Genoa, Livorno, Civitavecchia and Olbia.

Networking to promote LNG in maritime transport
LNG development as maritime fuel is complex from the normative and logistics side. It is necessary to work co-ordinately and in network. Hence, at Spanish level, the Asociación de Ingenieros Navales y Oceánicos de España (AINE) has set up a working Group (PAT-20) to address mainly LNG legal and technical aspects. Furthermore, several companies and entities are setting up an Association to promote natural gas in the transport sector. This measure aims at creating and making operational this Association to foster the use of natural gas in vessels and ports, at normative, logistics and supply levels. The Port of Barcelona and Catalan Government could also take part in this group to provide local knowledge and implement infrastructures.

Measure 1.2. On board air emissions inspections

Both national and regional plans to improve air quality consider on board air emissions controls for ships. European regulations regarding the sulphur content in fuel and conventional inspections seem to have a positive impact on reducing SOx emissions. However, in the case of NOx emissions, current inspections may not have effect since they depend on the settings of the engine.The state and regional authorities responsible for air quality should expose the need for this measure to the Merchant Navy General Directorate, and once there is an agreement to enhance emissions control, an inspection protocol should be developed for exhausted gases and admissible emission values. It would be also necessary to provide the maritime authorities with the necessary tools for measurement, or delegate this task to other accredited institutions.

Measure 1.3. Cold-ironing

Currently there are some ports worldwide where it is possible to supply electricity to ships while at berth, thus avoiding local emissions.Taking advantage of the potential of natural gas, it is proposed to deepen the ongoing study on the construction of floating platforms / barges equipped with natural gas generators that could produce electricity and supply it directly to cruise ships. It would also be necessary to study the possibility of deploying these generators on land, although they would have the disadvantage of loosing mobility.

2.2. Harbour craft

Harbour craft consists of tug boats and other vessels that perform various tasks such as cleaning of floating debris, bunkering, etc. Regarding air emissions, the main contribution corresponds to the activity of the tug boats.

Measure 2.1. Optimizing tug boats working time

The APB sets the time that tugs must operate for towing vessels entering and leaving the port. At present, the maximum response time is 25 minutes, but tug boats are often much earlier due to early notice, and therefore release emissions longer than necessary. The measure proposes to renegotiate the time of availability of tugs. For this, the APB should judge the adequacy and agree to modify the requirements, always ensuring the service quality and safety.

Measure 2.2. LNG as fuel for tug boats

Currently the Barcelona harbour tug boats have diesel engines and use fuel containing less than 0.1% sulphur, as required by law. All of them are certified IMO NOx and are relatively new. However, in the long term, it is appropriate to think about replacing the type of fuel and/or other retrofitting technologies. Considering the enhancement of natural gas in other maritime and port areas, the long-term measure is the conversion/replacement of the current fleet units by tug boats powered by LNG. To this aim, collaboration between different entities is desirable. The promoters of the project could be one of the towing companies and a gas supply company. The APB could facilitate procedures and regulations on safety, together with the Merchant Navy General Directorate. The Government could also participate in the pilot project through the Catalan Energy Institute (ICAEN).

2.3. Land traffic: heavy-duty vehicles

A fleet of approximately 4,500 trucks operates in the port of Barcelona, according to the APB for 2008, most of them diesel. In that year, 32,687,121 tons of goods were transported by truck, corresponding to 98.3% of goods (the rest is transported by train).

Measure 3.1. Trucks conversion to CNG

Taking advantage of the potential of natural gas in the port, the compressed natural gas (CNG) can be seen as a future fuel with much lower generation of air emissions.

The market already offers models of CNG tractors.The measure would consist on implementing a pilot program to which some companies could subscribe to replace their diesel engines to dual. To do this, support of natural gas supply companies and the administration should be made available, as there are financial incentive programs for the purchase of environmentally friendly vehicles.

Measure 3.2. Efficient driving in port

Currently there are agreements signed between entities such as the Logistics Activities Zone (ZAL), Port of Barcelona and Catalunya Barcelona Centre Logistics Association (BCL), Catalan Energy Institute (ICAEN) and Royal Automobile Club of Catalunya (RACC) on energy efficiency in transport and efficient driving, which can reduce fuel use by about 12%. The ZAL will explain and train on energy efficiency and efficient driving to the fleets operating in the port, both own brands as freelancers. It will explore the possibilities of microcredits to finance investments to benefit independent carriers. The ZAL will organize workshops to promote this initiative. It is intended to cover the entire fleet of trucks through CBL, including that in charge of shipping containers. The implementation of this measure may be accompanied by the explanation of the eventual introduction of the CNG program in trucks, described in the previous measure.

Measure 3.3. Wheel washing systems

According to the results of the APICE air quality monitoring campaign, vials, together with works, are a major source of contribution to particulate pollution. This is because of the passage of vehicles resulting in re-suspension of already deposited particles. The Port of Barcelona has a sweeper system to mitigate this problem.According to the report S*tudies of Mitigation and Corrective Measures of air emissions caused by port activities* by Ports of the State, two options are proposed: washing system with rollers or wheels-pass system. Another alternative would be gravel beds as the Catalan government propose for extractive activities.

2.4. Land traffic: locomotives

The Port of Barcelona has devoted great efforts to the development of the railway as land transportation option in the port, motivated by economic, strategic and environmental issues, particularly with the implementation of the Railway Master Plan of the Port of Barcelona. The image shows the new port rail system. Goods transported by rail have increased considerably, particularly in the case of containers.

Measure 4.1. Increased market share

Rail has been gaining ground to road in recent years, and it is expected to continue increasing in the future. In addition to the built infrastructure and operational improvements, there is a key area for increased market share: the commercial part. It is about gaining more customers using this transport. The Port of Barcelona, through its Commercial Department, works continuously on these aspects. A remarkable strategy to increase rail's share is the application of a rate policy that favours rail (APB applied the maximum benefits allowed by law). The measure consists on strengthening commercial missions to gain more customers using rail instead of road, taking advantage of the extensive network and existing commercial offer.

Measure 4.2. Locomotives powered with natural gas

The locomotives operating in the port are diesel, although most of them are electrified once they are outside the harbour at Can Tunis station. While there are different options regarding emission reduction technologies and alternative fuel, APICE goes for the introduction of natural gas locomotives operating within the port as tractors, either by substitution or conversion. The use of natural gas as an alternative to diesel fuel can be applied to the existing fleet of locomotives with a cost-benefit relatively effective. NOx emissions can be reduced by up to 78%. An advantage of the dual fuel technology is to have flexibility to operate fully with diesel if no natural gas available. The cost of replacing a diesel locomotive engine for dual engine diesel or natural gas is between 300,000 and 600,000 €.

2.5. Cargo handling equipment

Regarding this emission sector, APICE focuses on three container terminals: TCB, Prince of Spain Dock and Prat Dock (the two latter operated by TERCAT), where the largest number of cargo handling equipment is found. TCB has invested in the installation of catalytic converters in some machines. Most of the activity is done by machinery which has been improved and the oldest only come into operation at peaks of work. Regarding Prat Dock of TERCAT, it should be noted that it is semi-automated and much of its equipment is powered by electricity.

Measure 5.1. Equipment substitution/conversion to natural gas

Replacing diesel with natural gas equipment can significantly reduce emissions, up to 50-80% and 90-95% NOx and particulate matter respectively. However, it can be very expensive. Some engines need minimum requirements for conversion to natural gas, but many would have to be replaced at a cost of between 23,000 and € 54,500.The measure would consist on replacing or converting TCB equipment, fully or partially depending on possibilities, in an analogous manner to measure on tug boats powered natural.

Measure 5.2. Other abatement emissions strategies (technology, fuel and operations)

Regarding measures to improve equipment by reducing emissions through chemical and physical processes that change the composition of the exhaust gases, it is worth mentioning: particulate filters, partial particulate filters, diesel oxidation catalyst, NOx catalyst, catalytic reduction and selective catalyst for NOx absorption. As for fuel options, other alternatives are: diesel emulsions, biodiesel, Fischer-Tropsch diesel and E-diesel. Concerning operational measures, it would be interesting to introduce an idle reduction program, which also saves costs to companies. These programs have been successfully introduced in the ports of New York and New Jersey, among others.

2.6. Solid bulks

Measure 6.1. Best practices implementation as developed by Ports of the State

The Port of Barcelona has introduced significant improvements in handling solid bulks, governed by a port ordinance, and according to the previous air quality plan of the Catalan Government. Furthermore, it is planned to consider the transfer of the bulk terminal to another area of the port, although there is still no roadmap for action. This measure embraces the implementation of the *Best Practice Guidelines for Handling Solid Bulks* developed by Ports of the State under the HADA project.

2.7. Enlargement and maintenance works

The port of Barcelona has recently completed a major extension. Associated works have had a notable effect on the emission of particles due to the movement of sand and truck traffic, as evidenced by the air sampling campaign conducted by APICE. However, it should be noted that corrective actions have been taken as the zone watering. In addition to these works, the port area often undertakes other works, whether maintenance or minor extensions, and thus associated emissions should be controlled.

Measure 7.1. Works emissions control

As described in the 2011-2015 plan to improve the air quality of the Catalan Government for the case of municipalities, it would be desirable to restrict the operations of the port works in environmental pollution episodes. The Generalitat would warn about these episodes to the Port Authority, which in turn would do so to the companies responsible for execution of the work.

2.8. Emissions and air quality monitoring

Generalitat de Catalunya is the body responsible for the assessment of air quality in Catalonia through the Air Pollution Monitoring and Forecast Network. In addition, through its Technical Office for Air Quality Improvement Plans, conducts periodic emission inventories as the basis of their plans. The 2007-2010 plan established a tracking system by which the Port Authority of Barcelona reported annually on progress on measures affecting the port. Moreover, the Port of Barcelona has its own network of air quality monitoring and issue annual reports. Finally, it is to note that several port companies (such as tugs and container terminals) perform comprehensive monitoring of its operations and energy efficiency as part of their quality systems, and thus becoming a valuable resource for inventories.

Measure 8.1. Regular update of emissions inventories

So far, the Technical Office for Air Quality Improvement Plans is responsible for conducting, with data provided by the APB, the emissions inventory of the port focusing on vessel traffic, particularly in the phase of manoeuvring and berthing. The APICE project, working closely with the Port Authority and the Technical Office, has expanded the inventory to include other sources related to maritime traffic.

Given the position of the Port Authority and its accessibility to data, it is the most appropriate institution to conduct such inventories. APICE project offers the worksheet used for inventory of 2008, which could provide a basis for future inventories. In addition, the sheet includes the two scenarios considered so this tool can still be used. Emission inventories should be updated while the Catalan Government updates other emission sectors for their air quality plan, avoiding a duplication of efforts.

Measure 8.2. Air quality modelling

APICE has developed an air quality assessment system through the air dispersion model MM5-CHIMERE. Modelling activities have been conducted not only for the emissions scenario 2008, but also for the trend 2015 and mitigation scenario resulting from APICE plan implementation. Thus, it helps verifying the impact of the proposed measures on immission levels, for example regarding pollutants exceedances. APICE makes available to the Catalan Government and the Port Authority the emission data used for modelling and mapping generated. These data may be used free of charge for future modelling that any of the two entities may perform.

Measure 8.3. Air quality monitoring

The Port of Barcelona has an air quality monitoring network in place. Continuous air monitoring has been crucial for the identification of emission sources associated with these substances, and to take appropriate measures to mitigate adverse effects. The control of air pollution in the port of Barcelona should continue and APICE proposes restructuring the monitoring network in the light of the analysis of the sampling campaign, advising, for instance, the maintenance of two well-instrumented sites (particles, NOx, SO2 and VOCs).

Measure 8.4. Coordination structure on air emissions

The Generalitat de Catalunya and the APB are two key players in the control and monitoring of emissions and air quality in the port. Besides its regular collaboration, the APICE project has organized meetings with both entities in the form of "working tables", which have served to work together and validate preliminary results. APICE proposes as a measure to formalize these working tables as a follow-up tool and a body in which to agree on the necessary actions to control and monitor port emissions. The structure should be composed of at least the Industrial Security and Environment Department of the APB and the Technical Office for Air Quality Improvement Plans of the Generalitat. It is advised that other departments of these organizations attend meetings due to multi-sectoral aspects of air quality. In these meetings, which could be annual, progress on the abatement measures would be presented and the plan would be adapted when necessary.

2.9. Governance, monitoring and financing the plan

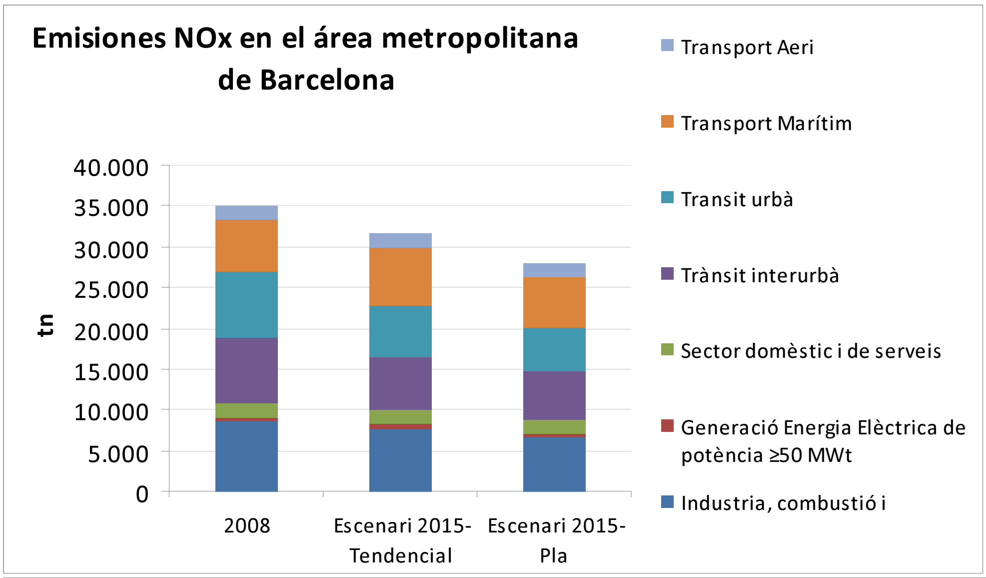
APICE Plan was developed in a spirit of consensus between the project partners and stakeholders, especially the APB and the Generalitat de Catalunya. These two institutions are responsible for its implementation and follow-up. The Generalitat may integrate these measures into their plans to improve air quality. The APB, through its various departments and regulations, may promote or perform some actions as described in the preceding chapters. APICE partners in Barcelona, EUCC Mediterranean Centre CSIC - IDÆA could contribute in the manner they deem most appropriate.

For measures concerning companies operating in the port, "Best Environmental Practices" conventions with the APB can be a good source of funding. When such agreements are set, companies are entitled to bonuses as described in Article 19 of Law 48/2003 of 26 November on financial regulation and the provision of services of general interest ports, as amended by Law 33/2010 of 5 August.

Regarding energy and fuel measures, gas suppliers companies could finance the conversion or replacement of some units as pilot projects. In addition, ICAEN could participate in such actions. In any case, the port companies should be involved in these efforts which in the medium and long term would have positive effects in operational expenditures. Finally, it is important to highlight the availability of European funding sources to implement some actions. For example, the APB has already mobilized over a million euro to improve the port's internal rail network through TEN-T, among other projects. The case of LNG seems best suited for such funding.

3. Future emission and immission scenarios for the Barcelona Metropolitan Area

APICE project has followed the same approach as the Generalitat de Catalunya on the emissions evolution. As evidenced in the plan, APICE has assessed emission sources derived from shipping and port activity, while the Generalitat estimates the overall emission sources, including power generation, heating, land transportation, extractive activities, etc.



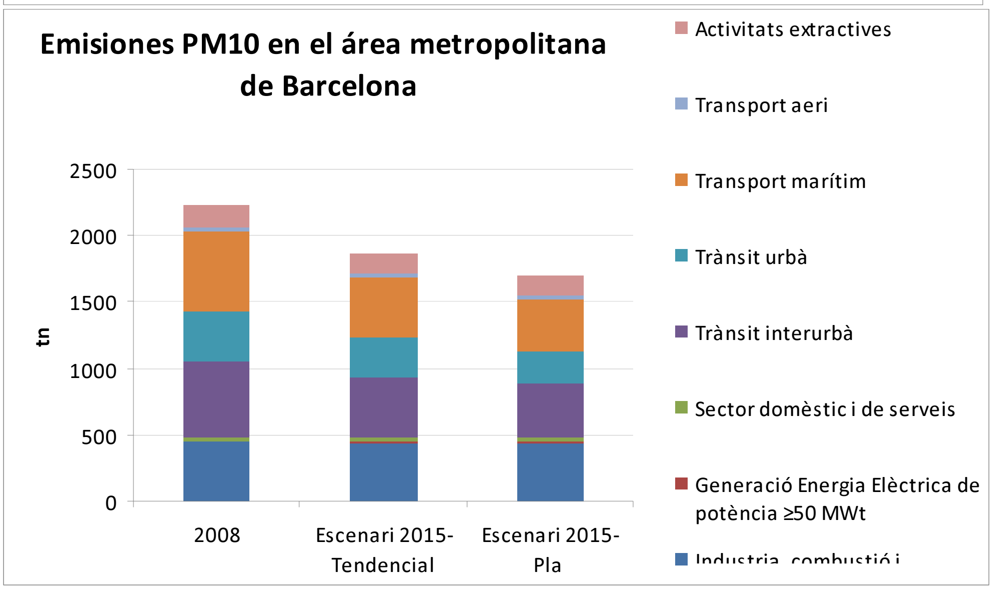


Figure 1.5 and 1.6: Emissions of NOx and PM10 of the Metropolitan area of Barcelona.

It is interesting to combine both assessments and note how APICE can contribute to the Government's efforts to reduce total emissions of the area affected by the air quality improvement plan. Thus, the shipping emissions estimated by the Government have been tuned with APICE studies, adding port emission sources and adjusting the baseline scenario and mitigation plan. The figures show the different emission sources with APICE contribution regarding fine-tuned sources of shipping and port.

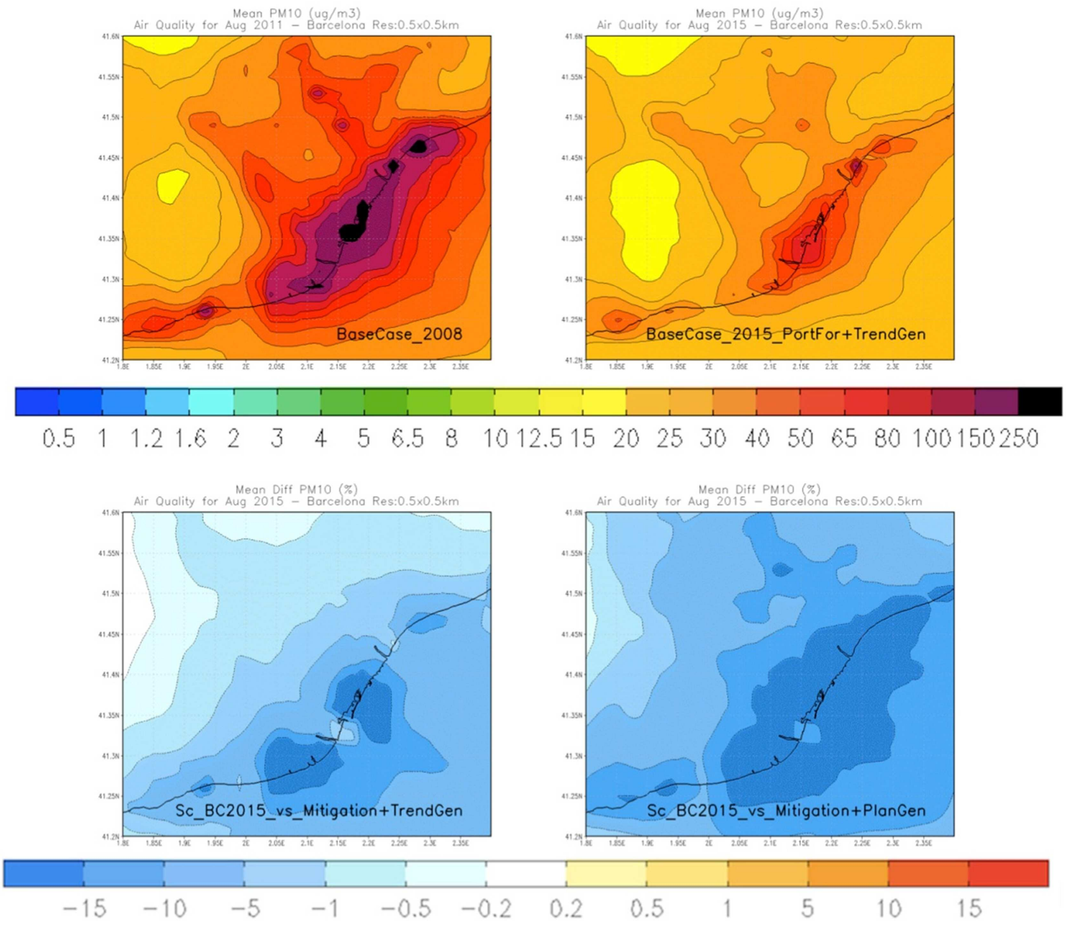


Fig: 1.7: Modelling air pollution and future evolution in different scenarios. Top-left map shows PM_{10} concentrations ($\mu g/m^3$) in August 2008. Top-right, concentrations are shown for the trend scenario 2015, where a slight decrease of concentrations is perceived. Bottom maps show two mitigation scenarios where difference with respect to scenario 2015 is shown in percentage. On the left, reductions achieved by APICE are shown, while on the right, the combination of joint Generalitat and APICE plans effect is displayed.

As a result, considering all sectors, the plans implementation scenario (both Generalitat and APICE) reflects reductions of 12% and 9% of NOx and PM10 respectively, compared to the trend scenario. Concerning the emissions reduction between 2008 and plans implementation, the reduction is for both substances 18%.

4. Conclusions

The implementation of the European project APICE has allowed consensus building while formulating a plan for the abatement of those air emissions linked to the port of Barcelona and negatively affecting air quality at the metropolitan area. It can be said that the strength of this project has been the collaboration not just among the APICE scientific and planning team but with the stakeholders in charge of port and maritime activities and air quality. The plan does not compromise by any means the growth of the port of Barcelona; on the opposite, it regards it as a key development hub and aims to support it on the field of environmental excellence and social compromise.
Following the scientific studies and the plan formulation the time has come to implement the agreed measures. Stakeholders' engagement is crucial to succeed on

air emissions abatement. Thus, the Catalan Government and the Port Authority play a major role in view of their competence on regulation. They can go further and encourage port and maritime enterprises to enhance their environmental management in ways that revert as financial savings in their operations. As regards financing, one of the challenges for implementation, the APICE Plan foresees existing sources which can be accessed by the affected group of actors.

To conclude, Barcelona APICE team is grateful to the MED Programme for the support provided to implement the project; we further want to thank the European partnership and especially the team leader, the Veneto Regional Agency for Prevention and Environment Protection (ARPA-Veneto) and the Catalan and Spanish stakeholders for their collaboration to take APICE to good port. We want to especially acknowledge the support among others of Joaquim Cortés, Isabel Hernández, Sergi Balagué, Meritxell Margarit, Albert Garcia, Carles Rua, Juan Carlos Murcia, David Pino, Juan Ramón Freire, Jordi Vila, Montserrat Beltrán, José Poblet, Esteban Molina, Pablo Pedrosa and Anna Parra.

Local Adaptation Plan for Genoa

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1. Introduction

In the participation process that has accomplished the whole Apice project, the Province of Genoa has involved the following stakeholders:

- Port Authority of Genoa
- Liguria Region and ARPA Liguria
- Muncipality of Genoa,
- Harbor Office of Genoa

The Genoa Port Authority has been involved since the earliest stage of the project, and this institution is officially “Observer” of the Apice Project.
The Genoa Port Authority is developing the new Port Master Plan, whose guidelines were published in July 2012. Apice is considered a good tool to support decisions in the construction of this Plan.
The Liguria Region is in charge of the Air quality plan. The in force plane is dated 2006. In this plane, the harbor is identified as air pollution source, but the measures envisaged in 2006 to mitigate this impact had necessity to be better evaluated and more supported by scientific knowledge.

The scenarios of development foreseen by Genoa Port Authority in the new port master plan, which describe the harbor towards 2020, focus on five main themes:

- Expanding the harbor entrance for hotelling the last generation ships which require maneuvering ray of 300 meters.
- Increase the linear length of the piers in TEUs Terminal, with a capacity of 12 meters deep, for hotelling post-Panamax cargo-ships.
- Expanding Terminal TEUs spaces;
- Improving the infrastructural interconnection considering also the dry port area (Catch Area), with particular reference to the new railway line over the Apennines.
- Overcoming and mitigate possible/future risk situations within the relationship City-Port.

The discussion on these five themes – proposed by Genoa Port Authority - was the starting point for the assessment of the measures, to be investigated with the APICE tools.
Since the development of the APICE project coincided with the revision of the Port Master Plan, a bottom up approach was used in the definition of the reduction target.
The main objective of such approach was to furnish a useful indication to the decision makers (and in particular to the Port Authority, which now is in charge of the new plan) on the possible impact of the future scenarios.

As first result of the APICE project, in Genoa for the first time it was developed a modelistic tool, able to reproduce with good agreement the actual situation and to simulate development scenarios.
The actual contribution of the port activities to the air pollution in Genoa, for the first time, was evaluated in a scientific and accurate manner.
A detailed analysis of the guide lines of the port master plan with APICE model requires a deeper knowledge of concrete actions which are going to be implemented by local stakeholders, and then a further study of expected effects of such actions.

This activity exceeds the objectives of APICE; nevertheless the stakeholders involved in the process decided, in agreement with the roadmap indicated by thy APICE partnership, to simulate the following scenarios:

1. Scenario at 2020 without mitigation actions
2. Scenario at 2020 with reduction of sulfur content in fuel.
3. Scenario at 2020 with reduction of sulfur content in fuel and electrification of selected quays

The power plant actually in activity in the Genoa harbour will be definitely closed in 2017, and this fact is considered in the three scenarios. Details on the methodology for the selection of the actions are reported in the following paragraph.

2. MEASURES ANALYSIS AND IMPLEMENTATION

2.1. Selection of the actions

According to the 47 different actions provided by Veneto Region for APICE project, the relevance have been evaluated in Genoa using the Delphi methodology.

APICE team has conducted the assessment according with the indications of Genoa Port Authority and Liguria Region in occasion of specific interviews.

The general ranking of these measures is provided in Table 2.1.

From this evaluation, the most important actions to improve air quality in Genoa are the on-shore power supply solution during the hotelling phase, the displacement of port activities, the inspection on board of air emissions and the communication strategy.

From the initial table provided by Veneto Region, this evaluation underline in particular 9 actions, mainly concerned ships and vessels emissions or inventoring, monitoring and communication strategies. These 9 actions has been selected in Genoa by a group of experts and stakeholders from the Port Authority.

Table 2.1: General ranking of the measures updated with assessment

Description of the action	Final ranking		Sub-ranking		
	Ranking	Total evaluation	6 criteria	3 criteria	1 criteria
Hotelling - Shore power	1	**324,08**	1	1	1
Displacement of port activities	2	**281,47**	2	2	1
Air emissions inspection on board	3	**238,69**	6	6	2
Communication strategy	4	**236,24**	3	5	2
Alternative fuel (LNG)	5	**226,63**	5	3	2
Manouvering - Change in fuel while manouvering	6	**224,12**	7	9	4
Mode switching - Alternative fuels (CNG, LNG, hybrid)	7	**219,96**	4	5	4
Data Sharing: Inventoring Emissions and Monitoring concentrations	8	**213,07**	7	7	4
Monitoring and control (protocol or agreement between stakeholders, etc)	9	**212,24**	8	8	4

The *Hotelling – shore power* reaches the first ranking as it combines a high emission reduction with good technical feasibility and adaptation capacity to the actual piers organization in Genoa. The *Displacement of port activities* action gets a high total because of the definition of new governance and development plans as the PRP (Port Authority Development Plan). The *Air emissions inspection on board* reaches an high ranking position even if not the best position, because of the necessity to control the high traffic within Genoa Port. The *Communication strategy* represent a key action for Genoa Port Authority because of the international role of the Port within Mediterranean Sea as well as in the APICE project.

2.2. The present situation in Genoa

The present situation in terms of pollutant concentration in the city of Genoa is represented in figure 1, where PM2,5 hourly concentrations in summer 2011 is represented.
This is the output of the APICE model, which reproduces the present situation in Genoa.
It is important to underline that the pollutants concentrations estimated in 2011 with APICE model are in good agreement with the values measured during the monitoring campaign held in Genoa in the period February – October 2011.
The projections and effect of the measures considered in the APICE scenarios is represented as a relative difference with respect to these reference values.

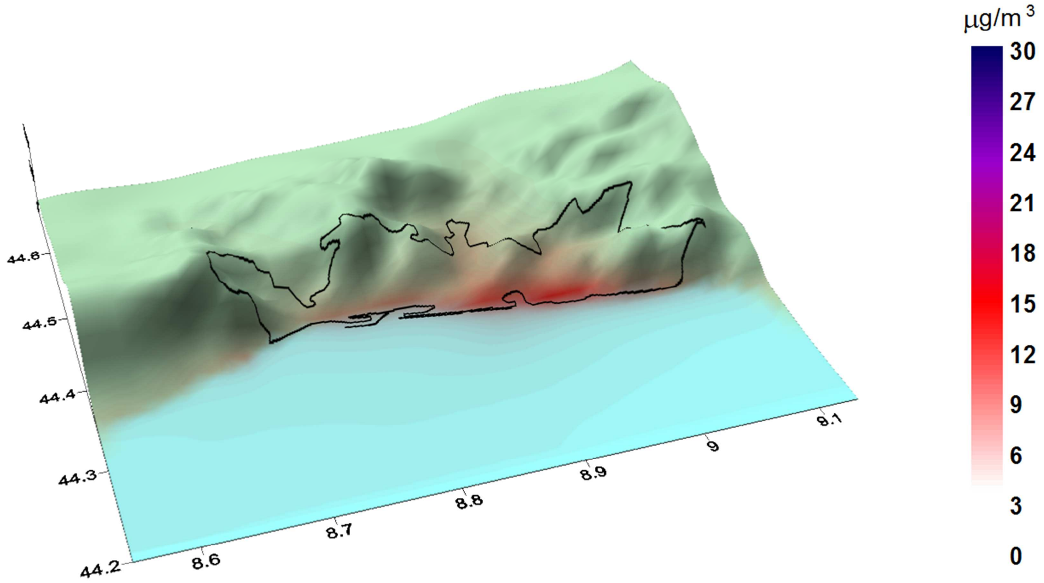

Figure 2.1 – PM2,5 hourly concentrations in summer 2011 in the city of Genoa

2.3. Scenario at 2020 without mitigation actions (Scenario n. 1)

The first scenario considered with APICE model is based on the projection of the emissions inventory to year 2020, in the absence of mitigation actions. The emission values at 2020 are calculated on the basis of the analysis of the ENEA project GAINS-Italy (http://gains-it.bologna.enea.it/gains/IT/index.login). According to this projection, there is an overall reduction in the concentration of PM2.5 in the atmosphere, due to a general reduction of all production activities, while an increase is expected for the emissions related to the maritime sector.

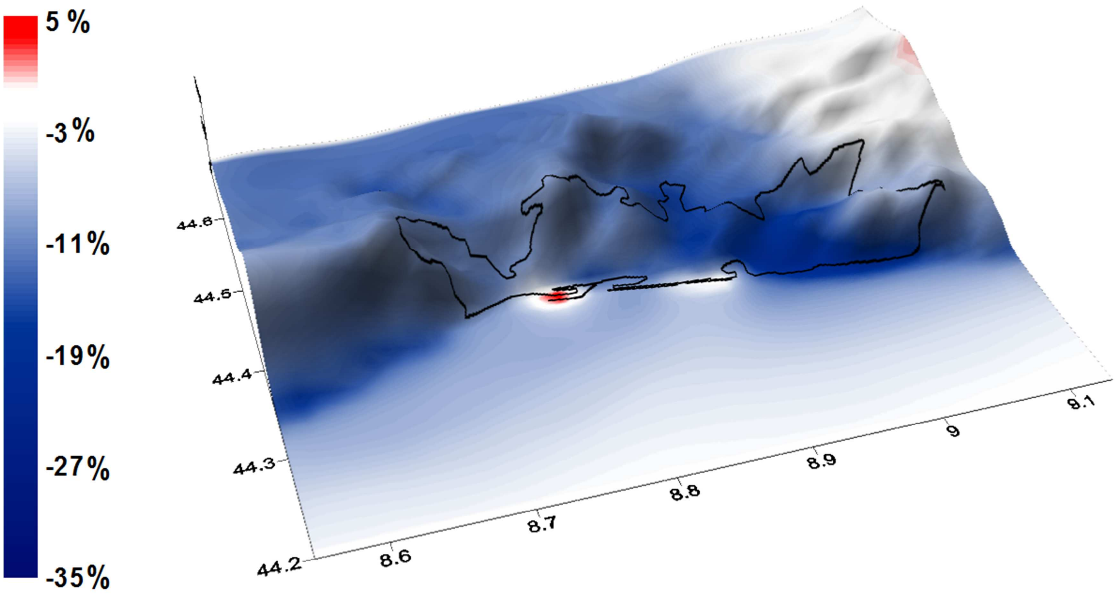

Figure 2.2: PM2,5 relative emissions in 2020 without mitigation actions

Table 2.2.: Scenario at 2020 of emission change (%) with respect to baseline inventory.

	Scenario I : 2020 emission					
	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2,5}$
Emission change (%) with respect to actual inventory	7,9	13,0	0,0	13,0	12,0	12,0

2.4. Scenarios at 2020 with reduction of sulfur content in fuels (Scenario n. 2)

The second scenario considered with APICE model is based on the projection of the emissions to 2020 (like in scenario 2.1) , considering the regulatory limit imposed for the content of S in the fuels used by vessels.
For the sake of clarity, it is useful to underline that in 2008, the IMO adopted a resolution to amend the MARPOL Protocol. This amendment - which came into force in July 2010 - introduces limits on the sulfur content for the marine fuel as follows:

- ✓ in the SECA: 1.00% from July 2010 and 0.10% from January 2015.
- ✓ in sea areas outside the SECA: 3.50% from January 2012, 0.50% from January 2020.

The simulation of the effect of such new regulatory limits required a series of assumptions which where shared with the APICE partners. In particular, it was assumed – based on literature data - that the reduction of sulfur in fuels causes a 20 % decrease in PM2.5 emission.

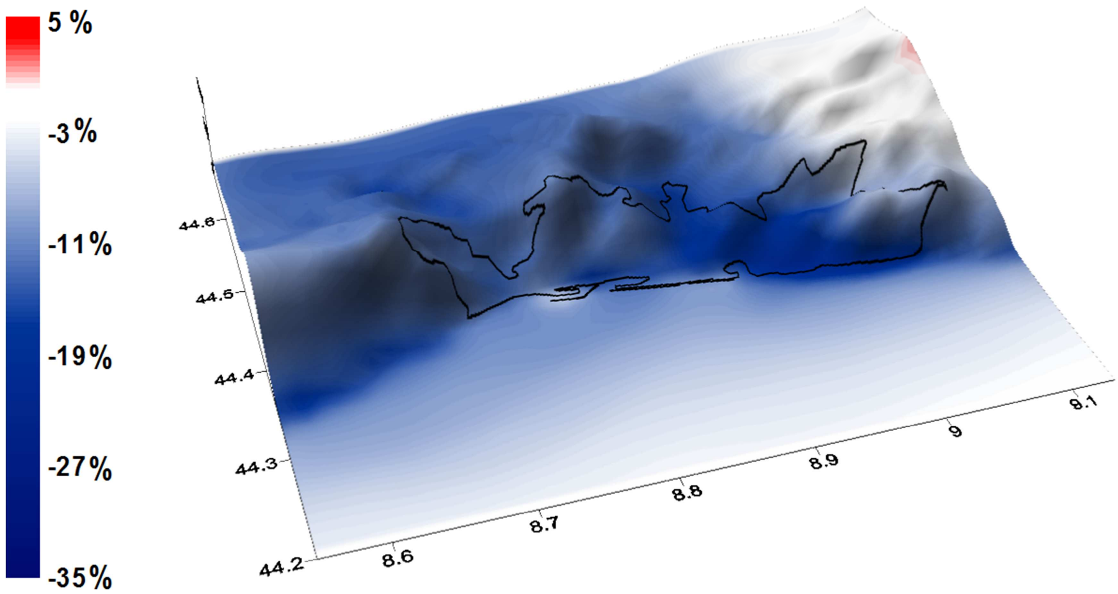

Figure 2.3: PM2,5 relative emissions in 2020 with Sulfur reduction in fuels

Table 2.3.: Scenario at 2020 of emission change (%) considering the Suphur reduction in fuel with respect to baseline inventory.

	Scenario II : 2020 emission + S% reduction in fuels					
Emission change (%) with respect to actual inventory	**NO_x**	**VOC**	**CO**	**SO_x**	**PM_{10}**	**$PM_{2,5}$**
	7,9	**13,0**	**0,0**	**-43,5**	**-9,0**	**-10,4**

Stakeholders: Genoa Port Authority, Harbour Office, Genoa Terminal Passengers, Ship Owners.
Advantages/Benefits: high impact on whole urban area of Genoa, with drastic reduction of particulate matter and SO2 derived fro port activities.
Uncertainties/Barriers/Bottlenecks/Disadvantages: level of control on the S level in fuels, availability of the fuel.
Implementation (Voluntary/regulatory action; Economic sources; etc): Regulatory action (EU directive)

2.5. Scenarios at 2020 with electrification of VTE and Ferries Terminal (Scenario n. 3)

The third scenario considered with APICE model is based on Scenario n. 2 with the electrification.

As reported in the following scheme, the contribution of VTE and Ferries Terminal emissions to total harbor emissions is around 10%, while the abatement of the emission in the area close to the electrified quays is very high (till 80%).

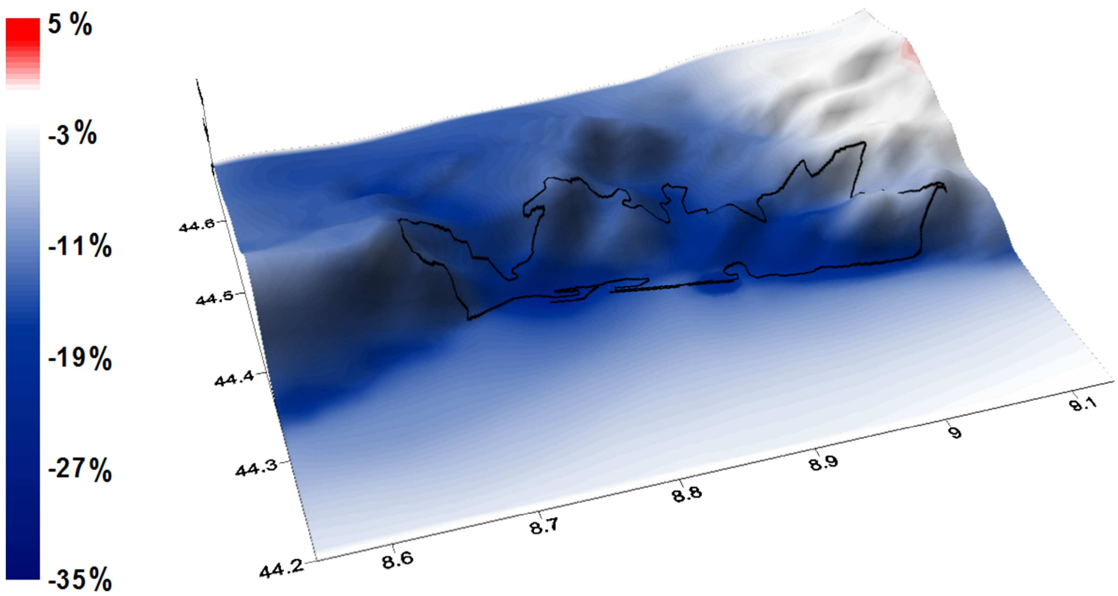

Figure 2.4: PM2,5 relative emissions in 2020 with Sulfur reduction in fuels and cold ironing (VTE and Ferries Terminal)

Table 2.4.: Scenario at 2020 of emission change (%) considering the Suphur reduction in fuel and cold ironing with respect to baseline inventory.

	Scenario II : 2020 emissions + S% reduction in fuels + cold ironing (VTE and Ferries Terminal)					
Emission change (%) with respect to actual inventory	**NO_x**	**VOC**	**CO**	**SO_x**	**PM_{10}**	**$PM_{2,5}$**
	-38,0	**-34,0**	**-35,0**	**-35,0**	**-35,0**	**-35,0**

Stakeholders: Genoa Port Authority, Genoa Terminal Passengers, Ship Owners.

Advantages/Benefits: very high mitigation at local level. Contemporary mitigation of noise from harbour.

Uncertainties/Barriers/Bottlenecks/Disadvantages: Economic impact.

Implementation (Voluntary/regulatory action; Economic sources; etc): Voluntary action.

2.6. Development of infrastructural network

The initial phase of the project has also considered the future development of the infrastructural network, surrounding not only the port but also Genoa metropolitan area, considering both short, medium and long-term solutions.
About the interventions to be fulfilled in short-to-medium term, it has been considered that the projects referred to the preliminary activities for new land infrastructure. These are linked also to the new railway lines (Terzo Valico) along the north / south main route and the expansion of some terminals in Genoa port (Calata Bettolo and Ronco-Canepa Piers).
About the interventions to be fulfilled in medium-to-long term, it has been considered both the construction of Genoa new motorway in order to bypass the city center along the east / west main route, and the different Port development scenarios as they were presented in 2012 Guideline documents for the review of Genoa main Port Planning activities.
The fallout of these infrastructures has not been evaluated in the context of APICE, since traffic studies necessary for the evaluation of these actions are not yet available.

2.7. Shipyard delocalization

In particular, a high impact proposal developed within APICE project in Genoa, deals with the reorganization of some Port risk activities (such as the shipyards) also for promoting urban regeneration of historical city center and connect the old harbour area (redesigned in 1992 by Renzo Piano) with the Expò to the west.

The aim of this proposal was clearly to study not only a mitigation strategy related to the old city tissues, but also to overcome the shipyards localization, defining an urban design operative approach to rethink entirely the western city waterfront.

At the same time, creating a cluster of shipyards activities concentrated in the eastern part of Genoa Port, would give strength to the already planned extension of Fincantieri areas, as preliminary economic conditions to realize the the new railway lines (Terzo Valico) along the north / south main route. It should be noted, in fact, that its realization depends directly on the possibility of relocating in that area (in order to create new piers) the huge amount of spoils derived from tunnel excavations process trough the Apennines mountains.

The idea of relocating the whole activities actually in the shipyard area in a new position of less impact to be realized within new expansions of Fincantieri area in Sestri Ponente is a project that will be evaluated in the new Port Master Plan.
This hypothesis in addition to eliminate all the existing conflicts between the port and the city, strengthen even more the node of the future shipyards activities and, because of this, the absolute necessity of providing better connections and new infrastructures to confirm the emerging and strategic role of this part of Genoa harbour.
The delocalization of shipyard area was considered and discussed with the stakeholders, but no simulation was possible within the time of APICE project.

2.8. Communication activities in Genoa Port Center

Although the scientific content of APICE is particularly high, the outputs of the project are interesting not only for institutional stakeholders - for which APICE is a useful tool to support decision - but also for the general public, which is directly involved in the socio-economic and environmental impacts associated with port activities.

In this context, the Province of Genoa promotes the development of a specific communication tool devoted to the general public to disseminate the results of APICE, which represents in a user friendly way the scenarios evaluated in APICE (present situation, future situation with an without mitigation actions).

The natural seat for this communication activities is the “Genoa Port Center”, which is a a connection point of the port with the city.

Following the Port Center Model, a section of the Genoa Port Center is devoted to the environmental sustainability in the Port of Genoa, with particular emphasis on innovative solutions to reduce emissions of pollutants, emission of climate-altering gases, noise pollution and on the exploitation of renewable energy (in agreement with the Port Authority Environmental Energy Plan, a project of the Port of Genoa, which involves the use of renewable energy sources and promoting energy efficiency in the port).

To disseminate the fundamental concept that respect for the environment and quality of life are the challenges that the port of Genoa will face in the future, in the Green Port section the following exhibit are currently present:

- ✓ *Exhibit dedicated to the electrification of the docks* - A special installation shows the virtuous cycle of energy adopted in the port of Genoa,
- ✓ *A film* illustrates the activities and the ecological services provided in port areas.

The area dedicate to APICE will be implemented in the near future with a new multimedia station, supported by a Microsoft Surface that will contain the results derived from the analysis carried out by the APICE project.

The goal of the exhibit is to provide a laboratory that allows visitors to explore the environmental impact data by manipulating a model of the port of Genoa, which allows both a tour of the current state, and the evolution of the sector plans. Touch, in real time, the consequences of certain choices helps to understand the complexity of the problem.

3. Mainstreaming for Genoa: Conclusion

The first result of the APICE project, is the development of a modelistic tool for air quality in the city of Genoa.
Within APICE project, it was explored the application of the model to a set of scenarios, shared with the local stakeholders. APICE model was demonstrated to be a suitable tool for predict the effects of a selection of measures.
The effect of the Sulfur reduction in fuel is a very effective measure in reducing impact of the port activity on the city.
The electrification of VTE and Ferry Terminal has mainly a local effect in the abatement of the emissions from port activity.
The delocalization of shipyard area was considered but no simulation was possible within the time of APICE project.
In addition, local stakeholders are interested in the future integration of the environmental effects studied with APICE within the other existing local plans.
The Genoa Port Authority, which followed from the very beginning the work of the scientific partners involved in APICE, remarks that the simulation tool developed within the project can be really useful, even in the immediate future, in order to measure and compare the different air quality levels and other environmental aspects on urban areas.
In this framework, it's significant that Genoa Port Authority, Province of Genoa and Department of Physic of the University of Genoa are defining a first draft of voluntary agreement about the capitalization process of APICE project in order to consolidate and support the future development of the simulation tool for the Environmental Assessment of the Genoa Port Plan.

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Local Adaptation Plan for Marseilles

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1. Introduction

To respect the European Directive, the French “Grenelle de l’environnement” has set an ambitious target for France to reduce by 30% $PM_{2.5}$ for 2015. To achieve this target, France has set up in July 2010 the Particles Plan which has to set up measures in domestic, industrial, tertiary, transport and agricultural sectors. This plan has a regional adaptation with the development of Atmosphere Protection Plans (PPA) submitted to the prefectural decision. PPA concretely defines different actions in order to ensure compliance with limit values for cities with more than 250 000 inhabitants and where excesses of these values are monitored or feared. The aim of regional plans is to design the most adapted measures in each area with significant differences in term of geographic, climate, emission, population. To take them in consideration, the spatial frame of these plans varies for each area. For Marseille, PPA is designed at the departmental scale (Figure). These plans are governed by L222-4 to L222-7 and R222-13 to R222-36 articles and will include some regulatory (norm, control …) and incentive (financial contribution, development of low emission area …) actions. At the end of 2012, a new plan for the Marseille department will be enacted by prefectural order.

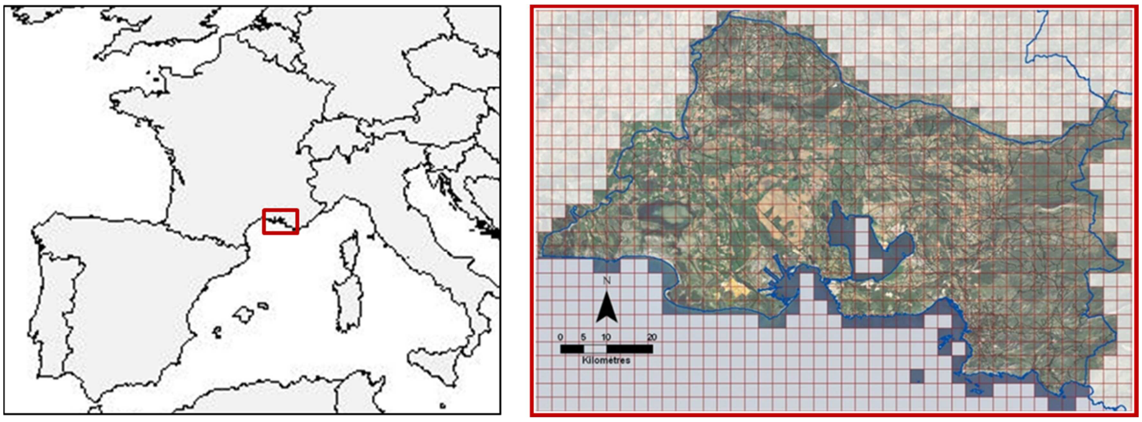

Figure 3.1: Location of the PPA area

During the development and monitoring phase of the plan, a strong leadership of State is required by the way of the public and regal power to involve each stakeholder. Also, it is very important to obtain the strong politic involvement from State, regional and local authorities, elected representatives … As an identification of leaders and stakeholders will be done, this involvement is very important. A competence sharing has to be making with technical stakeholders: air, transport, urban management … To set up and to monitor the actions, it is very important to improve the communication between State and local authorities. Also, a real control after the setting up of actions is a main issue. This control will have to be done independently. At the interested area scale, a sustainable working between stakeholders linked with structural actions has to be planed.

The aim of this plan is to reduce pollutant concentrations to reach levels below than limit values with a priority for particulate matter and nitrogen oxides. In terms of emissions, it aims to reach the ambitious targets defined in the French “Grenelle de l’environnement”. At last, it aims to decrease the population exposition and to define specific actions for residual hot spot in terms of pollution.

Each action which composes this PPA are issue from a cooperation done in a technical working group brought together stakeholders from State, local authorities, economical stakeholders and qualified people get together six times between March

2011 and January 2012. Actions have been validated by a steering committee piloted by Prefect and get together four times between April 2011 and March 2012.

To reach the initial targets, this plan includes 36 sectorial actions and 1 transverse action. A short description of these actions is given in table 3.1.

Table 3.1.: Description of the local action plan for Marseille

Number	Action	Type
	Diffuse dust emission reduction	
1.1	To improve the knowledge about emissions and to define target actions (installations with TSP emissions > 5 tons/year)	Regulatory
1.2	To improve the knowledge about emissions and to define target actions for quarry (production > 150 000 t/y)	Regulatory
1.3	To set up a logistic plan for transport and freight	Regulatory
	Canalized dust emissions reduction	
2.1	To realize technical and economic studies and to set suitable reduction actions (installations with TSP emissions > 5 tons/year)	Regulatory
	Reduction of PM and NO_x emissions	
3.1	To reduce emissions from combustion installations up to 20MW	Regulatory
3.2	To reduce emissions from combustion installations between 2 and 20MW	Regulatory
	Reduction in VOC and PAH emissions	
4.1	To reinforce the action of inspection for the listed installation over the multi-pollutant critical spots	Regulatory
	Improvement of road traffic management	
5.1	Speed reduction over the Bouches-du-Rhône area after a first technical feasibility study	Regulatory
5.2	To insert the air problematic into the dynamic regulation of the road traffic for the highway between St Maximin and Aix en Provence	Regulatory
	To improve air quality consideration with the land planning	
6.1	To insert the air problematic into urban plans and to require some urban control actions to limit the population exposition over areas with some risks to excess NO_x or PM limit values	Regulatory
6.2	To define criteria in relation with the air quality problematic for the impact studies	Regulatory
	To encourage the public transport development and active mode	
7.1	To set up different plans for the companies and for the schools	Regulatory
7.2	To impose air quality targets in the new urban displacement plan	Regulatory
	To improve the performances of vehicles	
8.1	To set a target of 30% for the fleet turnover (private and public fleet > 50 vehicles)	Regulatory
	To reduce the emissions from ports and airport	
9.1	To reduce the GPMM emissions with the OPS solution	Regulatory
9.2	To reduce the Marseille Provence airport emissions	Regulatory
	To reduce the emissions from infrastructures as “urban tunnel”	
10.1	To treat the emissions for road traffic into current and future urban tunnels	Regulatory
	Low emission zone	
11.1	To set up air quality targets inside low emission zone	Regulatory
	To reduce the emissions from combustion installations	

12.1	To set emission limit values for the combustion installations	Regulatory
	To reduce the emissions from installations using wood fuel	
13.1	To limit the emissions from combustion installations (< 400kw) used for home heating	Regulatory
	To reduce the emission due to open fire	
14.1	To limit the emissions of PM and PAH during outside open fires	Regulatory
	To improve road traffic management	
15.1	To set-up no stop ways along tall road	Voluntary
15.2	To set up or to increase size of carpool parking	Voluntary
	To improve air quality consideration with the land planning	
16.1	To insert air quality into the application of new projects as public transport over clean area	Voluntary
	To encourage the public transport development and active mode	
17.1	To promote the plan for the urban public transport	Voluntary
17.2	To give the priority to the public transport over the urban expressway	Voluntary
17.3	To develop regional railway project	Voluntary
17.4	To promote soft displacement	Voluntary
17.5	To develop the information for transport user	Voluntary
	To improve the transport of goods	
18.1	To support the diversification of transport mode of goods for the GPMM	Voluntary
18.2	To set up and to drive some thinking group about the diversification of transport	Voluntary
18.3	To develop the setting up of CO2 charter	Voluntary
	To reduce the environmental impact of building site	
19.1	To define a common guide of “good practice” for building site, demolition …	Voluntary
	Integration Air-Climate	
20.1	To ensure a good connection between PPA and local climate-energy plan	Voluntary
	To reduce the emissions from installations using wood fuel	
21.1	To set up an aid grant for combustion installations which obtain a certificate in relation to air quality	Voluntary
	Action of knowledge improvement	
22.1	To improve the knowledge about particulate matter, persistent organic pollutants …	Incentive
	Formation / awareness / pedagogy	
23.1	To set up formation, awareness and pedagogy processes for stakeholders involved in the setting up of the PPA and for public people.	Incentive

The reduction of emissions has to reach the national targets in 2015, which are: -40% for NO_x, -15% for PM_{10} and -30% for $PM_{2.5}$. To evaluate the compliance of the plan with these targets, a future scenario, including national measures, has been calculated. This scenario gives regional reductions by -30%, -21% and -21% for NO_x, PM_{10} and $PM_{2.5}$ respectively. The actions developed in the PPA have to complete this reduction to reach the initial targets. Three configurations are possible to evaluate these actions:

- Calculable actions from data given by stakeholders involved in the actions: an estimation of emission reduction is available.
- Calculable actions from sensitive tests or/and from benchmark: a range of emission reduction is available

- Non calculable actions: reduction targets are available.

The assessment of measures for each large activity sector over the PPA area is given in the **Error! Reference source not found.**. In association with the national measures, the setting up of this plan allows a total reduction of emissions by -29%, -22% and -28% for NO_x, PM_{10} and $PM_{2.5}$ respectively over the PPA area. For the NO_x emissions, the main reductions are issue from road/non-road transport and energy sectors, whereas the main reductions for PM_{10} and $PM_{2.5}$ are issue from road transport, residential and energy sectors.

Table 3.2.: Improvement of the emissions issue from the actions for different activity sectors over the PPA area

		NO_x	PM_{10}	$PM_{2.5}$
Industry / waste / energy production and supply	Current emissions (kt/y)	29,9	3,6	2,1
	Reduction (kt/y)	0,7	0,1	0,1
	Relative reduction	-2,4	-3,5	-3,7
Road and non-road transport	Current emissions (kt/y)	26,9	2,5	1,9
	Reduction (kt/y)	1,6	0,1	0,1
	Relative reduction	-5,8	-4,1	-4,3
Residential heating, tertiary and open fire	Current emissions (kt/y)	2,1	1,1	1,1
	Reduction (kt/y)	0,002	0,01	0,02
	Relative reduction	-0,1	-1,3	-1,4

Both a chemical transport model and an urban model have run to estimate the population exposition using the future scenario and the whole of actions issue from the PPA. The parameters used to compute an estimation of the population exposed are the daily PM_{10} concentration, with a percentile higher than 50µg/m^3 and the annual NO_2 concentration higher than 40µg/m^3. For each city, the most negative criterion is selected to compute this estimation.

The setting up of the whole PPA allows a significant contribution to the national targets of reduction of particles and NO_x emissions and to reduce by more than 90% the residential population exposed to a limit NO_2 or PM_{10} concentration (Table 3.3).

Table 3.3. : Evolution of population exposed to a limit value using current and future + PPA emissions over the PPA area

Total population	Current situation		Future scenario + PPA		Gains	
	NO_2	PM_{10}	NO_2	PM_{10}	NO_2	PM_{10}
1 349 000	243 000	277 000	10 400	5 700	96%	98%

2. Measures analysis and implementation

In this section a first part details the result of a previous work to rank different actions provided by Veneto Region for each APICE partner and a second section focus on three actions implemented in the framework of the local plan thanks to the APICE outputs.

2.1. General ranking

In the framework of APICE project, 47 different actions provided by the Veneto region have been evaluated by a group of experts in Marseille using the Delphi methodology previously described. The general ranking of these measures is provided in Table 3.4. From this evaluation, the most interesting actions to improve air quality in Marseilles are the on-shore power supply solution during the hotelling phase, the modification of fuel type by using liquefied natural gas (LNG) and the update of emissions inventories. The detail of the evaluation for these three actions according the different criteria is provided in Table3.4.

Table 3.4: General ranking of the measures updated with assessment

Description of the action	Final ranking		Sub-ranking		
	Ranking	Total evaluation	6 criteria	3 criteria	1 criteria
Hotelling - Shore power	**1**	314.13	**1**	**1**	**1**
Alternative fuel (LNG)	**2**	276.85	**2**	**2**	**2**
Update inventoring emissions	**3**	269.45	**4**	**6**	**3**
Data Sharing	**4**	255.45	**3**	**4**	**4**
Environmental excellence certification for trucks	**5**	239.46	9	9	**5**
Increase rail ratio through economic incentives	**6**	237.4	**6**	**5**	**6**
Improvement of rail system	7	223.85	**5**	**3**	7
Port Air Quality Steering/Working Committee/Group	8	221.4	7	7	8
Automated cargo handling systems	9	216.68	10	10	9
Accelerated fleet turnover	10	203.29	12	11	10
Communication strategy	11	191.68	8	8	11
Air emissions inspection on board	12	189.07	11	13	12
Improvement of road system	13	175.79	13	12	13
Accelerated fleet turnover	14	152.18	14	14	14
Displacement of port activities	15	126.11	15	15	15

As this evaluation has been provided by a group of experts mainly issue from the port authority, the actions with the best results directly concerned ships and vessels. The second group concerns the improvement of air quality knowledge. From the initial table provided by the Veneto region, several actions have not been evaluated as no expert has been available in the group.

To explain the three first criteria, Table gives details about their evaluation. The “Hotelling – shore power” reaches the first ranking as it combines a high emission reduction with and good technical feasibility and would be quickly implement in Marseille. The “Alternative fuel” action gets a high total but needs additional development to be better ranked as there is no current network to supply LNG fuel inside the port area.

The action to update the emission inventories allows an improvement of the knowledge of each area and to design efficient scenario. For Marseille experts, this action is a necessary action before to implement a local plan to improve air quality. Also, the data sharing between the different partners allows an additional improvement of local knowledge.

From the general ranking, only the first action will be implemented in the local adaptation plan for Marseille, named PPA (Atmospheric Protection Plan), as this plan is defined at the regional scale to tackle the PM pollution at a global scale as advised by the previous APICE studies about source apportionment.

For the other actions, some of them have been studied in the framework of the evaluation of scenarios supporting coast development strategies. The outcomes have displayed positive results as in the case of the alternative fuel for ships. Due to the timing required to design the local adaptation plan for Marseille, some actions have not been able to discuss during the development of this plan but outcomes of APICE project will be shared for the next local plans.

Table 3.5.: Details of the evaluation for the three first actions

Criteria	Weight	Hotelling - Shore power	Alternative fuel (LNG)	Update inventoring emissions
Cost-effectiveness	9.28	**4**	3	3
Implementability	9.00	**5**	**4**	3
Emissions reduction potential	8.67	**5**	**4**	2
Technical feasibility	8.39	**5**	**5**	**5**
Costs	8.22	2	2	**4**
Enforceability	8.17	1	2	2
Co-benefits	8.00	**5**	3	**5**
Potential funding opportunities	8.00	3	2	1
Measurable results	7.22	**5**	**5**	**5**
Timeframe	5.50	**4**	**5**	**4**

2.2. Measures analysis

2.2.1. Measure 9: Ships emissions

State of the art

From the reference year of 2007, ship emissions contribute to 17%, 4% and 5% of total emission for NO_x, PM_{10} and $PM_{2.5}$ respectively over the APICE domain for Marseille which centered over Marseille port with an area of 100 x 100km. As discussed in the previous task about the future scenario, Port Authority of Marseille forecasts a significant increase of the maritime activity by doubling the passenger traffic in 2025. Combined with the cargo activity, emissions from passenger ships will contribute to a quarter of total maritime emissions and will be the first activity in terms of emissions over the eastern part of Marseille port. On the other hand, hotelling phase for all the maritime activities will represent more than one half of the total emission distributed between hotelling, maneuvering and cruising phases. From the outcomes of the study about source apportionment, the contributions of maritime activity to PM_{10} and $PM_{2.5}$ concentrations are estimated between 9% and 6% at the location of an urban background site downtown in Marseille (Table 3.6).

Table 3.6.: Source apportionment for the maritime activity as the percent of the total concentrations of PM2.5 and PM10 during both winter and summer period at the urban background site of “5 Avenues” and at the port site

	$PM_{2.5}$		PM_{10}	
Site position	Summer	Winter	Summer	Winter
Urban Background	9%	7%	7%	6%
Port	10%	7%	8%	6%

Description of the measure

As the hotelling phase is located inside the port, related emissions directly impact surroundings population. The aim of this measure is to reduce emissions of hotelling phase from passenger ships located inside the eastern part of Marseille port.

Action 9.1: On-shore Power Supply solution

To reduce the contribution of ship emissions to the air pollution, this action proposes to apply the on-shore power supply (OPS) solution which should lead to switch off emissions of ships during the hotelling phase thanks to a connection with the terrestrial electrical network to supply energy. This action allows a maximal emission reduction inside the port area. In several European ports, this action has been already implemented and several feasibility studies are in progress. In Marseille, this action is considered by the port authority and the CNM Company, owner of passenger ships. A first study has been introduced to the French Environment and Energy Management Agency (ADEME). However, this action is very expensive as a financial invest is required by both port authority and ship owners.

Thanks to APICE project, this action has been simulated for three passenger ships in rotation between Marseille and Corsica, using an urban air quality model. The output results have shown a significant local improvement of the NO_2 concentration. In terms of emissions, the application of the OPS solution allows a light decrease of emissions, lower than 1% of the maritime emissions as this solution concerns only three ships even if the duration of their hotelling phases is important (table 3.7). However, if only hotelling emissions are considered, this action allows a gain of 0.8% and 1% for the port emissions of NO_x and PM respectively and a respective gain of 2.8% and 3% for NO_x and PM emissions if only the emissions of the hotelling phase inside the eastern port are considered. The evaluation of this scenario in terms of resulting concentrations needs to compute it with an urban model. The area with a significant improvement is located close to the terminal involved. The maximal improvement in terms of monthly concentrations is 0.25µg/m^3 and 3.4µg/m^3 for $PM_{2.5}$ and NO_2 respectively.

The implementation of this action needs to consider the impact of the energy production which will be used to supply ships during their hotelling phases. To be a good mitigation action, this energy should be provided by a non-pollutant and renewable energy. Also, it will be necessary to share a technical standard at the European scale and beyond to allow a connection of ships inside every port.

Table 3.7: Emissions from ships and vessels activities inside the APICE domain (100 x 100km^2) without or with the application of the OPS solution.

Emission [Mg/year]	CO	NOx	SO_2	NMVOC	PM_{10}	$PM_{2.5}$
Base future (2025)	29 533	22 107	4270	6 384	443	443
OPS solution	29 260	22 044	4265	6 321	439	439

In Marseille local plan, this action is piloted by Marseille Port Authority with the collaboration of several stakeholders as the Regional direction for environment, development and accommodation (DREAL), the Facilities, Transport and Maritime General Direction (DGITM), the ADEME, the Regional authority (CG13) and ship companies as CNM. To evaluate this action, the local plan forecasts to provide a criterion based on the number of ships using the OPS solution and to monitor the evolution of this criterion. This action is regulatory and would be implemented between 2012 and 2016.

This action is supported by the European Commission which has introduced a project of directive by the 15th July 2011, aiming to reduce fine particulate emissions by around 80%, by the annex 4 of the MARPOL convention and by European recommendation (2006/339/EC) which promotes the using of terrestrial electrical networks for the ships during their hotelling phase inside European ports and encourages member states to propose economic incentives for ownerships to use these terrestrial networks, to awareness local, maritime and port authorities and to exchange about the best practices to supply energy by the terrestrial network and to standardize procedures.

2.2.2. Measure 13: Emissions reduction from small installations using wood fuel

State of the art

Residential sector contribute to 4%, 14% and 20% of NO_x, PM_{10} and $PM_{2.5}$ emissions respectively over the PPA area. For this sector, biomass burning represents 9%, 93% and 93% of NO_x, PM_{10} and $PM_{2.5}$ emissions respectively.

The APICE project has allowed the development of new tools in Marseille to estimate the contribution of each pollution source for PM_{10} and $PM_{2.5}$ concentrations. Over Marseille area, two chemical transport models with two different approaches have been used to get this evaluation. CHIMERE model has been updated with a “zero-out” methodology and CAMx has run with a tracer approach thank to PSAT module.

During the winter time, residential sector, dominated by biomass burning emissions, displays a significant contribution to PM concentrations at an urban background site downtown in Marseille (

Table 3.8). For the total $PM_{2.5}$ concentrations, this sector displays the highest contribution and is the second for the total PM_{10} concentrations.

Table 3.8.: Source apportionment for the residential sector as the percent of the total concentrations of PM2.5 and PM10 during both winter and summer period at the urban background site of "5 Avenues" using CAMx and CHIMERE models.

	Winter		Summer	
	CHIMERE	CAMx	CHIMERE	CAMx
PM_{10}	30 %	20 %	11 %	5 %
$PM_{2.5}$	38 %	24 %	19 %	6 %

Description of the measure

This measure aims to reduce the emissions from installations using wood fuel to decrease the contribution of biomass burning emissions associated to residential sector for the PM concentrations during the winter time. It concerns the domestic combustion installations.

Action 13.1: To limit the emissions from combustion installations (< 400kw) used for home heating

This action provides a new regulation to limit the number of wood fireplaces of old generation. The open wood fireplace will be forbidden for a house transaction and each new wood fireplace will have to obtain the "Blue Flame" label or to respect the following criteria: CO rate < 0.12% and performance > 70%.

An information point will be done by notaries during the house transaction and by assurance companies in the framework of the decree n°2011-36 dated from the 10th January 2011 which forecasts the obligation for each occupant to give at the home assurance a certificate which guaranties the presence of a smoke detector before the 8th March 2015.

The performance improvement of individual combustion installations using wood fuel allows a significant improvement of the air quality mainly for PM and NO_x and also for VOC and PAH. By increasing the performance of installations, the energy conservancy and the resource conservation are also considered. Also, removing open wood fireplace improves the indoor air quality and reduces health impact.

Over the PPA area, this action contributes to reduce the global emissions issue from the residential sector by -1.3%, -1.4% and -0.1% for PM_{10}, $PM_{2.5}$ and NO_x respectively.

This action would be supported by the setting up of a network to salvage old installations organized by the ADEME. Also, this action would be combined with a financial support.

This action will be piloted by the ADEME, the DREAL and the Energy information area (EIE) network with a more particular implication of DREAL. This action is regulatory and would be implemented during 2013. It will be evaluated by the number of installations with the "Blue Flame" label.

2.2.3 Measure 14: To reduce the emission due to open fire

State of the art

Source apportionment based on monitoring campaigns in Marseille has also highlighted a significant contribution of biomass burning to $PM_{2.5}$ concentration using organic tracers and chemical markers. From analysis of these results and with a local knowledge of Marseille surroundings, a part of the biomass burning contribution is associated to open fire. There are some difficulties to reproduce these emissions in the inventories as no data are available for this activity because it is forbidden since several years whatever season or location.

To explain the necessity of this action and to illustrate the impact of open fires, it is reminded that an open fire with 50 kg of green waste is equivalent to a ride of 22 000 km in a current car or 5 days of wood heating for a house with an insert fireplace set up after 1996 or 1 month of heating with wood boiler with an high performance or a half of season of heating with oil boiler.

Description of the measure

This action aims to confirm the prohibition to burn green wastes and agricultural waste, to precise the practices for managed open fires and to obtain an exemption to burn green wastes and agricultural waste except during particulate pollution events.

Action 14.1: To limit the emissions of PM during outside open fires

The article 84 of the regional health regulation prohibits open fire of green and domestic wastes. Green waste from park and garden are considered as domestic wastes. They are mainly made up of wood coming from garden cleaning and greenery coming from grass-cutting. This prohibition is implemented for private and professional people. Green wastes will be recycled by individual composting, in the form of woodchips or collected thanks to a system set up by local authorities.

The managed open fires concern the vegetables burns by farmers to clean an area or by fireman or forester before summer to prevent wildfire.

To burn agricultural green wastes needs a prefectural permission which have to be given for agronomical or health reasons only (Article D615-47 and D681-5 of the rural code).

By the forest code, the forest management includes the removal by burning or incineration of a part of vegetable issue from forest interventions as forest cut, processing after a storm, infected vegetables or prevention of wildfire.

This action confirms the prohibition to burn green and wastes from household or local authorities over the PPA area. Eventually, some exemptions to burn agricultural green wastes in the framework of managed open fires or in the framework of requirements to clean wild areas will be given during periods without pollution event and during periods with a thermal instability: between 11h and 15h30 during December, January and February and between 10h and 16h30 for the other months except for the months with a wildfire risk.

Over the PPA area, this action contributes to reduce the global emissions issue from the residential sector by -1.3%, -1.4% and -0.1% for PM_{10}, $PM_{2.5}$ and NO_x respectively.

This action is regulatory and piloted by prefect and mayor with the collaboration of DDTM (land and maritime local direction), SDIS (Emergency and Firefighting Local Service), ONF (National Forest Office), URVN (Local Union for Life and Nature) and DREAL. It will be implemented in 2012 and will be set up with the action number 23 about communication and awareness.

3. Mainstreaming of local adaptation plan for your cities

Thanks to the APICE project, a new collaboration between the port authority of Marseille (GPMM) and the regional air quality observatory (AirPACA) has been set up. This collaboration has allowed sharing precise data about the maritime activity to calculate a new accurate maritime emission inventory over the port area and surroundings.

This new maritime emission inventory has been included in the updated regional emissions inventory over the PACA region. At the same time, the first technical working groups brought together stakeholders from State, local authorities, economical stakeholders and qualified persons to define concrete actions in the framework of the local atmosphere protection plan (PPA) to reduce PM and NO_2 concentrations. During these technical working groups, the on-shore power supply (OPS) scenario which forecasts to switch off emissions of ships during the hotelling phase has been introduced. As this action displayed positive results in terms of reduction of both PM and NO_x emissions, this APICE scenario has been successfully integrated in the local action plan as a regulatory action. Also, the CNM Company, ownership of passenger vessels in rotation between Marseille and Mediterranean cities has submitted this project to the French Environment and Energy Management Agency (ADEME) to receive a financial support.

In the framework of the study about source apportionment, APICE project has allowed a significant improvement of the knowledge on PM pollution origins. Over Marseille area, two chemical transport models have been updates to analyze the contributions of pollutant sources. Also, long monitoring and intercomparison campaigns have allowed to identify source pollution and to quantify them. The main outcomes of these studies have displayed the significant contribution of the residential sector, mainly due to the biomass burning, during the winter time. From these results, a first regulatory action has been designed to reduce the contribution of emission from heating installations using wood fuel. Also, a second regulatory action has been integrated in the local action plan to confirm the prohibition to burn green wastes to reduce PM concentrations.

As the source apportionment studies have also displayed significant contributions of road transport, industry-energy activities and long-range transport of pollution, their conclusions advise to consider PM pollution at a large scale and to set up a cluster of actions related to the whole of pollutant sources to reduce PM concentrations at a local scale and to be accepted by everybody.

In the framework of design and evaluation of scenarios supporting coast development strategies in Marseille, several scenarios have been tested as an alternative fuel for passenger ships or the displacement of a terminal to move hotelling ship emissions away from the city center. Although these scenarios have not been retained for the local action plan, they have provided interesting results which will be able to be discussed and shared during the development of future local plans after the end of the APICE project.

www.apice-project.eu

Local adaptation plan for Thessaloniki

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Acknowledgments:
The authors would like to thank the Thessaloniki Port Authority S.A. and more specifically Mr. G.Vangelas (Ph.D.) for providing us with data for the activities in the port of Thessaloniki. We thank also all stakeholders that participated to the consultation procedure. Their participation was important and they all contributed with suggestions and cooperation spirit.
Finally, we acknowledge the Programme Med of the European Commission for their financial support in the framework of the APICE project.

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1. Introduction

This document is the Local Adaptation Plan in the frame of the Common Mediterranean strategy and local practical Actions for the mitigation of Port, Industries and Cities Emissions (APICE) project. The purpose of this Plan is to define a roadmap for the Port Authority of Thessaloniki and stakeholders to ensure that air emissions generated by sources associated with port activities and affects the city of Thessaloniki will decline even with anticipated future port growth over the next years. The actions identified in this Plan are meant to address the bellow primary emissions mitigation objectives:

- Develop a knowledge-based approach for air pollution mitigation and sustainable development of port activities, managed by spatial planning policies at local level, which includes the territory around the port and the centre of city of Thessaloniki;
- Reduce maritime-related air quality impacts on human health and the environment from criteria air pollutants;
- Merge environmental and socio-economic needs of port-cities policies;
- Support eco-friendly changes in shipping practices and ownership of shared emission abatements options;
- Mainstream the LAP raising policy makers awareness.

1.1. Stakeholders

The integration of the Local Adaptation Plan is based in three procedural elements:

- the stakeholder consultation process which took place at the two Local Working Tables;
- the Delphi Method (Criteria Assess and Measure Evaluation process) and
- the evaluation process conducted by the scientific project team (Aristotle University of Thessaloniki - Department of Physics - Laboratory of Atmospheric Physics, University of Western Macedonia – Mechanical Engineering – Environmental Technology Laboratory, Decentralized Administration of Macedonia and Thrace - Department of Environmental and Spatial Planning).

An important part of developing this Local Adaptation Plan was seeking and incorporating input and feedback from agencies and key stakeholders such as:

- Department of Environmental and Spatial Planning – DAMT;
- Department of Environment – Municipality of Thessaloniki;
- Organization of Planning and Environmental Protection of Thessaloniki - OR.TH.;
- Department of Environment and Spatial Planning – RCM;
- Aristotle University of Thessaloniki - Separate Divisions.

These groups, along with the Port Authority of Thessaloniki, comprised the Working Group, which oversaw the development of this Plan. Several face-to-face meetings and calls were held to scope, draft, and further refine the list of actions to reduce air emissions as provided within this Plan. The above key stakeholders recognize that the development of this Plan is only the first step in achieving future emissions reductions that build upon those already occurring. The key will be transitioning from the promising strategies contained herein to actual implementation of the specific actions needed to achieve further emissions reductions.

1.2. Port infrastructures and future development

The Port of Thessaloniki is fully organized and secure, with experienced personnel, modern and productive equipment, investment plans under implementation and the vision to serve as a hub transit trade center of the Balkan Region. Through the port of Thessaloniki, the year of 2011, 13,708,313 tones of cargo had transported and approximately 2,000 vessels arrived.

The development of the Thessaloniki's Port is a key target achieved through both the evolution of infrastructure and the new innovative practices.

The future plans with respect to extensive port infrastructures are:

- the extension of the 6th pier (container Terminal)
- the construction of a marina
- the improvement and functionality of the rail network

The upgrading and expansion of the technological infrastructures of the Thessaloniki Port Authority S.A. along with the use of state-of-the-art software packages and the development of specialized applications will allow the company to increase its productivity, to simplify and achieve quality services to its customers.

The participation of Thessaloniki Port Authority to research contributes to the transfer of know-how and to the follow-up of modern safe and quality ship service trends while improving the performance of the port activities (Programs SPIN, TRAPIST IONAS, e-LOGMAR-M, NAYTILOS, EFFORTS, FREIGHTWISE, MIRTO). Such research programs (GREENPORTh and GILDA.NET) contribute to the development of the port's environmental protection policy and to the acquisition of significant know-how in the new transaction of Information and Communication Technologies in the transportation field.

1.3. Maritime emissions in the port area of Thessaloniki

The main port related activities studied within APICE, which release pollutant emissions in the atmosphere, are the ship and vessel traffic, the operation of the port vehicles and the processes of loading/unloading and pilling goods and materials in the port.

Table 4.1 presents the emissions from these activities which were calculated for a reference domain with 100x100km^2 extend centered over Thessaloniki. According to Table 4.1, cargo shipping is the major emission source for all pollutants. The in-port storage processes like loading, unloading and pilling of goods/materials can be identified as the second in rank PM emission source.

Table 4.1 Pollutant emissions from the maritime and harbor activities under the responsibility of the Thessaloniki Port Authority S.A. (reference year 2010, reference area: 100x100km^2).

ACTIVITIES OF SHIPS AND VESSELS							
Emissions (tn/y)	**CO**	**NOx**	**SOx**	**NMVOCs**	**NH_3**	**PM10**	**PM2.5**
Passenger ships*	60.67	36.80	10.38	12.73	0.009	1.62	1.62
Cargo ships*	881.02	7022.23	4399.48	113.92	0.904	220.79	220.79
Tugs	2.13	10.10	0.44	0.39	0.004	0.39	0.39

Total	943.82	7069.13	4410.30	127.04	0.92	222.80	222.80
IN-PORT STORAGE							
Emissions (tn/y)	**CO**	**NOx**	**SOx**	**NMVOCs**	**NH_3**	**PM10**	**PM2.5**
Loading	-	-	-	-	-	6.2	0.94
Unloading	-	-	-	-	-	14.7	2.23
Pilling	-	-	-	-	-	16.3	2.47
Total	-	-	-	-	-	**37.2**	**5.64**
IN-PORT TRAFFIC LOAD INDUCED BY PORT ACTIVITIES							
Emissions (tn/y)	**CO**	**NOx**	**SOx**	**NMVOCs**	**NH_3**	**PM10**	**PM2.5**
Vehicles operating in the port	-	-	-	-	-	**0.181**	**0.043**

**total emissions: "on-route"+"maneuvering"+"hotelling".*

1.4. Mitigation objectives

Port of Thessaloniki represents a significant potential for the economic development, but also has a potential negative environmental impact due to multiple emission sources. The presence of competing activities in coastal areas can lead to potential conflicts which need to be managed by the institutional actors like Port Authority and official stakeholders.

This plan establishes a strategy for reducing port-related emissions while allowing the continuation of port development and job creation and economic activity associated with that development. The plan introduces anti-air pollution measures and best practices that applied mainly in the USA and Australia including all suggestions and opinions that were exchanged with EU partners within the project APICE. In addition, some of the proposed measures have a direct and measurable impact on reducing air pollution while for other measures cannot be quantified their contribution on air pollution mitigation despite their positive impact. The main issues for specific port-related emissions that this plan will address are ships, diesel powered equipment, bulk cargo management, rail, diesel road vehicles and inventorying/monitoring/communicating tools. The above port-related issues and parameters are further specified in the next section that details the proposed measures for air pollution mitigation.

Within the framework of environmental protection and sustainable development, Thessaloniki Port Authority S.A. was the first port of the Mediterranean to receive the "Port Environmental Review System" certification for environmental issues by the European Sea Ports Organisation (ESPO) and the ECOPORTS Foundation. Moreover, in harmonization with the community directive 2000/59/CE and the MARPOL 73/78 Convention, Thessaloniki Port Authority implements a ship's waste receipt and management plan. Port Authority acknowledges the significance of environmental issues related to air, soil and water quality as well as resource consumption and endeavors to achieve long-term sustainable development by minimizing air, land and water emissions in all its operations.

The main goal of Thessaloniki Port Authority, regarding air pollution, is to reduce emissions up to 20% and take compensatory actions for the greenhouse gas (GHG) emissions up to 25% annually.

2. Analysis of the measures

2.1. Dry bulk cargo management

Dry bulk cargo is a commodity cargo that is transported unpackaged in large quantities. It refers to material granular, particulate form, as a mass of relatively small solids, such as grain, coal, or gravel. This cargo is usually dropped or poured, with a spout or shovel bucket, into a bulk carrier ships hold, railroad car, or tanker truck/trailer/semi-trailer body and sometimes stored in the port specific areas until the upload. Dry bulk cargo management is classified as an important measure which faces the air quality problems from the airborne particles. The generation of dust from handling dry bulk materials and blowing of dust from piles causes significant environmental impact close to the port city areas of Thessaloniki.

The cargo is accommodated in the Terrestrial Zone of Thessaloniki's port in an area extending on a total surface of approximately 1,000,000m^2 with quay length of 4,000m and depth up to 12m. Cargo of all origins and destinations, including the above, are handled in the Free Zone. Such as:

- General Cargo (steelwork products, metal sheets, timber, marble, pallet cargo, tobacco, fruits, etc)
- Dry Bulk Cargo (minerals, ores, coal, solid fuel, cereals, feed stuffs, fertilizers, cement, scrap)
- Liquid Bulk Cargo with pipelines (spirits, chloroform, asphalt, chemicals, mineral oils, wine)
- Ro-Ro vehicles

The storage of cargo takes place in:

- Warehouses: 85,000 m^2 (out of which 21,500 m^2 and a reefer warehouse of 4,000 m^2 are located in the Free Zone)
- Sheds: 12,000 m^2
- Outdoor Storage Areas: 500,000 m^2
- Silo of 20,000 tones

Table 4.2: Total dry bulk cargo for the port of Thessaloniki (year 2011).

DRY BULK CARGO (tones)			
	IN	OUT	TOTAL
Cereals	93.544,00	74.613,00	168.157,00
Cattle feed/Fodder/Oil Seeds	134.494,00	4.441,00	138.935,00
Coal	479.241,00	-	479.241,00
Ores	1.215.519,00	703.155,00	1.918.674,00
Fertilizers	56.768,00	-	56.768,00
Other dry bulk	544.912,00	286.270,00	831.182,00
	2.524.478,00	**1.068.479,00**	**3.592.957,00**

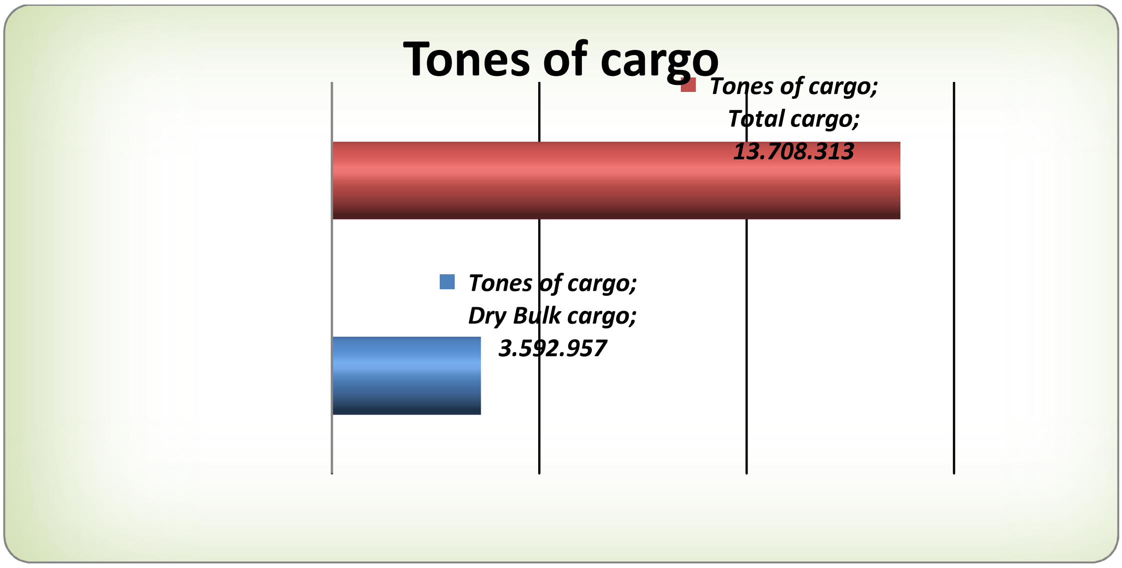

Figure 4.1 Statistical data of cargo in Thessaloniki port (year 2011)

Specifically, in Thessaloniki's port, the problems with airborne particles generated mainly at piers 5 and 6, where the dry bulk cargo is stored. The average residence time of dry bulk storage in the port of Thessaloniki area is ten days. The intense weather sometimes aggravates the air quality of the close port area at the western part of Thessaloniki city center.

2.1.1. Wetting of dry bulk

In order to reduce airborne particles emission mainly to the close port areas a wetting system is proposed. The proposed wetting system will consist of special sprinklers properly installed at specific locations to completely cover the selected area. The sprinklers will operate scheduled, according to the daily needs and depending on the prevailing weather conditions. Water will be supplied from the hydraulic network of the port and the positions will be stable and properly configured for the reception of water cannons. In some cases the wetting system will use chemical wetting that creates a protective crust above the cargo for greater protection when permitted due to chemical reactions. For chemical stability reasons, most of dry bulk cargo is proposed to be wetted with water rather than with chemical (foam). The proposed system is totally applicable and suitable for the Thessaloniki's port needs and has reasonable installation cost (12,000€) and low maintenance cost (500€/y).

Chemical wetting is based in advanced powerful polymer emulsion that produces highly effective dust control, erosion control and soil stabilization. This technology should provide bonding, cohesion, versatility, cost-effectiveness and environmental compliance and overall performance. Also, the choice of the chemical product should be based on internationally recognized scientific and engineering evaluators of environmental performance and should have international verifications.

It should be noted that the chemical impregnation, even the extended wetting with water and the interaction between the loads can cause distortion. Also, because of the chemical reactions or poor ventilation may result: sweating load and change of humidity, molding, self-heating and possible spontaneous combustion, oxidation of metal parts, etc causing extends environmental and other problems. For all the reasons above, the wetting measure should be used in a very careful and sophisticated manner. Only authorized and well qualified employees should manage the wetting systems and, a consultation (approval) from a specialist in chemical sciences should follow.

On a local scale (in and near the port area of Thessaloniki) and for the reference year 2020, the dry bulk wetting is expected to reduce significantly the PM10 and PM2.5 maritime/harbor emissions by -31% and -14% respectively. In the figure below, the results of the change (%) in the mean PM10 concentration values are presented when implementing the wetting system. The results are based on the implementation of a modeling system that consists of the meteorological model WRF and the photochemical model CAMx. The system was implemented using the meteorology of the year 2011, while the reference year for the pollutant emission data used was 2020. According to Figure 2, the use of the wetting system could be characterized as more beneficial for the port and neighboring areas. In and near the port area, the decrease of PM10 mean concentration in the summer month reaches -4.5%, whilst in winter is about -1%.

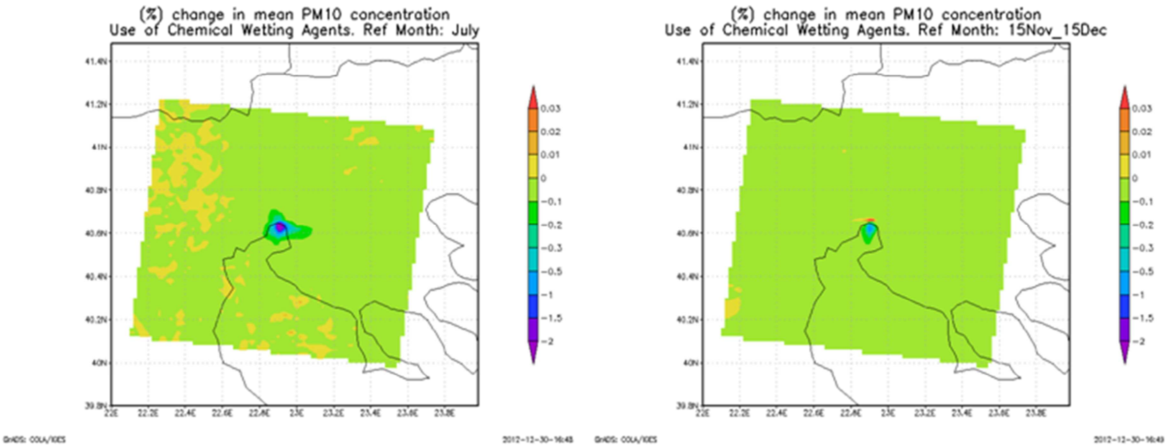

Figure 4.2: Change (%) in the mean PM10 concentration values implementing the “Use of Wetting Agents” mitigation action during July and 15 of November to 15 of December periods.

2.1.2. Loading and uploading management

The dry bulk cargo management requires proper and well operational practices of loading/uploading. The proposed practices refer to both storage and time residence of the bulk cargo in the region of the port and to the permissive conditions of dry bulk cargo handling, as mentioned bellow:

- direct loading of bulk cargo to the means of transport (trucks, railway etc) in order to achieve the minimum stay of cargo at the ports’ region;
- maintaining pile size/volume consistent with customer demand, transportation schedules and materials cost to reduce the amount of material exposed to weather conditions;
- suspending unloading and handling operations during unfavorable weather conditions (precipitation, wind) that could, otherwise, increase run-off or blowing dust;

- using enclosed conveyors or chutes and telescoping arm loaders to reduce spillage and dust;
- minimize the distance between the working face and trucks/trains being loaded to reduce the area that has to be swept/cleaned;
- regularly inspecting dry bulk storage piles, facilities and handling equipment to ensure proper operation is maintained;
- scheduling regular mechanized sweeping of the bulk storage and access/egress areas;
- wash down or spray the underside and tires of trucks transporting dry bulk materials on to public roads to reduce dust;
- use of modernized loading/uploading technologies (hopper, silo/elevator, loading boom etc.).

The success of the proposed processes depends on the organization and management of transports, loading schedules and operational procedures, accuracy of cargo ships arrivals, proper function of the customs office and coast guard and the good cooperation between all the above factors.

2.2. Air quality monitoring and policy awareness

The Local Plan includes standards that achieve real emissions reductions, a nested set of implementation strategies, investment in the development and integration of new/cleaner technologies into port operations and the creation of a comprehensive air quality monitoring system within the ports' region in order to help in the control of the ports' operational activities.

One way to protect and assess air quality was through the development of an air quality monitoring station. Air quality samples are generally collected for one or more of the following purposes:

- To judge compliance with and/or progress made towards meeting ambient air quality standards;
- To activate emergency control procedures those prevents or alleviate air pollution episodes;
- To observe pollution trends throughout the port region;
- To provide a data base for research evaluation of effects: urban, land-use, and transportation planning, development and evaluation of abatement strategies, and development and validation of diffusion models.

For all the above reasons, the monitoring station can be an essential tool for achieving the environmental objectives of the Port Authority, who will be responsible for the station installation which is estimated to cost approximately 50,000€. The cost of maintenance and calibration is proposed to be outsourced and estimated at 6,000€ per year.

The operation of the monitoring station may assist towards the publication of air quality information according to the national legislation (Common Ministerial Decision 77921/1440/1995) concerning the access to environmental information. The management of the monitoring station and the publication of air quality information may be under the responsibility of a newly established working committee which will consist of official and scientific staff of the Environment Departments of the Thessaloniki Port Authority, Municipality of Thessaloniki, Regional Unit of Thessaloniki and the Decentralized Administration of Macedonia-Thrace.

2.3. Improvement of the rail system operation

Reducing the dependency on trucks by enhancing the use of rail and the implementation of short sea shipping is a goal that many ports should achieve. Consider a long term, operational change to increase the amount of cargo leaving or reaching the Port on rail versus truck. The extensive and effective use of rail will reduce trucks from the port of Thessaloniki, which will result in changes both in the traffic within the ports' area and in the loading/unloading cargo process. It is estimated that an effective and complete rail operation could decrease 40% to 50% the use of trucks as a mean of cargo and container transport.

Presently, moving goods with locomotives generates less pollution than with trucks per tone of freight moved over the same distance. It is estimated that the cargo moving from or to the port of Thessaloniki by rail is approximately 2,000,000 tones in the year of 2011 representing 15% of the total freight.

Compared to trucking and rail efficiency numbers, train has an efficiency of approximately 400 ton-miles per gallon (diesel) whereas trucks around 130 ton-miles per gallon. These efficiency indicators relate in direct proportion to air pollution caused by the transport of port cargo.

An analysis of the costs involved with rail and truck freight transportation is illustrated bellow (Table 4.3). The focus to the costs that are currently not reflected in the rates, or private costs, when is decided the mean of transport freight over one of the two modes. A direct comparison of the public and external costs can be difficult because of the wide variety of vehicles, operating environments, different types of freight and hauling distances. Also, the methods used to measure these costs vary widely and can often result in very different numbers. The costs discussed previously were analyzed both in aggregate and in the context of shipments that are competitive between the two modes, depending on the data used in the analyses. Similar methodologies were employed to quantify both truck and rail costs for a valid comparison. These results show that truck freight transportation imposes a higher cost than rail transportation.

Table 4.3: Summary of costs for truck-rail competitive freight shipments (cents per ton-mile)

Mode	Private Cost	Public Cost	External Cost	Total non-private costs	%
Truck	7.69	0.25	0.86	1.11	14.4%
Rail	2.68	0.00	0.25	0.25	9.3%

- *In economic terms, private costs are the costs that are borne directly by the user.*
- *Public costs are costs that are borne by the public through taxes or other fixed-rate fees, and are used to provide an indirect but essential part of a particular good or service.*
- *External costs generally include environmental costs imposed on non-users. Air pollution, noise, and the cost to society of accidents are typically categorized as external costs.*

Setting performance requirements is becoming more and more common practice in the management of railway infrastructure. The recent development of EN50126, the European Standard for Reliability, Availability, Maintainability and Safety of Railway Systems, shows the changing attitude towards maintenance of railway assets. Maintenance of railway assets is not regarded anymore as something that needs to be done, but more and more as a professional business delivering very important products for rail operations by improving the most important operational indicators:

- Availability: the time that the infrastructure is available for operations per calendar period.

- Reliability: the time that the infrastructure is available for operations during the operation periods agreed.
- Safety: this aspect is covered in design criteria, maintenance thresholds (e.g. geometry control limits), inspection and failure response strategies (e.g. inspection frequencies and speed restrictions).

The improvement and extensive use of rail transportation system is a constant target of the Port Authority. Despite the high cost for the rail infrastructure improvements that is required and the difficulties in the organizational collaboration between all related agencies and actors, the use of rail system can deliver significant environmental effects on air quality.

2.4. Ship best practices during hotelling and maneuvering

Ships are generally powered by large diesel engines operating on low quality fuel oil of relatively high sulfur content (average around 2.7% sulfur by mass). These large slow revving diesel engines produce more NO_x and particle emissions per unit of power output than smaller automotive diesel engines. The sulfur content of marine fuels is emitted as SO_2, leading to secondary formation of very fine aqueous sulfate particles. The shipping industry provides a market for low quality residual oil produced during oil refining and so contributes to the overall economics of oil as a fuel source.

Ships use diesel powered electrical generators on board for lighting, air conditioning, control systems, fuel and water systems, bow thrusters and cargo handling. Ships also use oil fired boilers for fuel heating, cargo heating and to produce steam to supply turbines for cargo and ballast pumping. Cruise ships have relatively high electrical loads to supply the needs of passengers. Container vessels also use electricity to run refrigerated containers. Oil tankers tend to use fairly inefficient steam driven pumps to deliver cargo, driven by oil fired boilers.

Table 4.4 presents the calculated emissions from shipping in each operation mode (cruising, maneuvering and hotelling) for a reference domain with 100x100km^2 extend centered over Thessaloniki. Emissions are shown for different types of ships. The most important source for NO_x, SO_x and NMVOCs total emissions is the Containers while for PM and NH_3 is the General Cargo ships. The emissions from the Containers and the General Cargo ships are generally comparable. CO is emitted mainly by the Other Cargo Vessels. For all pollutants, the total cruising emissions represent the highest share of total emissions from all operation modes (cruising, maneuvering and hotelling).

On a more local scale (in and near the port of Thessaloniki), the comparison of ship hotelling and maneuvering emissions shows that the hotelling of ships is a more important emission source for CO, NMVOCs and PM in relation to ship maneuvering. The highest CO and NMVOCs hotelling emissions are emitted from ferries. PM hotelling emissions are emitted mainly from Containers and General Cargo ships. NO_x and SO_x emissions released from the maneuvering of ships, mostly of Containers and General Cargo ships, are greater than those from hotelling.

Table 4.4 Pollutant emissions (tn/year) from shipping in the area of Thessaloniki (reference area: 100x100km^2; reference year 2010)

		CO	NOx	SOx	NMVOC	NH_3	PM10	PM2.5
On-route (Cruising)	Other Passenger ships	1.14	13.83	6.73	0.21	0.01	0.52	0.52
	Ferries	0.41	4.71	2.40	0.07	0.00	0.19	0.19
	General Cargo	5.85	2536.94	1612.47	40.59	0.37	90.61	90.61
	Container	5.33	2896.73	1829.41	46.35	0.33	81.64	81.64
	Tugs	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Other Cargo Vessels	840.99	1308.27	842.79	21.98	0.20	36.42	36.42
	Total	**853.72**	**6760.48**	**4293.8**	**109.20**	**0.91**	**209.38**	**209.38**
Maneuvering	Other Passenger ships	0.42	1.97	0.09	0.08	0.001	0.08	0.08
	Ferries	0.64	2.78	0.13	0.12	0.001	0.12	0.12
	General Cargo	0.16	53.98	34.28	0.86	0.004	0.57	0.57
	Container	0.18	76.82	48.37	1.23	0.005	0.64	0.64
	Tugs	2.13	10.10	0.44	0.39	0.004	0.39	0.39
	Other Cargo Vessels	14.99	23.68	15.58	0.45	0.002	0.25	0.25
	Total	**18.52**	**169.33**	**98.89**	**3.13**	**0.017**	**2.05**	**2.05**
Hotelling (in port)	Other Passenger ships	20.37	4.73	0.41	4.75	-	0.25	0.25
	Ferries	37.76	8.81	0.63	7.52	-	0.47	0.47
	General Cargo	0.28	28.73	3.72	0.46	-	4.13	4.13
	Container	0.48	74.44	9.55	1.19	-	4.64	4.64
	Tugs	0.00	0.00	0.00	0.00	-	0.00	0.00
	Other Cargo Vessels	12.76	22.66	3.32	0.81	-	1.89	1.89
	Total	**71.65**	**139.37**	**17.63**	**14.73**	**0.00**	**11.38**	**11.38**
Total	Other Passenger ships	21.92	20.53	7.23	5.03	0.01	0.84	0.84
	Ferries	38.81	16.30	3.16	7.71	0.00	0.77	0.77
	General Cargo	6.29	2619.64	1650.46	41.91	0.37	95.31	95.31
	Container	5.99	3047.99	1887.32	48.77	0.33	86.92	86.92
	Tugs	2.13	10.10	0.44	0.39	0.01	0.39	0.39
	Other Cargo Vessels	868.75	1354.61	861.69	23.24	0.20	38.56	38.56
	Total	**943.88**	**7069.17**	**4410.30**	**127.05**	**0.92**	**222.80**	**222.80**

2.4.1. Speed reduction on approach or departure from port

Slowing the speed of ships as they approach or depart the port, results in overall less fuel use and reduces overall emissions. Reduced vessel speeds demand less power from the main engine, which in turn reduces emissions and fuel consumption. A 10%

speed reduction may reduce emissions by approximately 20%. A 20% speed reduction may reduce emissions by approximately 35%.

Port boundaries at sea are defined by an arc centered on a defined point at the port entrance. For Thessaloniki, the radius of the arc is 4 nautical miles. The Restricted Speed Zones are administered by the Maritime Safety (General) Regulation 2009 and begin at the harbor entrance. They exist for operational safety within the confined harbor waters.

Reducing vessel speed within a specified geographical limit reduces fuel consumption and emissions. The Port Authority of Thessaloniki should impose speed reduction to 6 knots within 10 nautical miles from the coast. Speed restrictions should be in force within the port limits. Also, for vessels with a length over 12 meters the maximum speed could be 6 knots. For vessels with a length under 12 meters, the maximum speed could be 12 knots.

Costs of reduced vessel speed include the cost to shippers for operating their vessels for a longer period due to the reduced speed. Increased costs will be offset by reduced fuel costs within the reduced speed zones due to reduced fuel consumption. Alternatively, shippers may choose to cruise at higher speeds outside the vessel speed reduction zones to make up for lost time. Current global deliberations around greenhouse gas emissions from shipping are also considering the use of slow steaming and optimized schedules for reduction of greenhouse gas emissions.

2.4.2. Low sulfur fuel

The two potentially effective options to reduce emissions from ships are the use of low sulfur fuel and shore power. For low sulfur fuel, there is a range of options for the level of fuel sulfur and the extent of the area in which the fuel sulfur is controlled. Reducing fuel sulfur significantly reduces particles as well as sulfur dioxide emissions.

The EU has directed that from 2010 fuel of sulfur content 0.1% or less by mass must be used at berth in European Union ports from January 1, 2010. The sulfur limit is detailed in Article 4b, EU fuel sulfur directive 2005 (EU, 2005) and a subsequent amendment. The terminology “at berth” covers ships alongside, buoys or anchored and whether or not they are working cargo. The rule covers all grades of fuel oil and all types of combustion machinery including main and auxiliary boilers. Ships need not comply with this 0.1% limit while maneuvering but must comply as soon as possible after arrival in port and comply till as late as possible before departure. The Bunker Delivery Note (BDN) from the fuel supplier must clearly indicate the actual sulfur content of the fuel. The requirement also applies to all vessels while operating on inland waterways.

Meanwhile, the MARPOL Annex VI amendments in 2008 introduced requirements for lower sulfur content in fuels globally, but also more stringent limits in the Emission Control Areas. In order to ensure regulatory consistency the European Commission presented a proposal in July 2011 to amend Directive 05/33/EC1 aligning EU legislation with the latest IMO requirements. In addition, the alignment with the international standards will be accompanied at EU level by a set of dedicated measures, which are further elaborated in the Commission Staff Working Paper published on 16 September 2011. The proposal includes limits for sulfur content in marine fuels used in Member States’ territorial seas outside ECAs: 3.5% from 1 January 2012, 0.5% from 1 January 2020. The latter date could be changed to 1

January 2025 subject to assessment by the IMO of the availability of marine fuel to comply with the maximum sulfur content of fuel of 0.50%.

Port police of Thessaloniki is responsible for the enforcement of all the above requirements at least in respect of vessels flying their flag and vessels of all flags while in their ports.

The implementation of ship emission reduction measures has been driven largely by either regulation or the provision of incentives to reward changed practices. Some identified ship emission mitigation practices include:

- low sulfur fuel within a 10 nautical miles distance from the coast: Required use of low sulfur fuel in ship main engines, auxiliary engines and auxiliary boilers within a 10 nautical miles distance of the coast. The required sulfur content will drop to 0.1%;
- continuous emission monitoring equipment on board.

There is a limit to how far the sulfur content of Residual Oil (RO) used by ships can cost-effectively be reduced. Low sulfur RO down to 1% sulfur content is available. Higher quality marine diesel fuels with sulfur content as low as 0.1% (i.e. distillates such as Marine Diesel Oil-MDO and Marine Gas Oil-MGO) are produced, at a greater cost. If ships were required to use fuel other than heavy fuel oil in or near port, they would have to either bring MDO or MGO with them.

For any given engine, using MGO fuel with sulfur content of 0.1% may reduce particles by 80-90%, SO_2 by 80-90% and NO_x by 5-6%. Alternatively, using RO with 1% sulfur content may only reduce particles by 20% and SO_2 by 50-60%.

Low sulfur MGO costs at least 50% more than conventional RO. There would also be capital costs for ship owners to modify on-board systems to allow use of low sulfur fuel in auxiliary engines and auxiliary boilers of 5,000€ - 25,000€ per boiler.

There is a significant risk of problems with fuel changeover in main engines and thus loss of propulsion while on-route. The international experience being developed regarding fuel changeover and operation on low sulfur fuels whilst cruising will provide more detailed information on this measure in the near future.

2.4.3. Shore power (future action)

Shore power, also referred to as cold ironing, involves switching off auxiliary engines at berth and supplying the ships with electricity from shore. The rate of uptake of the shore power option is limited by the high capital cost required for both ports and ship owners. The emissions benefits at berth also depend on the contribution of auxiliary boilers to total emissions. Use of shore power has the significant added benefit of protecting adjacent premises from the noise from the generators.

The feasibility of installation of shore power depends on the physical space on the wharves, the available electrical supplies and the number of relevant cruise vessels that have shore power capability or can be reasonably converted. The maximum auxiliary engine power generation indicates the peak electrical loading which would need to be supplied from the shore. The maximum electricity demand for any individual vessel at these berths is 11 MW, which would require a large substation. The greatest cost benefit for installing shore power at berths and connections on ships would be obtained for frequent visitors with high auxiliary engine energy production per visit.

The cost of installation of the shore power facility may be approximately 3 million € or more per berth if new substations need to be installed. The cost of installation of the facility per ship is of the order of 0.4 million €. The high capital investment for ports and ship owners is a barrier and reduces the overall cost-effectiveness of this option when considered against the emissions savings. However, the current purchase cost of electricity is less than the cost of fuel to run ship auxiliary generators, depending on the means used to generate the shore power and the required fuel sulfur content. Also, there will be reduced auxiliary engine maintenance costs.

On a local scale (in and near the port area of Thessaloniki) and for the reference year 2020, the cold ironing is expected to reduce significantly pollutant emissions according to the following: -80% for CO, -46% for NOx, -15% for SO2, -82% for NMVOCs, -19% for PM10 and -55% for PM2.5. The implementation of a modeling system that consists of the meteorological model WRF and the photochemical model CAMx has revealed that the expected changes in mean PM10 and PM2.5 concentrations, which are the key pollutants within APICE, due to the cold ironing emission control are expected to be very small (<-1%). However, this may not be the case for the gaseous pollutants like SOx, NOx and CO.

2.5. Trucks operation mode, traffic and handling

The growth in freight traffic has resulted in growth in the associated environmental impacts. Diesel truck emissions are responsible for the primary environmental impact of truck freight transport.

Diesel trucks have served freight needs very well for over 40 years because of their durability, reliability and relative efficiency. Since 1970, with the focus on air pollution and the setting of air quality standards, heavy-duty diesel engines have become less harmful for the environment. Despite this progress, the air pollution from diesel trucks is still a health concern and contributes to continuing air quality problems. Trucks release unburned hydrocarbons, carbon monoxide (CO), sulfur oxides (SO_x), nitrogen oxides (NO_x), particulate matter, and other toxic compounds. Although diesel trucks account for only a small amount of hydrocarbon emissions and carbon monoxide emissions, they do contribute large amounts of NO_x and particulates.

Trucks that serve port terminals are a vitally important link in Thessaloniki's port operations. In Thessaloniki, the majority (85%) of cargo and containers are moved via trucks and tractor-trailers. More than 11 million tones of cargo moved the 2011 by truck. While delivery vans and small trucks (light trucks) account for a significant portion of activity, tractor-trailer trucks (heavy trucks) move a large volume of goods.

A broad based mitigation strategy like the proposed measures bellow could be beneficial for addressing diesel road trucks emissions.

2.5.1. Operational actions

All trucks accessing the Port of Thessaloniki maritime terminals to pick up or drop off cargo should behave in a manner that favors the increase of roadway capacity and the reduction of congestion. It is estimated that more than 100,000 trucks of all types per year entering the port of Thessaloniki for loading and unloading.

The Port Authority and stakeholders should begin an initial phase of truck-related emissions reductions with a range of operational actions, such as:

- The development of an appointment system for trucks serving the terminals, including a fast lane in order to decrease total truck turnaround time

- The development of a Port truck parking areas to reduce idling emissions. Consider including rest stop amenities as part of the parking area to encourage use

The conduct of a study of freight movement, modal splits, and short sea shipping.

2.5.2. Idle reduction programs

Idle reduction programs aim to decrease the amount of time vehicles spend in idle mode as part of their overall operation. Idle reduction could be implemented through local anti-idling rules as well as educational programs. Anti-idling rules stipulate areas where idling is not permitted or regulate the duration of idling. Educational programs relating to engine warming and advocate fuel cost savings associated with switching off an engine after a certain period of idling.

One hour of idling is estimated to produce 1-5 grams of PM_{10} and 140 grams of NO_x, based on a post-1995 diesel truck. Idle Free BC, a program hosted by the BC Climate Exchange in British Columbia, Canada, has estimated that vehicle idling reduction programs have the potential to reduce approximately 20% of annual fuel budgets.

2.6. Technological improvements on Diesel powered port equipment

Thessaloniki Port use a wide range of **diesel powered equipment** (cranes, forklifts, loaders, derricks, small locomotives and trucks, platforms, etc) to move cargo. There is a range of technologies that have been developed to reduce emissions from diesel engines, and which are applicable to landside freight handling and port operations.

The cargo handling equipment of the Thessaloniki's Port Authority consists of:

Cargo handling equipment	Energy usage
44 rail-mounted power driven cranes	Electric powered
4 cranes for containers	Electric powered
1 transtainer	Electric powered
1 Gottwald HMK 260 EG mobile harbor crane	Diesel powered
2 mobile cranes	Diesel powered
78 forklifts	Diesel powered
24 Loaders	Diesel powered
17 straddle carriers	Diesel powered
5 front lifts	Diesel powered
4 tractors	Diesel powered
Numerous other cargo handling equipment (derricks, platforms, etc)	Electric and diesel powered

There are suggested some practices like accelerated fleet turnover and idle reduction programs to reduce emissions during the use of cargo handling equipment. Although, it is highlighted the available technologies aiming in reducing particulate, VOC and NO_x emissions through chemical and physical processes to change the composition of the exhaust from cargo handling equipment. These technologies reduce the operating cost of the vehicle however the capital cost of installation is high. Two equipment emissions improvement technology options that were discussed during the stakeholders' consultation are presented below.

2.6.1. Diesel Oxidation Catalyst (DOC)

A diesel oxidation catalyst (DOC) device can be connected to the exhaust of a diesel engine or vehicle to reduce the emissions of CO, VOCs by converting them to CO_2 and water. DOC technology is proven and installed in many locations throughout the world. The installation of a DOC is able to reduce CO and VOCs emissions by up to 90% by oxidising CO to CO_2 and combusting VOCs to CO_2 and water. Particulate emissions can be reduced by up to 30% using this technology. DOCs are a cost effective method of emission reduction, costing around 3,000€ depending on the size of the engine and the configuration of the exhaust. They are relatively easy to install and are largely maintenance free.

2.6.2. Hybrid Diesel Electric

A diesel-electric hybrid conversion can also significantly reduce the emissions from diesel powered equipment use. The Hybrid Diesel Electric equipments use a combination of a heavy duty battery rack and a small diesel generator. Apart from the reduction in air emissions and fuel consumption, hybrid diesel electric equipments also have the co-benefit of reducing noise levels at port facilities. The conversion to a diesel electric hybrid engine can reduce emissions of NO_x by 50-90%, particulate matter by 50-90%, SO_2 by 40-60% as well as reducing fuel consumption by 40-60% each. Since this technology is innovative and “fresh” in industry, current costs of hybrid diesel electric cannot be accurately estimated and expected to be fairly high particularly if there are an integrated purchase of equipment and not a retrofitting intervention.

3. Mainstreaming

Within APICE project and due to consultation actions the key stakeholders emerged and revealed their intentions on mitigation practices regarding air quality in the urban area of Thessaloniki. Therefore, the key stakeholders view the Local Adaptation Plan as a roadmap for future regional/local air quality environmental plans and urban master plans in the region of Thessaloniki.

In this framework, the Thessaloniki Port Authority understands the Local Adaptation Plan as a tool for both achieving the environmental objectives and validating the upcoming Port Master Plan. Also, future actions on the field of urban or port infrastru-cture and strategic investments should be analyzed and evaluated in the light of the Local Adaptation Plan in order to ensure their sustainability and environmental utility.

Furthermore, the stakeholders realized the need of transitioning from the promising strategies to actual implementation of the specific actions needed to achieve further emissions reductions and remark that the work procedure developed within the project can be really useful, in order to define and communicate different air quality measures and other environmental aspects on urban areas.

4. Summary - Conclusions

This Plan has outlined a comprehensive approach for reducing emissions over the next years from maritime-related activities associated with the Port Authority of Thessaloniki and the official stakeholders. These actions aim in reducing air quality impacts on human health and the environment, into attainment with applicable air quality standards. A suite of measures for reducing emissions are included for different sectors of maritime activities (ships, diesel powered equipment, bulk cargo management, rail and diesel road vehicles).

As the proposed measures illustrate, this Plan builds upon a basic set of emissions reduction activities undertaken by the Port Authority and the key stakeholders. The list of proposed measures (

Table 4.5) highlights the dedication of the Port Authority and stakeholders to move above and beyond the current status with a range of actions to be implemented. The proposed future actions will ensure the sustainable development of the port and this Plan could be a potent think-tank as the Port authority has initiated the procedures for contracting the elaboration of the Port Master Plan.

In conclusion, the bundle of measures for different sectors of maritime activities presents a path for reducing maritime-related emissions which, when implemented, will result in achieving the environmental goals of the Port as well as improving the air quality of the city of Thessaloniki.

Table 4.5: Proposed measures and estimated goals and costs

Proposed measures		**Estimated cost**	**Main benefits**
Solid bulk cargo management	Wetting of solid bulk	Installation of the wetting system: 12,000€ Maintenance of the wetting system: 500€/year	Decrease of airborne particles PM10 and PM2.5 emissions
	Loading/uploading management	Implementation details needed prior to calculation	Decrease of airborne particles PM10 and PM2.5 emissions
Air quality monitoring and policy awareness		Installation of the monitoring station: 50,000€ Maintenance of the monitoring station: 6,000€/year	- compliance with air quality standards - avoid air pollution episodes - observe pollution trends - provide a data base
Improvement of the rail system operation		Implementation details needed prior to calculation	Decrease of CO, NOx, SOx, NMVOCs and PM emissions
Ship best practices	Speed reduction on approach or departure from port	Not quantifiable	Decrease of CO, NOx, SOx, PM and NMVOCs emissions
	Low sulfur fuel	- 50% more than conventional RO	

Proposed measures		Estimated cost	Main benefits
		- to modify on-board systems: 5,000€ - 25,000€ per boiler	
	Shore power (Future action)	Installation of the shore power facility: 3 million € Installation of the facility per ship: 0.4 million €	
Trucks operation mode, traffic and handling	Operational actions	Not quantifiable	Decrease of CO, NOx, SOx, NMVOCs and PM emissions
	Idle reduction programs	Reduce approximately 20% of annual fuel budgets	
Diesel powered port equipment emissions improvement	Diesel Oxidation Catalyst (DOC)	Installation of the DOC technology: approximately 3,000€	Decrease of CO, NOx, SOx, NMVOCs and PM emissions
	Hybrid Diesel Electric	- Reduce fuel consumption by 40-60% - The installation cost cannot be accurately estimated	

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Local Adaptation Plan for Venice

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1. Setting the local strategy for the Venice Lagoon

1.1. General approach

Environmental management in the Venice Lagoon is a high topic, since the balance between anthropogenic uses and natural dynamics of the peculiar transitional environment of the lagoon is fragile, and deserve great attention from all sectors of activities insisting in different ways on it.
With respect to air quality management, peculiar conditions of the Venice lagoon within the Northern flat plain of Veneto Region have been taken into consideration and intertwined with the sources of emissions of different sectors that insist on the area, in line with the general approach shared by APICE project.
The APICE project in Venice opened the discussion to Stakeholders participation in co-thinking and co-operating in developing actions for mitigation of Air Pollution, as key action to found a strategy supported by different actors within the lagoon complex environment. In fact, the legal framework of the Venice Lagoon is characterized by the Special Law for the protection of the lagoon Environment (L.798/84), which establishes the principles for conservation and management as well as the competencies. The lagoon management is complicated by the presence of other plans and of several actors and uses within the Venice Lagoon, as the Port of Venice, which is located within the lagoon.
APICE has been interpreted as a platform for discussion on the interaction between anthropogenic activities in the Lagoon context and their compatibility with Air Quality, as to support the dialogue between the sectorial planning and territorial planning and its Bodies.
Contents and analysis were co-built with the local stakeholders according to their competences and their roles with respect to the topics taken into consideration.

1.2. A way to the local strategy: the role of the stakeholders

As one of the most important objective of APICE project is to promote the decision-making approach and the related set of mitigation measures, designed by the project and contained in the Local Action Plan, across the policy-makers and private operators, a stable and proactive exchange scheme between the key public and private players was an outstanding phase of the project implementation in the Venice area.
The engagement process adopted in the Venetian pilot area was mainly based upon bilateral and larger round tables between the local partners - Veneto Region and the Regional Agency for the Environmental Protection (ARPAV) - and those governmental and economic actors that play a role in addressing solutions to reduce emissions and improve the air-quality. Among the others, the Port Authority of Venice, the Municipality of Venice, the Venice Passengers Terminal, the Venice Harbour Master, the Customs Agency and the Consortium for Researches for the Venice Lagoon were involved in the mainstreaming process since the beginning of the project operation, then stretched throughout the project life.
This kind of approach focused mainly on the organization of technical workshops during which Veneto Region and ARPAV transfered to the above mentioned local networks the APICE scientific findings related to the emission sources and risk factors, with the final purpose of shaping a common analytic frame, getting feedbacks on potential mitigation strategies and pave the way towards agreements between economic operators, ship-owners and Public Administrations.

Table 5.1: Stakeholders involved in Venice local working table

Stakeholders Involved in APICE project
Municipality of Venice – Air Quality Department
Venice Port Authority
Harbour Master
Venice Terminal Passeggeri S.r.l.
Interregional section of Veneto and Friuli Venezia Giulia Customs Agency
APICE project partners for Venice
Environmental Agency of Veneto Region (ARPAV) – Regional Air Observatory
Veneto Region, Department of Territorial and Strategic Planning

The general panel of actions were discussed and assessed with the stakeholders during bilateral meetings and the local working tables, according to main scientific findings produced by ARPAV through the APICE activities.

The approach of the Local Adaptation Plan for the Venice lagoon has been oriented towards the compatibility of anthropogenic activities with air quality of urban ecosystem, taking into consideration the analysis developed and the effects investigated at different scales, from the local scale of the areas next to the Port docks, to the analysis at the regional scale, considering the dynamics of the aerological basin and the different contribution of activities sectors.

Specific attention has been given to the uncertainties deriving from macro-economic factors and from normative development that have guided the preference towards a shared discussion and participation of all actors (institutional and economic ones) on robust measures, which are valid for a range of scenarios that might take place, characterized by less intense initial investments.

2. The Strategy for Venice

2.1. The Venice lagoon and its peculiar context

To set the analysis oriented to identify main robust actions of mitigation of air pollution, the analysis of APICE project for the Venice lagoon has taken into consideration the peculiar characteristic of interaction of coastal and maritime uses within the context of the lagoon, focusing on the role of the port activities and the other anthropogenic sectors.

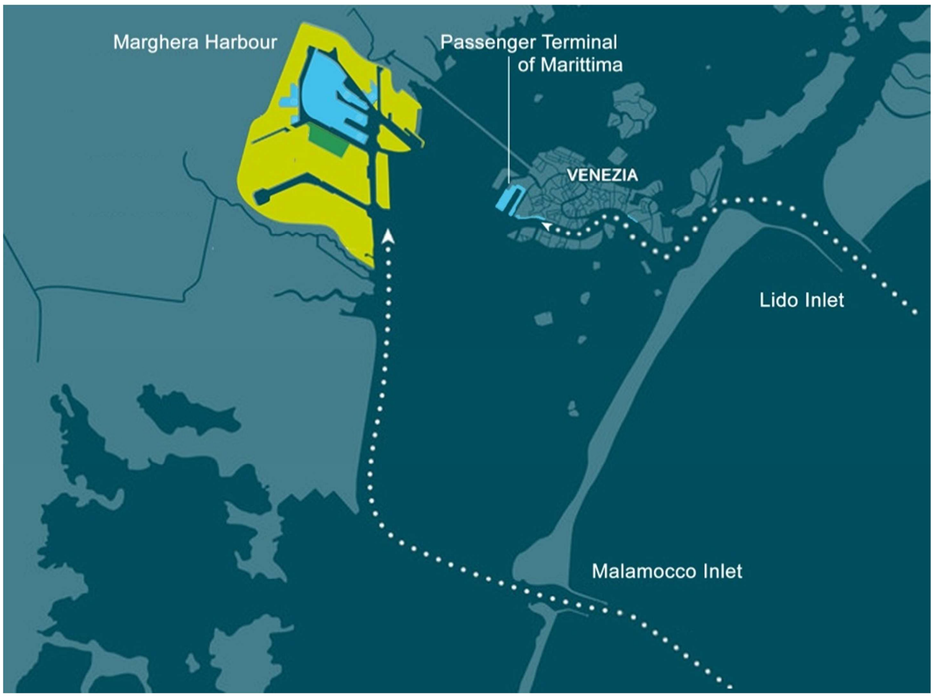

Figure 5.1.: Venice Port inside the lagoon, divided in the Marghera Harbour and Passengers Terminal of Marittima

The Harbour of Venice is located inside the Venice Lagoon, and it is divided in two main sections: i) Commercial and Industrial Harbour in Marghera; ii) Passengers Port in Marittima. As the port is inside the lagoon, the phase of maneuvering is quite long, from the Inlets to the berths (2h 45' to Marghera; 1h 45' to Marittima), and it influences significantly the emissions inventory for the maritime sector.
The APICE project in Venice considers a time projection for the scenario to the year 2020 because the year 2020 is a referenced one for EU requirements on different sectors, as, for example, the entry into force of the Directive on Sulphure content of fuels for maritime sector.
The scenario analysis has taken into consideration the main projections deriving from the implementation of Port development. The Port of Venice, in fact, is facing a considerable development of its activities, both for the commercial and the passenger terminal. In the commercial area in Marghera, in the inland border of the lagoon, the new developments include a new container terminal and a new Ro-Ro terminal, while in Marittima Station in the historical islands of Venice, the tourist port's attractiveness will be augmented by new cruise ship terminals, and a large re-developed area with offices, leisure facilities, and a multi-storey car park. The project of the off-shore terminal at some 10 km off the Malamocco port mouth has not been taken into consideration as its completion is foreseen for 2030, behind the temporal projection adopted by the APICE Project for Venice.

2.2. Harbour contribution to air pollution and mitigation scenarios design: main scientific findings for the Venice Area

2.2.1. Source Apportionment analysis focused on maritime emissions and PM2.5 concentrations

The first specific objective of the scientific insight of APICE activities was to estimate the relative contribution of several pollution sources to the air quality in each harbour-city, focusing on harbour activities and on Particular Matter concentrations (both PM10 and PM2.5).

The identification of the pollutant emissions that mostly affect PM10 and PM2.5 concentrations has been carried out for the Venice area following two different techniques of Source Apportionment analysis: receptor models and Chemical Transport Models (CTMs).

As for the receptor model, the PMF technique was carried out by University of Genoa –Department of Physics, starting from monitoring data recorded, during the whole 2011, in three sites of the ARPAV Air Quality Network: Sacca Fisola (Venice historical center), Malcontenta (industrial background and site near the Commercial/Industrial terminals in Porto Marghera) and Parco Bissuola (urban background). The measurements data set used with the PMF model was made up of inorganic components, ions and metals, and organic species: not only total carbon, but also some semivolatiles species as PAH, hopane and alkanes as tracers of biomass burning, biogenic component and road transport contributes. Particulate Matter components have been measured on the PM10 or PM2.5 fraction, following the schedule for analyses and sampling frequency reported below (Fig. ??). Source Apportionment outcomes have been calculated for PM10; moreover ship emissions have been pointed out using the Nickel Vanadium ratio as heavy oil combustion tracer. Since in Porto Marghera there's an important consumption of heavy oil in industrial combustion the ship contribution estimation can be considered as the highest percentage attributable to maritime traffic in the Venetian area.

Venetian long monitoring campaign

Overall schedule for analytes and sampling frequency (in days)

	PM10		PM2.5			
Site	**Mass**	**HM (PM10)**	**Mass**	**Ions**	**SVOC**	**Ctot**
HA	1	1				
UB	1	2	1	2	1	2
IB	1	1	1	2	1	2

Ions: **Na, Cl, K, SO4, NO3, NH4, Mg, Ca** by IC (Ion Chromatography)
HM: **Heavy Metals As, Ni, Pb, Cd, V, Cu, Zn, Al, Mn, Cr, Co, Sb, Sn, Tl, Fe** by ICP-OES (Inductively Coupled Plasma Optical Emission Spectrometry)
SVOC: **PAHs, Alkanes, hopanes, steranes** by TD-GCMS (thermal desorption gaschromatography–mass spectrometry).

Figure 5.2.. Overall schedule for analytes and sampling frequency of the Venetian long monitoring campaign.

As for the CTM approach, the modeling chain implemented by the Regional Air Observatory of ARPAV was constituted by the LAMI meteorological local model and the CAMx model, run from June to August 2011, and from mid November to mid December 2011. The main CAMx grid had an extent of about 250 km and a 4 km resolution, whereas a nested one covered the wide urban area of Venice with an extent of 30 km and a resolution of 1 km (see figure below). Source Apportionment analysis has been applied using the CAMx Particulate Source Apportionment Tool (PSAT) and discussed for PM2.5.
The emission data come from the updating and the projection to the year 2010 of the Veneto Regional Emission Inventory 2005, whereas for the harbor emissions a bottom-up estimation, following the EMEP/EEA air pollutant emission inventory guidebook (version of March 2011), has been carried out starting from vessels movements registered in the year 2011. Moreover natural emission data (biogenic NMVOCs, wind-blown dust and sea salt) have been calculated using the meteorological fields in input to the CAMx model.

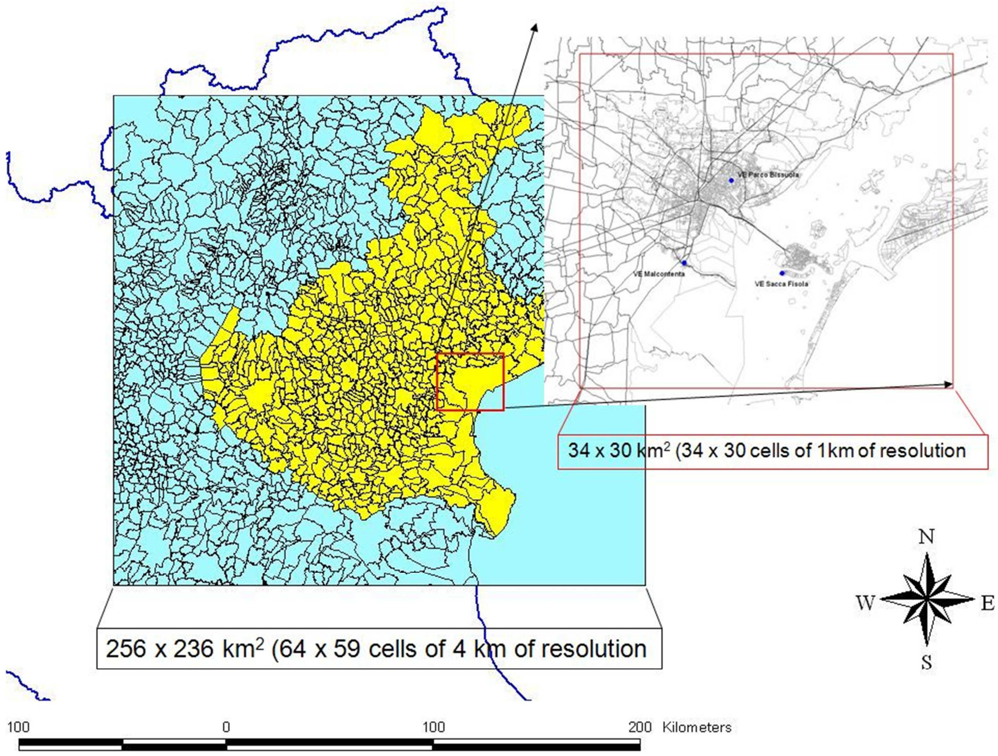

Figure 5.3:. The CAMx modelling domain for Venice and the 3 monitoring sites used for the PMF receptor model analysis.

The use of the two modeling approaches aimed to integrate the singular potentialities of the two different techniques: by one side receptor models more suitable to pointing out the bonds between specific emission sources and specific markers, and on the other side CTMs, that apportion the gas precursor emissions, too into the formation of secondary aerosols. The comparison between the output obtained with the two modeling techniques was a challenging task of the project, because the two approaches handle the several aerosol components in a very different manner, particularly in respect to the primary particulate matter. Moreover the two methods, for specific and different reasons inside each methodology, have discussed different fractions of PM: PM10, the recptor model, PM2.5 the PSAT-CAMx.

The higher contributions of harbor activities, in terms of ships emissions, have been estimated by receptor model techniques, whereas lower figures come out by CTM application.
Both methods estimate higher contribution in summertime, when passenger ship movements are at their maximum and contribution by domestic heating is at its minimum and when the concentrations level for PM10 are well above the daily limit of 50 $\mu g/m^3$. In wintertime, otherwise, PM10 concentrations are about 3 times the summer concentrations, with several exceedances of the daily limit, and with the PM2.5 fraction more than 90% of the PM10 one.

As for PMF outcomes, ship emissions contributions, spotted by the oil combustion tracer method already mentioned, have the following percentages to the PM10 average concentrations:

- at Sacca Fisola site: 13% on the annual average, while 23% for Spring/Summer period and 7% for Fall/Winter period
- at Malcontenta site 17% on the annual average, while for 25% Spring/Summer period and 12% for Fall/Winter period
- at Parco Bissuola site 11% on the annual average, 18% while Spring/Summer period and 7% in the Fall/Winter period.

As for CAMx-PSAT outcomes, during the summer period (June-August) when blows from N – NE during the morning and turns from E – SE during the afternoon, following the sea breeze regime, the ship emissions contributions to the PM2.5 average concentrations are:

- 8%, both at Sacca Fisola and Malcontenta sites
- 6% in Parco Bissuola site.

The highest ship emission contribution of 15% within the modelling domain has been estimated near the commercial/industrial terminals in Porto Marghera.
On the same summer period the other emission sources within the municipality of Venice have a contribution of 28%, the emissions of the Veneto region other than Venice have a contribution of 12% and lastly emission sources outside the Veneto Region territory added together natural emission sources have an overall contribution more than 50%.

During the late autumn period (mid November – mid December), when wind mostly blew from West bringing polluted air masses coming from the Veneto plain region, the ship emissions contributions to the PM2.5 average concentrations are:

- 8%, both at Sacca Fisola and Malcontenta sites;
- 6% in Parco Bissuola site.

On the same late Autumn period the other emission sources within the municipality of Venice have a contribution of 16%, the emissions of the Veneto region other than Venice have a contribution of 50% and lastly emission sources outside the Veneto Region territory added together natural emission sources have an overall contribution more than 30%.
The emission sectors and their contribution are described on the following table (Tab. 5.2.)

Table 5.2. PM2.5 Source Apportionment by PSAT-CAMx on the ARPAV monitoring sites (expressed as % contribution to mean concentration).

	Venice Sacca Fisola	Venice Sacca Fisola	Mestre Parco Bissuola	Mestre Parco Bissuola	Marghera Malcontenta	Marghera Malcontenta
	(June-August 2011)	(15 Nov to 15 Dec 2011)	(June-August 2011)	(15 Nov to 15 Dec 2011)	(June-August 2011)	(15 Nov to 15 Dec 2011)
Boundary conditions	27.0%	19%	27%	18%	28%	18%
Road Transport	9%	17%	17%	20%	12%	17%
Maritime/Harbor	8%	2%	6%	0%	8%	1%
Central Heating	0%	27%	1%	33%	0%	33%
Industries	6%	8%	9%	6%	11%	7%
Agriculture	5%	8%	6%	9%	8%	9%
Biogenic sources	29%	13%	28%	11%	27%	12%
Leftover Sources	17%	6%	7%	3%	6%	3%

The source apportionment outcomes discussed can be better understand considering the proportion between harbour emissions and the other emission sectors inside the emission inventory.
This proportion is obviously different if we consider the Venice municipality level (harbour's contribution: 31%) or the region level (harbour's contribution: 5%) as shown on the following figure (fig. 5.4).

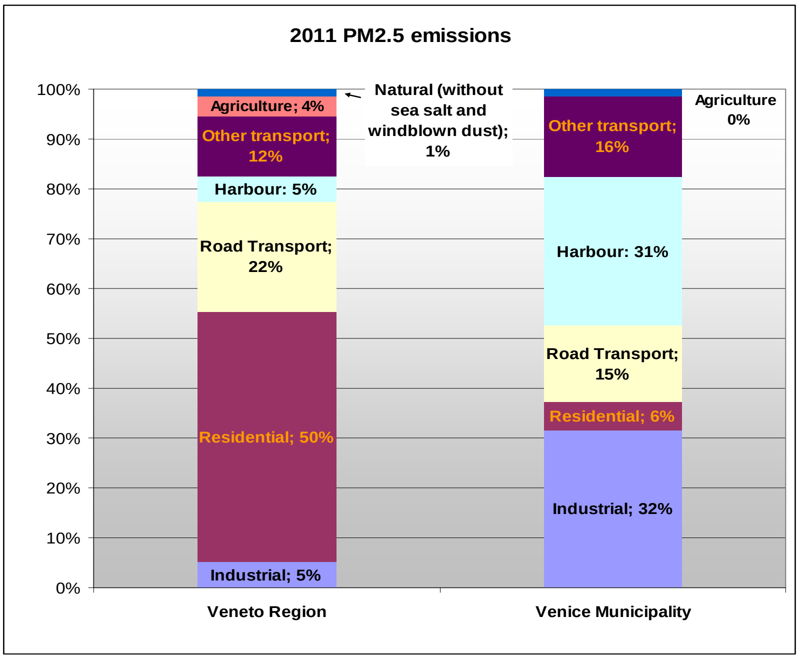

Fig. 5.4. PM2.5 emission sectors at Veneto Region level and at Venice Municipality level for 2011 year (ARPAV elaboration)

2.2.2. Future time emission scenarios considering harbour development planned projects

A second specific objective of the scientific insight of APICE activities was to estimate the 2020 emission scenarios in Venice, taking into consideration the development of the Venice Harbour already planned and the projection of all the other emissions according to future legislation and trend drivers (for example fleet renewal for road transport or change in fuel consumptions).
In particular, future maritime emissions have been calculated considering the reduction to 0.5% for the fuel sulphur content in force as of 2020, according to the Directive 2012/33/EC.
This base future emission scenario was configured to act as a basis for the application of the CAMx model in order to investigate the impact of mitigation actions relevant with the maritime and harbor activities on the air quality in the future.
The future time emissions at 2020 in Venice has been calculated considering the two main Port development projects with a realistic realization within 2020: the Venice Motorways of the Sea Terminal and the first development of the a Container terminal (about 155 more containership per year), for which a much more important growth is foreseen after 2020 with the realization of the off – shore Terminal outside the Venice Lagoon. Moreover, for the port emission projection an yearly rate increase of 2% for the cruise movements has been considered, as shown by trend on this sector in the last years.
The increase of ship traffic volumes of the harbour development scenarios foreseen for 2020 year is reported on the following table (Table 5.3.).

Table 5.3. Traffic increase of the 2020 Port development scenario

Traffic increase:	(2020-2011)/2011
Containership	18%
Passenger ship	17%
Ro-ro cargo ship	11%
Ro-ro passenger vessel	77%
All other typologies	0%
Total arrivals	26%

Beside the emissions by ships, also for the development scenario the traffic emissions induced on roads and railways by the total amount of vehicles arriving to and departing from the port of Venice has been considered. The induced traffic emission estimation has been calculated starting from the forecast of duty and passenger vehicles on road, as well on railway provided by APV for the two projects. The estimation refers to the studied domain of 100 x 100 Km^2, as previously done for the present time scenario (see “APICE risk activity report” for Venice).
For the SOx estimation, the 2020 scenario has considered the following limit on sulphur content:

- 0.1 % S in hotelling phase for all ships, as the present time scenario (this sulphur limit implies a total shift from Bunfer Fuel Oil to Marine Gas Oil)
- 0.5% S in manouvering and cruising phases for all ships (since this sulphur limit doesn’t imply a shift from BFO to MGO, the same proportion between BFO and MDO/MGO of the EMEP/EEA methodology has been considered; moreover for BFO an emission reduction of 20% for PM10 and PM2.5 has been applied as suggested in EC, 2006).

The relative variation (calculated as (2020-2011)/2011 and expressed as percentages) of the Venice harbour emissions as a consequence of the increase of maritime flows described is reported on the following graph (Fig. 5.5.). The variations are calculated both considering separately the terminals in Venice and Porto Marghera and then together. Emissions during cruise phase is considered only on the last data set.

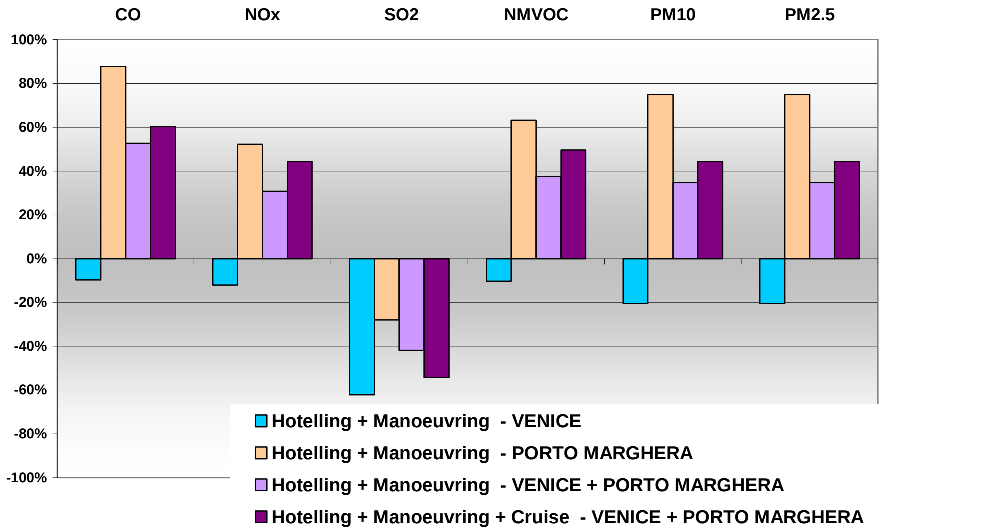

Figure 5.5. Change in Ship emissions in Venice Harbour due to development: 2020 vs 2011 emissions

Except for SO_2 emissions, for which the limitation of 0.5% in sulphur content of ship fuels for the maneuvering and cruising phases results to an important decrease, all the other pollutants record an increase between 40% to 60%, considering the whole Port of Venice and the three phases of navigation.
Letting aside the cruise phase, that in the Port of Venice starts outside the Venice lagoon entrances and so it is quite distant in respect to both the historical city and the inland one (Mestre) and considering separately the commercial/industrial terminals in Porto Marghera and the other terminals in the historical city of Venice, the 2020 development scenario records a decrease for all the pollutants in the historical city of Venice: - 10-12% for CO, NOx and NMVOC, -20% for PM10 and PM2.5. On the other hand, there's to report the increase on the total emission for the Porto Marghera terminals: +88% for CO, +52% for NOx, +63% for NMVOC and +75% for both PM10 and PM2.5. This is due to the fact that the Venice Motorways of the Sea Terminal foresees a displacement of the present Ro-passenger vessels from Venice to Porto Marghera.

2.2.3. Mitigation scenarios

Emission mitigation measures and corresponding emission scenarios relevant with the maritime and harbor activities have been studied for each port-city with the use of Chemical Transport Models (CTM) in order to assess the effectiveness of mitigation actions, addressed in strict collaboration with the territorial authorities involved in local working tables.
The mitigation scenarios investigated for Venice has considered 2 mitigation actions, at the same time.

- the cold ironing for the cruise vessels hotelling in Venice at the Marittima Terminal, with a total amount of 6195 hours of power supply in a year and a local production of electricity by the near coal power plan in Fusina (Porto Marghera)

- the limitation of 0.1% for the sulfur content for all the passenger ships arriving at and departing from the terminals inside the historical city of Venice in manouvering and cruising phases. The emission estimation calculation has considered an obligation to switch from BFO to Marine Gas Oil in order to reach the limit.

The emission decreases for each of the mitigation actions are reported on fig. 5.6 and 5.7.

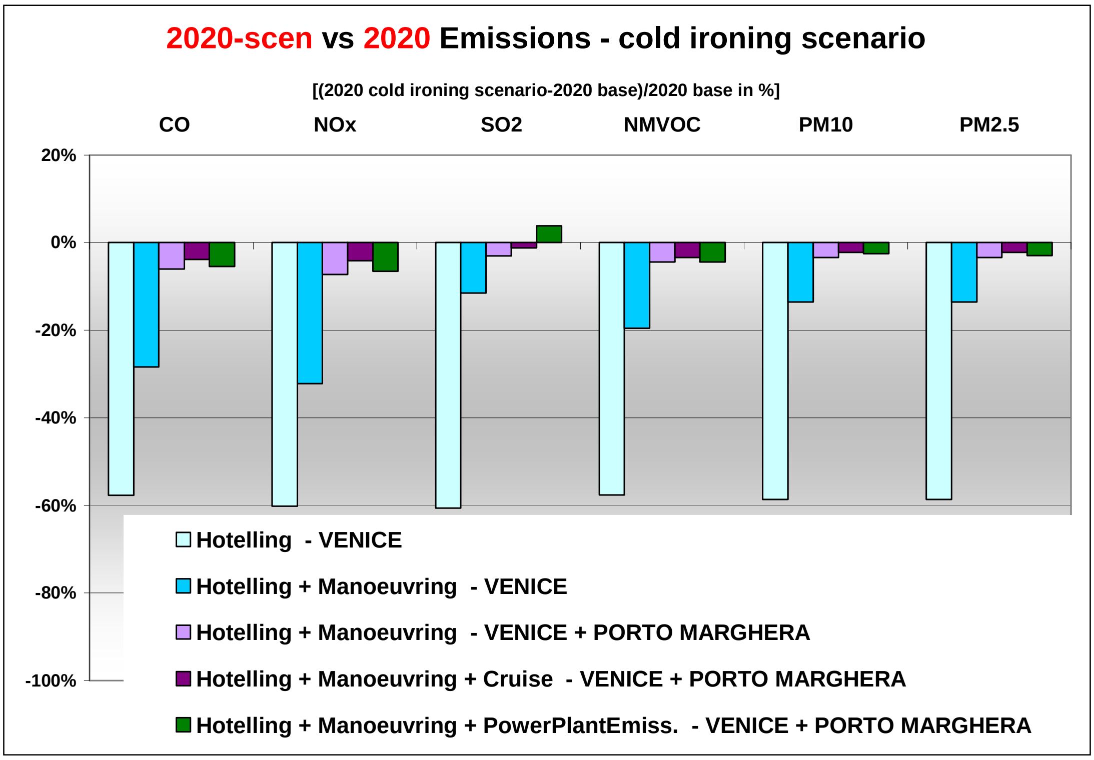

Fig. 5.6. Change in Ship emissions in Venice Harbour due to 6195 hours of cold ironing for cruise vessels at the Marittima Terminal.

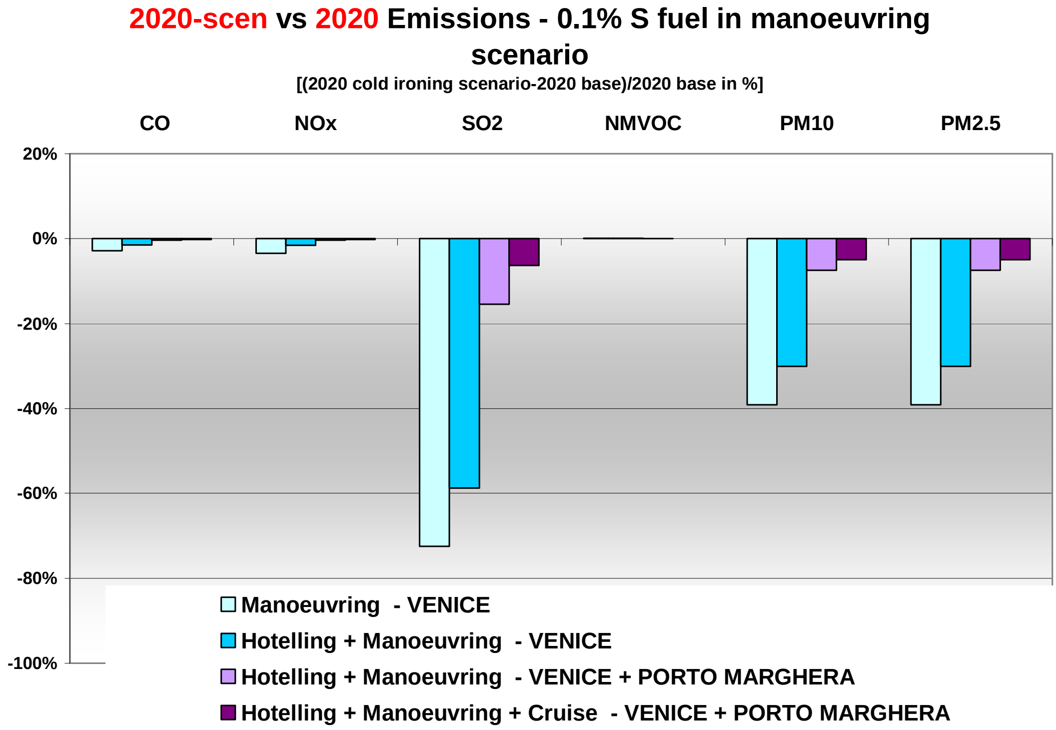

Figure 5.7: Change in Ship emissions in Venice Harbour due to 0.1 % S fuel in maneuvering for passenger ships arriving at and departing form terminals in Venice.

Considering the two mentioned mitigation actions together the total emission decrease is reported on the following graph (fig. 5.8):

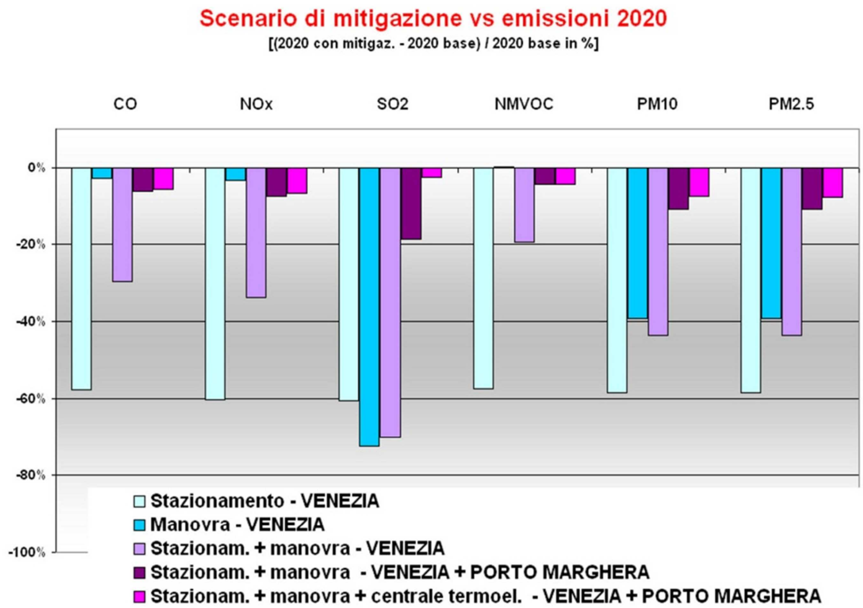

Figure 5.8: Emissions mitigation of the actions of low sulphure fuel and cold ironing on the 2020 Emiaaions scenario.

The following Figure (Fig. 5.9) illustrates the expected impact of both mitigation actions on the PM2.5 concentration levels of the 2020 year base future scenario in the Venice area for a summer month (using the meteorology of the corresponding month for the year 2011).

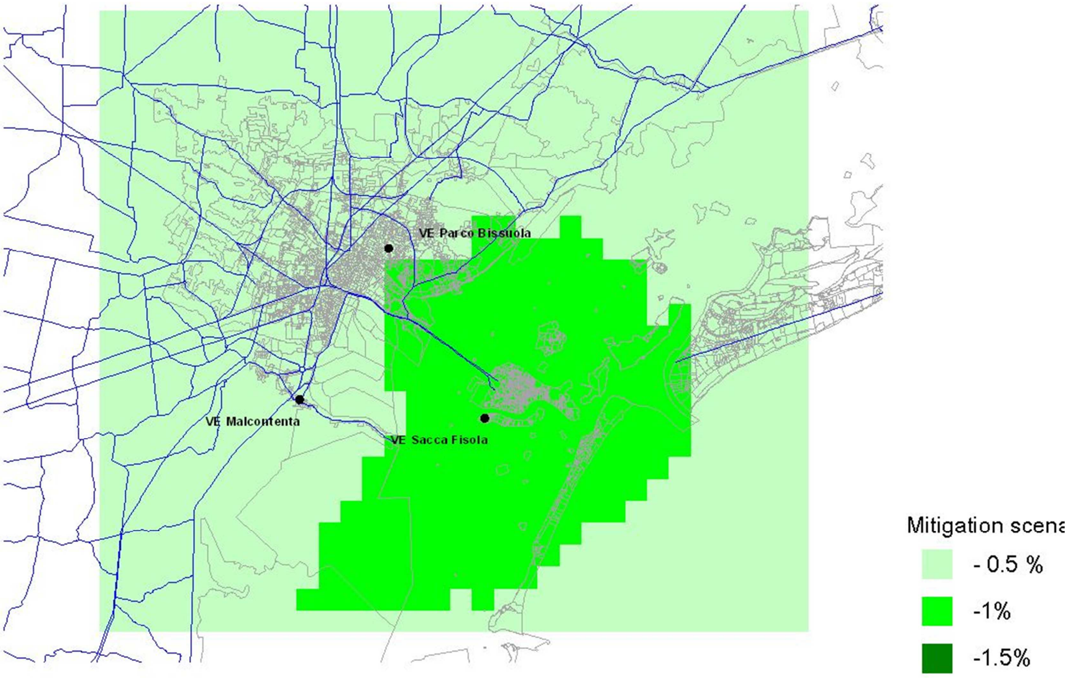

Figure 5.9.: Expected impact of both mitigation actions on the PM2.5 concentration levels of the 2020 year base future scenario in the Venice area for a summer month.

Model runs for a winter period were not performed since the mitigation actions selected consider the passenger ship traffic that has not negligible contribution only in summer.
The highest decrease in PM2.5 concentrations occurs in the cell of the Passenger Terminal in which cold ironing has been modeled; the decrease is about 1.5%.

2.3. Towards the evaluation of the actions

Considering the general approach of the Local Adaptation Plan for Venice, the strategy is oriented towards the identification of main actions according to the level of uncertainty deriving from contextual aspects, as well as in term of enforceability and implementability, as defined within the general approach of the Common Transnational Strategy of the APICE project.
The Actions that have been evaluated with high scores by the stakeholders are the ones that arise from the negotiation between public and private actors. They answer to the necessity, on one side, of a coordination of actors according to different role and competences around common goals, sharing benefits and costs as well. From the other side, these groups of actions answer to the different aspects of uncertainty, as they are more cost-effective, with smaller initial infrastructural investments.
The strategy for Venice takes into consideration the discussion which is under development in the local context, considering the rising awareness that the future scenario will be oriented towards a mix of solutions presented as below. Different measures will be implemented in strict relation with ship companies and local institutions, according to a framework in evolution towards 2020. For this very purpose the actions are discussed according to benefits and uncertainties, as to nourish the local debate as well as to support decision making.

2.3.1. Change in fuel while maneuvering through agreements

The most robust action envisaged by the stakeholders is the use of low sulphur fuel during the operation of maneuvering from the entrance of the Lagoon inlets to the Harbour. The way of implementing the action is through voluntary agreements between ship companies and local key actors, as the stringent limits with respect to content of sulphur will enter into force in 2020. The action, modeled by ARPAV in the scenario at 2020 as a 0,1% limit for fuel sulphur content that obliges passenger ships to switch from Bunker Fuel Oil (BFO) to Marine Gas Oil, would result in a significant reduction of SOx emissions, and the containment in the increment of particulate matters.
With respect to the lagoon of Venice, the stakeholders foresee the feasibility of the action for the cruise sector, while for the commercial sector there are several barriers in implementing the action, deriving from the capacity of negotiation with global economic actors as shipping companies.

2.3.2. Air emissions inspection on board

The action has been considered as it has a great impact in coordinating different actors towards the achievement the requirements established by law on fuels. In fact, an existent agreement between Venice Port Authority, the Harbour Master and the Interregional Section of Veneto and Friuli Venezia Giulia Custom Agency of 29/03/2012 regulates the modalities with respect to the controls on ship and the analysis of the fuel samples for the Port of Venice. The stakeholders have considered the idea to enlarge the agreement as to fortify the collaboration with respect to air quality management. Modalities and rules should be set according to roles and competences of each participant to the agreement.

2.3.3. Retrofitting technologies: scrubbers through hotelling and maneuvering

As the MARPOL Annex VI foresees the use of retrofitting technologies as alternative to the use of low sulphur fuel, the Venice local working table has evaluated as positive and robust the use of seawater scrubbers to mitigate air emissions. As from ARPAV modeling, the use of scrubbers will contain particulate matter while significantly reducing SOx, as they could be used in the hotelling as well as in maneuvering phase. However, it is important to point out that some strict rules on scrubbers typology in use inside the lagoon should be issued by the competent authority to preserve the lagoon aquatic environmental, with respect to water and sludge disposal from the scrubbers purification system. Finally, the use of seawater scrubbers depend on Ship Owner choices, and the capacity of local stakeholders to negotiate this kind of action is subjected to the low enforceability deriving from a lack of International regulation in forced at present time.

2.3.4. Alternative fuel: Liquefied Natural Gas (LNG)

The scenario with respect to the use and implementation of Liquefied Natural Gas within the Port of Venice has been evaluated as with high uncertainty depending of several aspects that have been discussed with local stakeholders, as well as deriving from contextual analysis of the implementation of LNG in Northern Europe ports.
The orientation towards the implementation of LNG in the harbor of Venice, besides the uncertainties, should be considered as a strategic choice to be shared by a panel of actors of different sectors, from Public sectors related to planning, infrastructure and energy, to Ship Companies as well as to industrial sectors devoted to technological innovation.
With respect to the implementation, LNG system might be conceived only from some segments of the Port of Venice, as for dual-fuel tugs to abate emissions deriving from long operation timings.
An opportunity could be to conceive the implementation to LNG connected to a network of Port (attended by the Venice Port) of the Short Sea Shipping, so to optimize the construction of LNG infrastructure, or, in case of Cruises, with respect to the network of the Home ports.
In any case, it would be important to evaluate the CO2 emissions, as the potential of abatement of LNG technology is high for particulate matters, NOx and SOx, but less relevant for CO2. Further investigations are needed on this point, as APICE didn't consider CO2 in its analysis.

2.3.5. On shore power supply

The action has been taken into consideration for the Marittima Station, which is located closed to the historical islands of Venice. Specifically, two different studies analyse the use of On shore Power Supply (OPS): the first one, from Venice Port Authority, takes into consideration the production of energy by power plant, and the second by VTP Engineering, where energy is produced in situ by co-generation with LNG.
ARPAV has calculated emissions deriving from the two options analyzing the contribution of the emission at 2020. If at local scale, the action contributes to an abatement of 80% of emissions deriving from cruises ships (data from ARPAV and from Venice Port Authority converge), the contribution to the entire maritime transport contribution is less relevant, only 6.5% of NOx and 3% on particulate matter. From

the side of the costs, the infrastructure requires a high investment estimated by APV in 55 Million of Euros, without considering the costs for the Ship predisposition.
Besides local factors, the action might be more cost-effective if implemented in a network of ports according to home ports and intermediate ports, so to maximize environmental benefits and to optimize investments in accordance with Cruise companies.

2.3.6. Traffic induced by port activities: Road Emissions (diesel road vehicles) and rail emissions

Within the area of the Venice lagoon, the actions that have been considered as the most robust to work for the mitigation of the air pollution deriving from the traffic induced by port activities are of three types: the first type are actions devoted to reducing emission at source (diesel motors), as retrofitting technologies or supporting fleet renewal; the second type takes into consideration the operational aspects of diesel motors, that is to say to potentiate and ease the traffic flow by acting on port access and infrastructure; the third type is devoted to the improvement of the rail freight ratio insisting in the Port of Venice. These actions are in line with the objectives of the White paper "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" (COM(2011) 144 final). However, the implementation of these set of actions is complicated by the difficult interaction between different levels of government and of enforceability, to be intertwined with the network of transport and logistics operators. Several aspects with respect to road traffic induced by port activities are related to National Policies and European directives. A strategic reflection on the implementation of Intelligent Traffic System might be beneficial for air quality, as well as for competitiveness of transport sector. Finally, the environmental effects of national Policies (as incentives to transport by ship instead of road between internal destinations) should be verified both at local and national scale.

2.3.7. Diesel powered equipment and Cargo handling equipment

From the analysis of emissions contribution of the equipment of loading and unloading of goods and containers, it results that the contribution is of some orders lower than the contribution of maritime and road traffic, which contribute much more, and it is not taken into consideration in the LAP.

2.3.8. Inventoring, Monitoring, Comunicating

These set of actions were carefully considered by the local stakeholders for the benefits deriving in coordination the activities in inventorying, monitoring and communicating. These actions have no direct impacts on reducing air pollution, but are beneficial in terms of organizing the network of data, knowledge, competences that are necessary to support decision making, as well as monitoring actions implementation and verifying achievements in pollution reduction. The three actions considered are: i) the constitution of a Coastal Air Quality Steering/Working Group in charge to coordinate and to integrate the activities going on about Air Quality, according to each stakeholder's competences and roles, to be defined and specify by the participants; ii) Monitoring and control (protocol or agreement between stakeholders, etc), connected to the action of inspection on board; iii) Data Sharing: Inventoring Emissions and Monitoring concentrations as the base for planning.
Those actions attains on a high ranking position, as to witness the great interest on the necessity to coordinate and to capitalize results, data and actions. Data and

information will be used to update emissions inventory on a regular base as to evaluate and re-orient the decisions to be made with respect to actions for pollution mitigation.

3. Mainstreaming of LAP within Venice knowledge framework as driver for the sustainable development in the Venetian port-city

As mainstreaming of the activities supported by the APICE project, it is foreseen the launching of a Second Edition of the Venice Blue Flag, by the Municipality of Venice, the Venice Port Authority, the Venice Terminal Passengers and the Harbour Master. The Venice Blue Flag is a voluntary agreement between the group of local actors with Ship Cruise Companies, which commit themselves to use low sulphur fuels while maneuvering from the lagoon inlet of Lido to the Marittima Station. The agreement is currently under discussion, and the sulphur content in percentage has not yet been defined, and also the schedule of the implementation of the agreement. It aims to anticipate the prescription on fuels by 2020, to be implemented towards an agreement with Ship Companies. (Venice Blue Flag, first edition in 2007-2009 attended by n.30 Ship Companies)
Moreover, Venice Port Autority, Venice Harbour Master, Venice Custom Agency will explore the possibility to extend the recent agreement on fuel controls, towards a perspective of sharing data to update emissions inventory and related management activities;
The idea of establishing a permanent table between stakeholders with respect to monitoring and controls for air quality is currently under debate, and modalities will be defined by participants with respect to their roles and competences.
From the side of the mainstraming of APICE project within the main sectorial planning with respect to air quality management, the Regional Plan for Air Quality of Veneto (Piano di Risanamento e Tutela dell'Atmosfera, PRTRA), currently under revision, will acquire the APICE results for the Venice Lagoon in terms of methodology, as well as in terms of insight on the Venice port emissions. The main scientific as well as planning results of APICE will constitute a preliminary study for the local action plan for Venice compartment.
With respect to the interaction with the Regional Masterplan of Veneto (Piano Territoriale Regionale di Coordinamento, PTRC), which is in charge of the spatial planning of Veneto, currently under revision, APICE project for Venice will be acquired with respect to transport indications and environmental results within the Regional Masterplan updating activities. Specific objectives on rationalization and optimization of infrastructure; mobility policies, environmental compatibility and landscape quality will be discussed according to the main results of APICE project.