



The results of CAIMANs project

Future emission scenarios

ARPAV, IDAEA, Air PACA, UNIGE, AUTH

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Mitigation Air Pollution in the Mediterranean Port Cities
Venice, 12th June 2015



Definition of future scenarios depends on...

- **Development trends of the Port Authorities** (e.g. changes in ship traffic, infrastructural interventions, etc.)
- **Legislation** (Annex VI of the International Convention for the Prevention of Pollution from Ships by the International Maritime Organization):
 - **Reduction of the sulfur content in ship fuels in the cruising and maneuvering** modes (to 0.5% m/m on and after 1 January 2020)
 - **Post-2010 vessels meeting the Tier II standards resulting in 20% lower NO_x emissions** (4% average annual replacement rate for vessels was assumed according the state-of-the-art reports)

Future scenarios defined

Scenario	Venice	Barcelona	Marseille	Thessaloniki	Genoa
Future trend	2020	2020	2025	2025	2020
LNG (Liquified Natural Gas)	✓	✓	✓	✓	✓
Cold ironing	✓	*	*	✓	✓
Other local scenarios	✓				

** The Cold Ironing scenario was studied in Marseilles and Barcelona in the framework of APICE*

	Future Year	N years proj.	Traffic Cruise Trend		Traffic Ro-Pax Trend	
			Yearly increase	Total period inc.	Yearly increase	Total period inc.
Marseilles	2025	12	3%	32%	3%	32%
Genoa	2020	7	2.90%	20%	1.40%	10%
Thessaloniki	2025	12	24%	288%	13%	150%
Barcelona	2020	7	2.5%	18%	2.5%	18%
Venice	2020	7	0%	0%		107%

Future baseline and mitigation scenarios: Barcelona

Scenario	Measures	Expected reduction
2020 Scenario (SC2020)	<ul style="list-style-type: none"> Proposed increase by 20% for passengers arriving at the port No changes in the number of vessels, but in the size (GT) of the passenger ships arriving at the port 	<p>For NO_x, -5.6% reduction in the emission factor.</p> <p>a) 4% average annual rate of replacement for vessels</p> <p>b) new engines emitting roughly 20% lower NO_x emissions than a pre-2011 engine.</p> <p>7 years x 4% x 20% = 5.6%</p>
2020+LNG Scenario (LNG2020)	<ul style="list-style-type: none"> Future projection of +20% in passengers for 2020 Reduction of emission factors in all phases (hotelling, manoeuvring and cruising) 	<p>-90% NO_x, -100% PM10, -100% SO_x, -20% CO₂ (IMO, 2009), with respect to SC2020</p>

Future baseline and mitigation scenarios: Marseille

Scenario	Measures	Expected reduction
2025 Scenario (SC2025)	<ul style="list-style-type: none"> Proposed increase by 20% for passengers arriving at the port No changes in the number of vessels, but in the size (GT) of the passenger ships arriving at the port 	<p>For NO_x, -9.6% reduction in the emission factor.</p> <p>a) 4% average annual rate of replacement for vessels</p> <p>b) new engines emitting roughly 20% lower NO_x emissions than a pre-2011 engine.</p> <p>12 years x 4% x 20% = 9.6%</p>
2025+LNG Scenario (LNG2025)	<ul style="list-style-type: none"> Future projection of +36% in passengers (ferry and cruise) for 2025 Reduction of emission factors in all phases (hotelling, manoeuvring and cruising) 	<p>-90% NO_x, -100% PM10, -100% SO_x, -20% CO₂ (IMO, 2009), with respect to SC2025</p>

Future baseline and mitigation scenarios: Genoa

Scenario	Measures	Expected reduction
2020 Scenario (SC2020)	<ul style="list-style-type: none"> Proposed increase in maritime traffic: <ul style="list-style-type: none"> + 20% cruise ships +15% ro-pax ships No changes in the harbour structure: each terminal with traffic values close to the maximum capacity 	<p>For NO_x, -5.6% reduction in the emission factor.</p> <p>a) 4% average annual rate of replacement for vessels</p> <p>b) new engines emitting roughly 20% lower NO_x emissions than a pre-2011 engine.</p> <p>7 years x 4% x 20% = 5.6%</p>
2020+LNG Scenario (LNG2020)	<ul style="list-style-type: none"> Future projection of passenger ships traffic (2020 Scenario) Reduction of emission factors in all phases (hotelling, manoeuvring and cruising) 	<p>-90% NO_x, -100% PM₁₀, -100% SO_x, -20% CO₂ (IMO, 2009), with respect to SC2020</p>
2020+OPS Scenario (OPS2020)	<ul style="list-style-type: none"> Future projection of passenger ships traffic (2020 Scenario) Reduction of emission in hotelling phase studied for passenger terminals 	<p>Emission reduction for NO_x, SO₂ and PM with respect to SC2020:</p> <ul style="list-style-type: none"> Cruises terminals -80% Ro-pax terminals -90%

Future baseline and mitigation scenarios: Venice

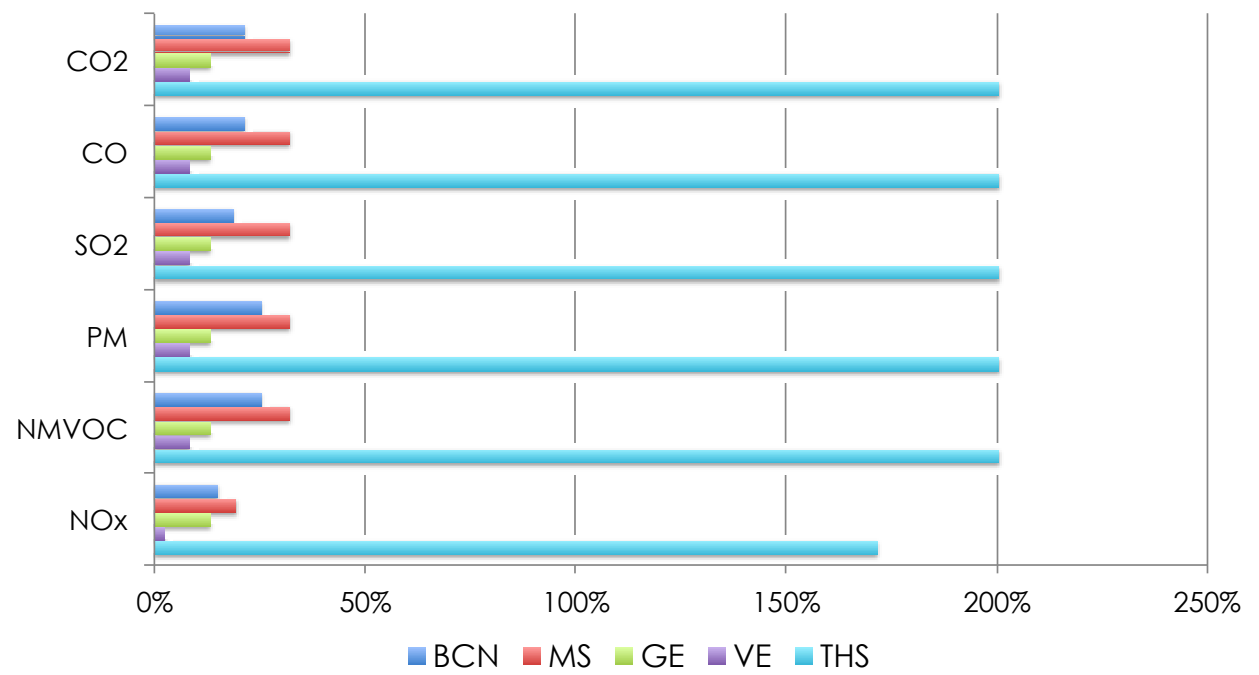
Scenario	Measures	Expected reduction
2020 Scenario (SC2020)	<p>No increase of cruise ships No changes in the Cruise Terminal: actual traffic values close to the maximum capacity</p> <ul style="list-style-type: none"> +107% ro-pax ships and displacement from the historical city to Fusina Terminal in Porto Marghera 	<p>For NO_x, -5.6% reduction in the emission factor.</p> <p>a) 4% average annual rate of replacement for vessels b) new engines emitting roughly 20% lower NO_x emissions than a pre-2011 engine. 7 years x 4% x 20% = 5.6%</p>
2020+LNG Scenario (LNG2020)	<ul style="list-style-type: none"> Future projection of passenger ships traffic (2020 Scenario) Reduction of emission factors in all phases (hotelling, manoeuvring and cruising) 	<p>-90% NO_x, -100% PM₁₀, -100% SO_x, -20% CO₂ (IMO, 2009), with respect to SC2020</p>
2020+OPS Scenario (OPS2020)	<ul style="list-style-type: none"> Future projection of passenger ships traffic (2020 Scenario) Reduction of emission in hotelling phase for cruise ships larger than 40 kGT (4 electrified quays) 	<p>Emission reduction for NO_x, SO₂ and PM with respect to SC2020:</p> <ul style="list-style-type: none"> Hotelling Cruise ships > 40 kGT - 90% Hoteling all Cruise ships -73%
Local scenarios	<ul style="list-style-type: none"> Displacement of Cruise ships manoeuvring route Displacement of Cruise Terminal 	<p><i>Commented in the Venice session results</i></p>

Future baseline and mitigation scenarios: Thessaloniki

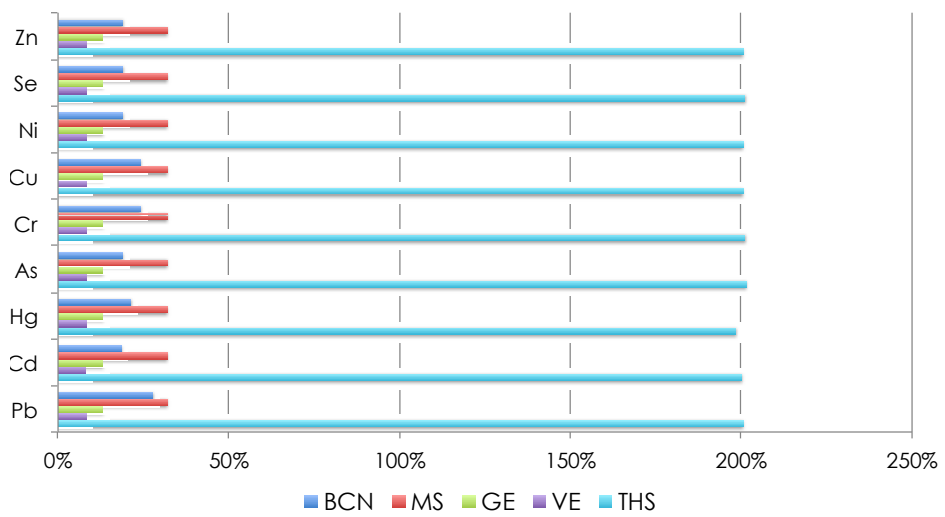
Scenario	Measures	Expected reduction
2025 Scenario (SC2025)	<ul style="list-style-type: none"> Proposed increase in maritime traffic: <ul style="list-style-type: none"> + 284% cruise ships +150% ro-pax ships No changes in the harbour structure: each terminal with traffic values close to the maximum capacity. 	<p>For NO_x, -9.6% reduction in the emission factor.</p> <p>a) 4% average annual rate of replacement for vessels b) new engines emitting roughly 20% lower NO_x emissions than a pre-2011 engine.</p> <p>12 years x 4% x 20% = 9.6%</p>
2025+LNG Scenario (LNG2025)	<ul style="list-style-type: none"> Future projection of passenger ships traffic (2025 Scenario) Reduction of emission factors in all phases (hotelling, manoeuvring and cruising) 	<p>-90% NO_x, -100% PM₁₀, -100% SO_x, -20% CO₂ (IMO, 2009), with respect to SC2025</p>
2025+OPS Scenario (OPS2025)	<ul style="list-style-type: none"> Future projection of passenger ships traffic (2025 Scenario) Emissions in hotelling phase studied for passenger terminals are forced to zero 	<p>Emission reduction for NO_x, SO₂ and PM with respect to SC2025:</p> <ul style="list-style-type: none"> •Cruise ships : -20% •Ro-pax: -18%

**Future-Present
% variation,
baseline
scenarios,
Hotelling
All Pass**

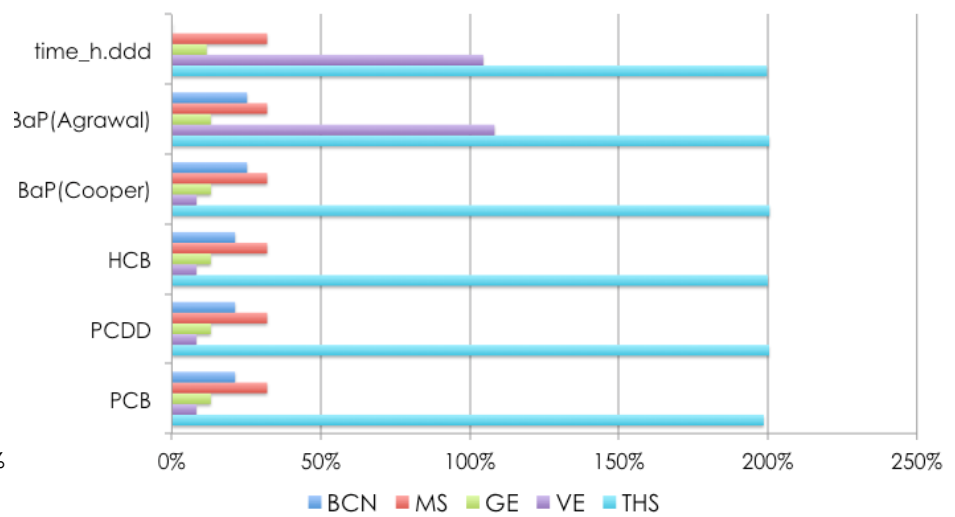
Hotelling Emissions, Future Trend (%), All Passengers



Hotelling Emissions, Future Trend (%), All Passengers

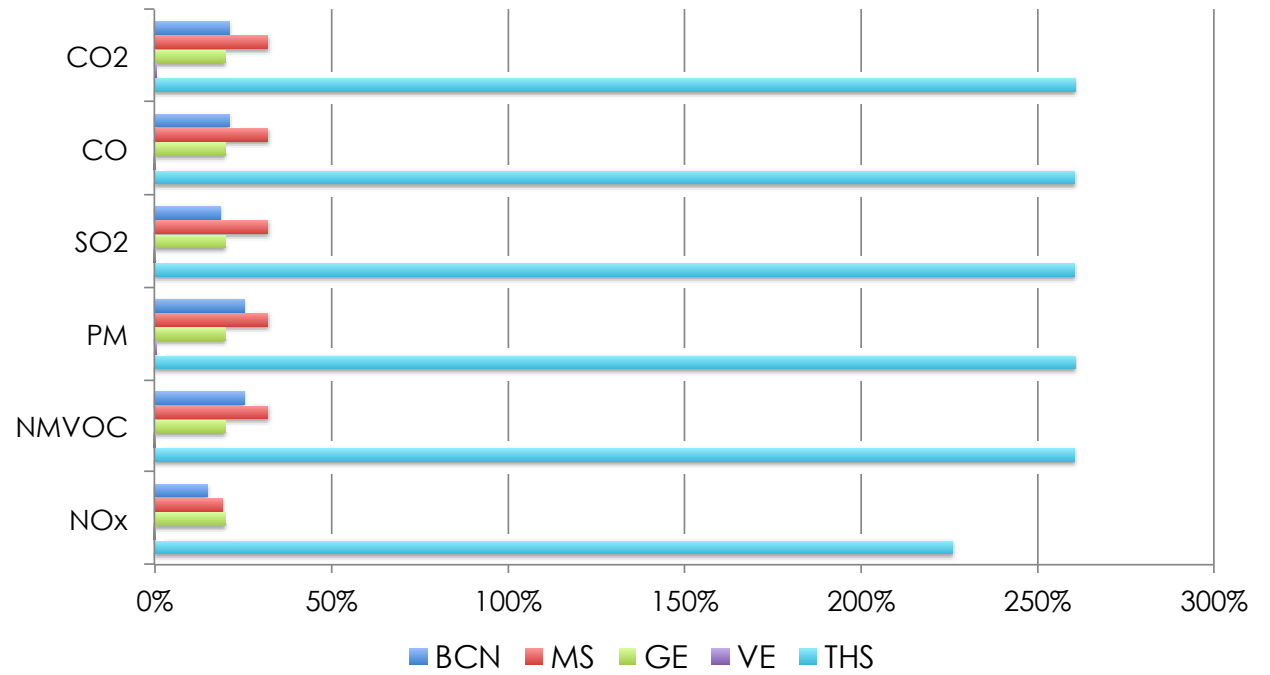


Hotelling Emissions, Future Trend (%), All Passengers

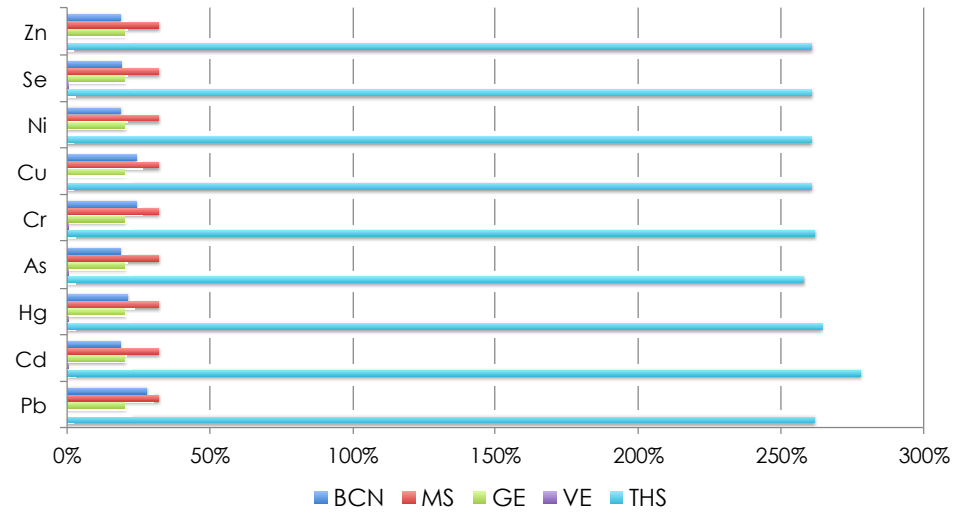


**Future-Present
% variation,
baseline
scenarios,
Hotelling
Cruise only**

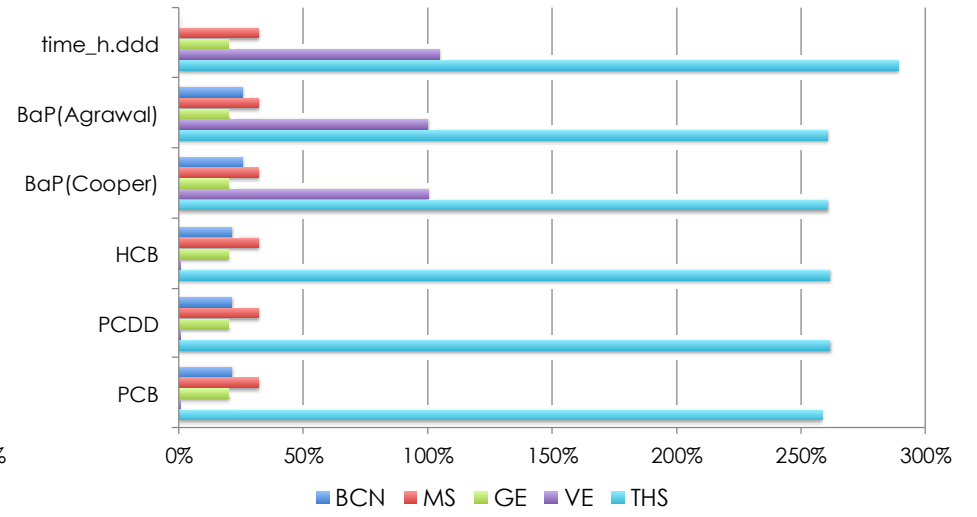
Hotelling Emissions, Future Trend (%), Cruise Only



Hotelling Emissions, Future Trend (%), Cruise Only

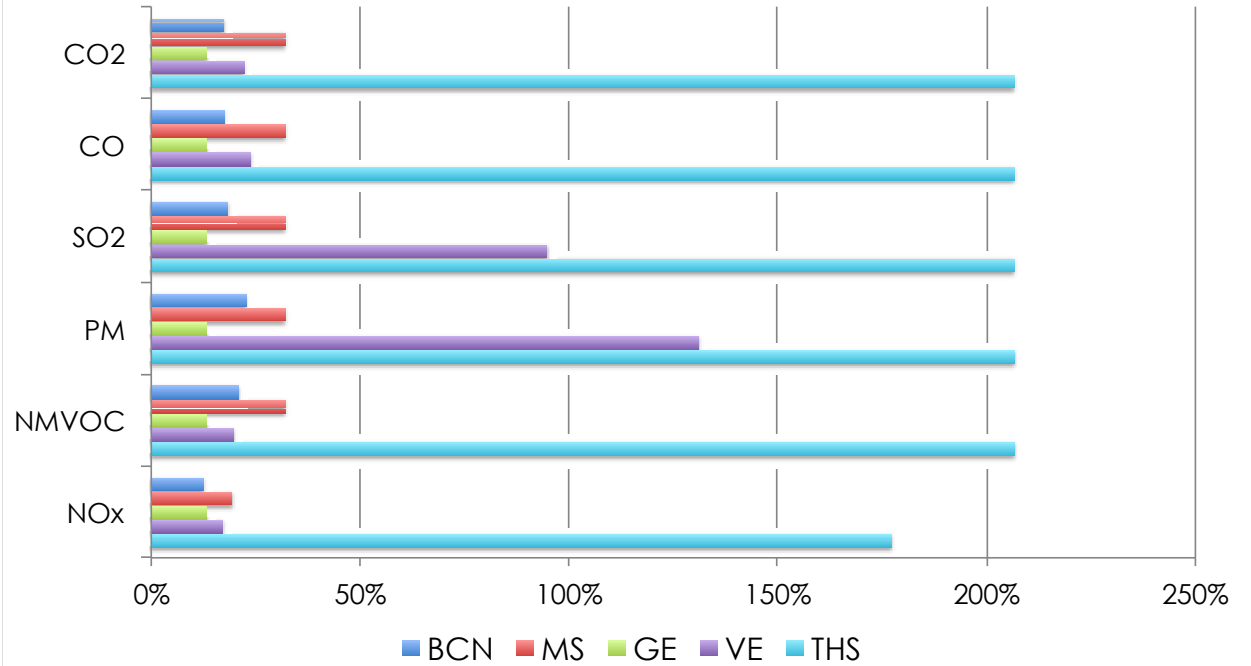


Hotelling Emissions, Future Trend (%), Cruise Only

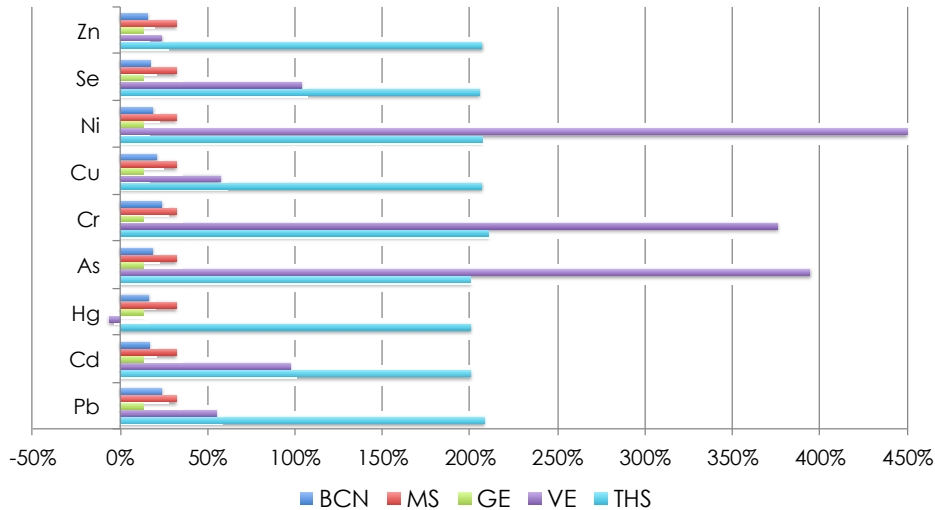


**Future-Present
% variation,
baseline
scenarios,
Manoeuvring
All Pass**

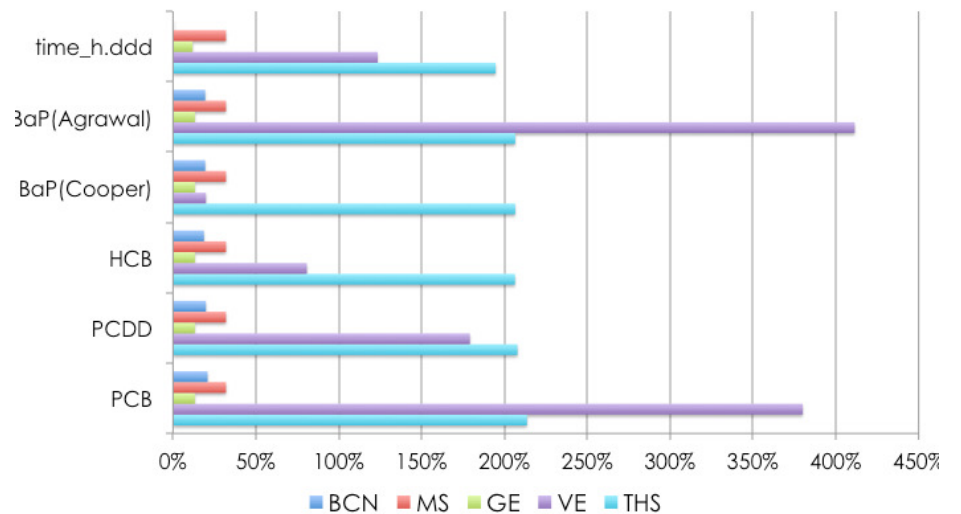
Manoeuvring Emissions, Future Trend (%), All Passengers



Manoeuvring Emissions, Future Trend (%), All Passengers

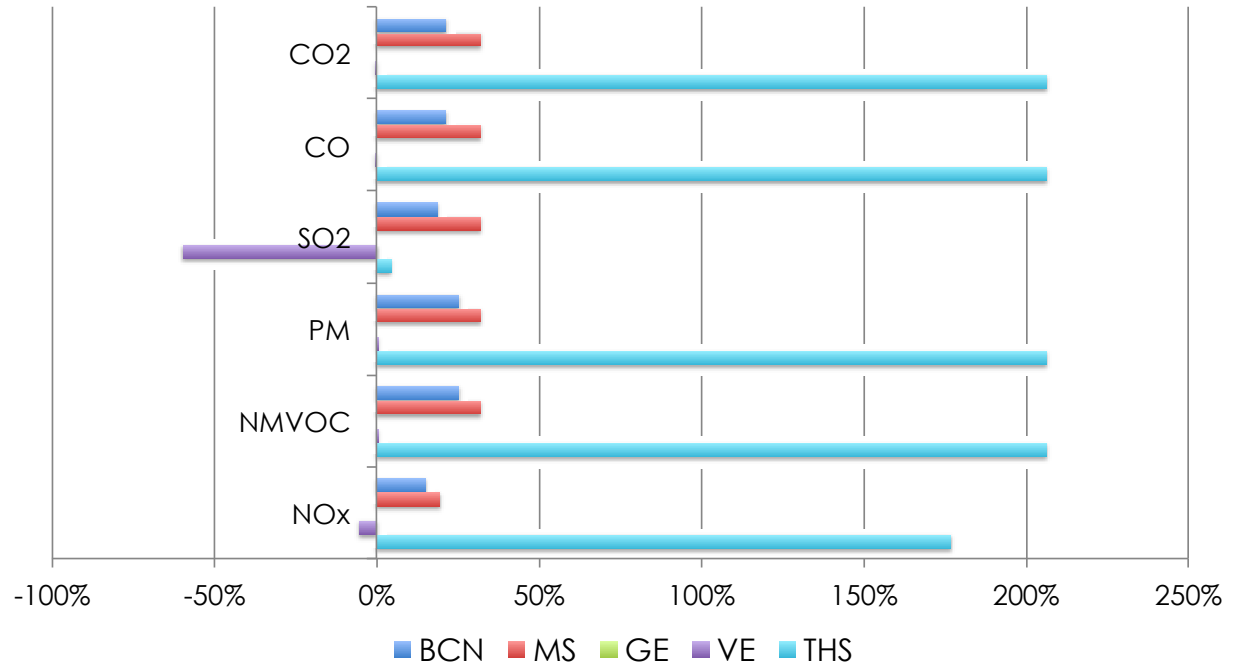


Manoeuvring Emissions, Future Trend (%), All Passengers

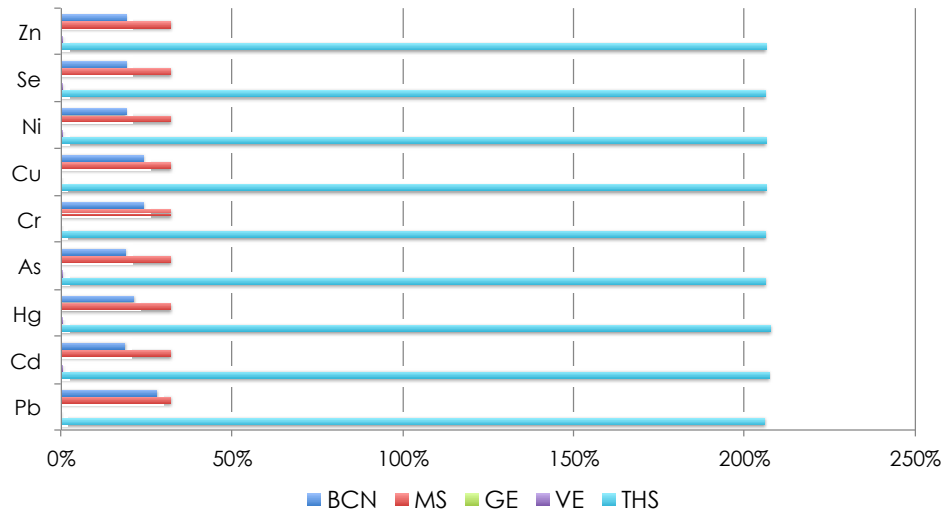


**Future-Present
% variation,
baseline
scenarios,
Cruising_Terr
All Pass**

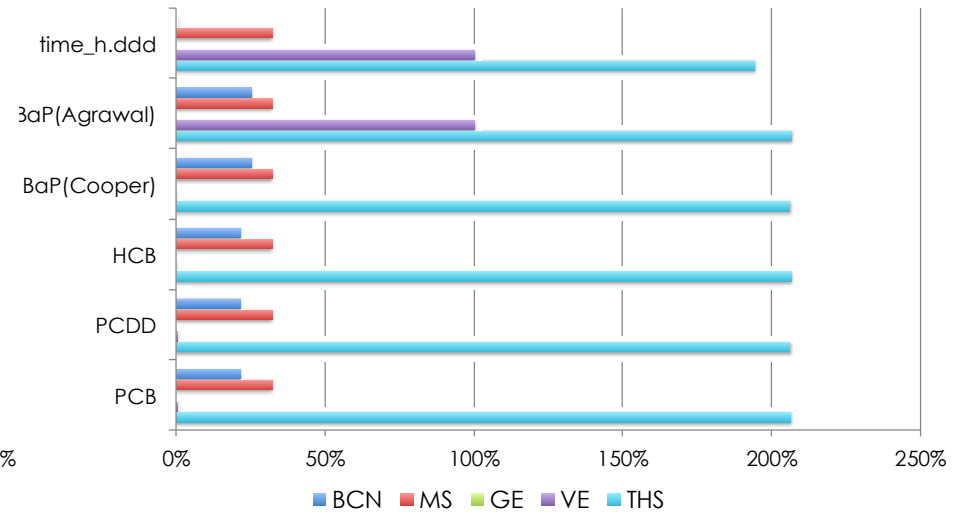
Cruising_Terr Emissions, Future Trend (%), All Passengers



Cruising_Terr Emissions, Future Trend (%), All Passengers

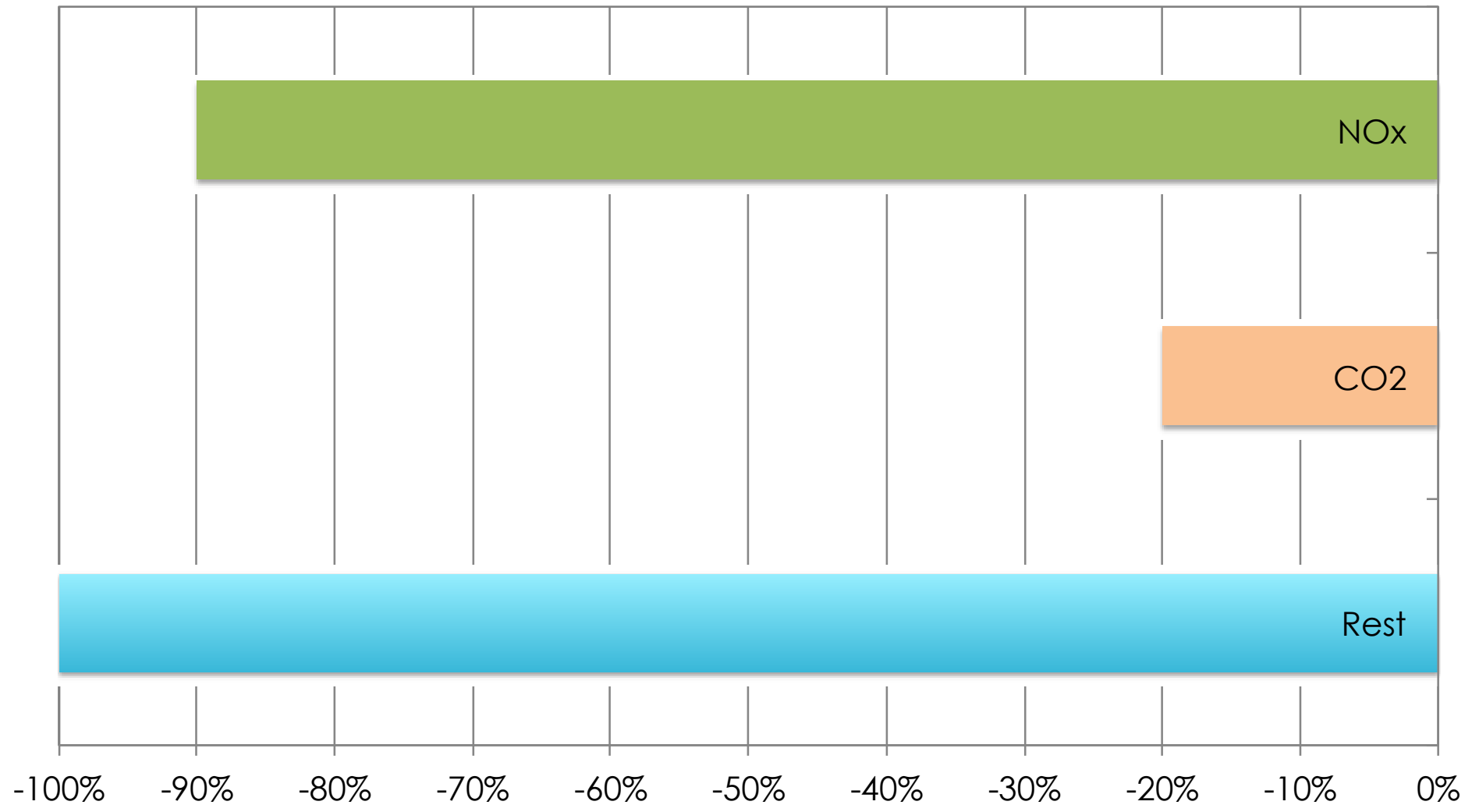


Cruising_Terr Emissions, Future Trend (%), All Passengers



LNG-Future % variation, All nav. phases.

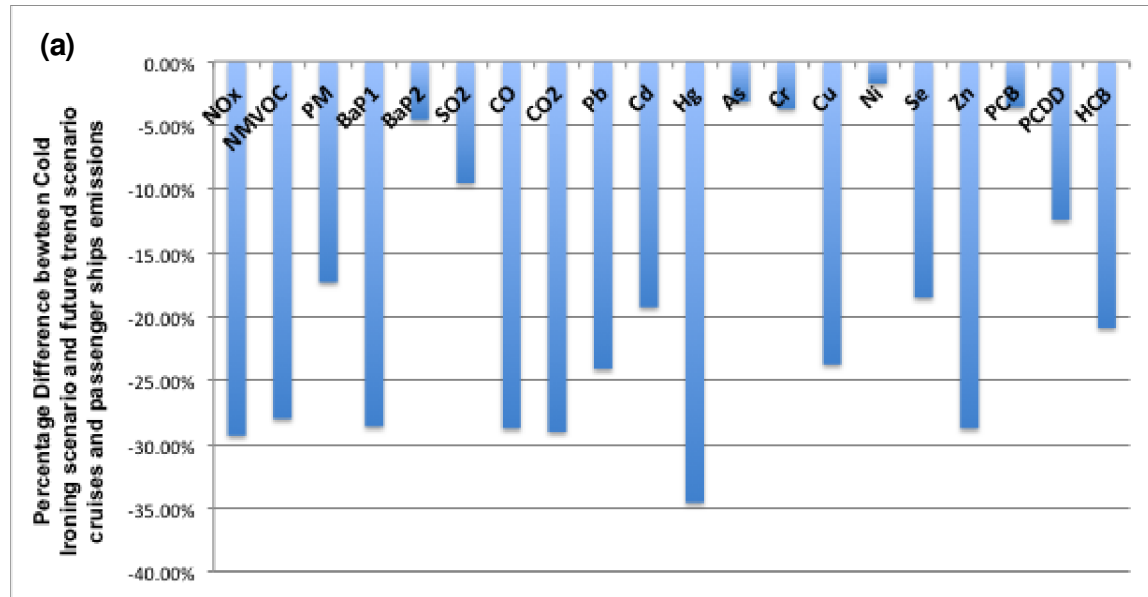
All nav. phases, LNG changes (%)



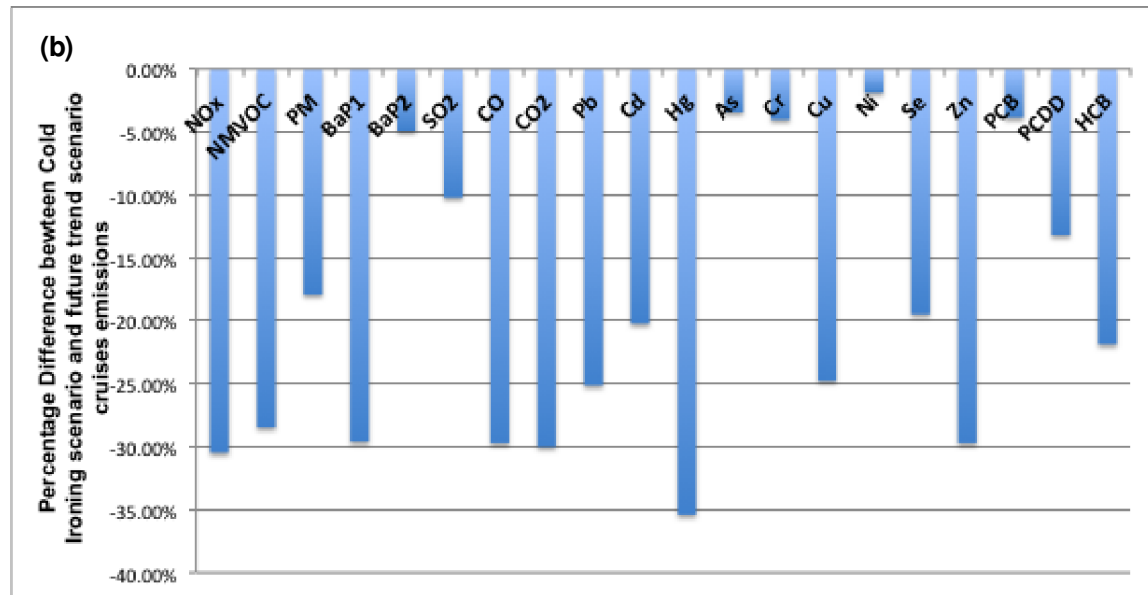
Other individual mitigation scenarios

e.g. Cold ironing,
Thessaloniki

All pass.



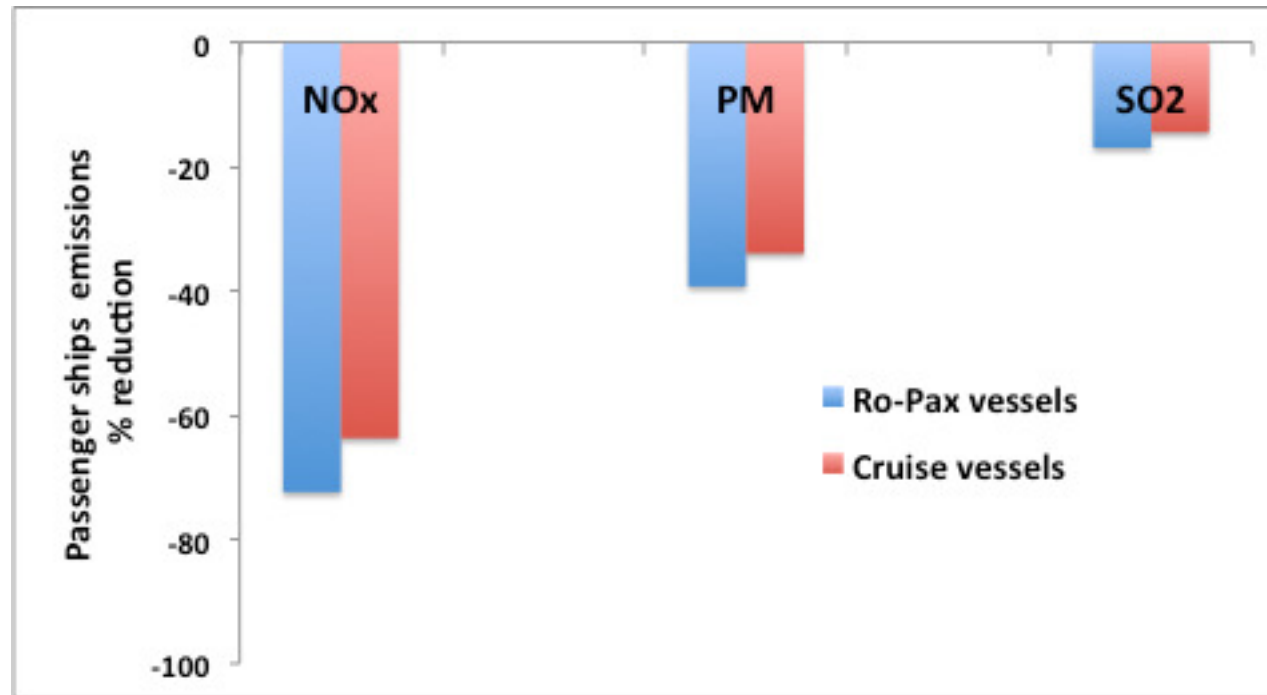
Cruise only



Other individual mitigation scenarios

e.g. Cold ironing, Genoa

Emission reduction evaluated for NO_x, PM and SO₂ (study by Liguria Region)

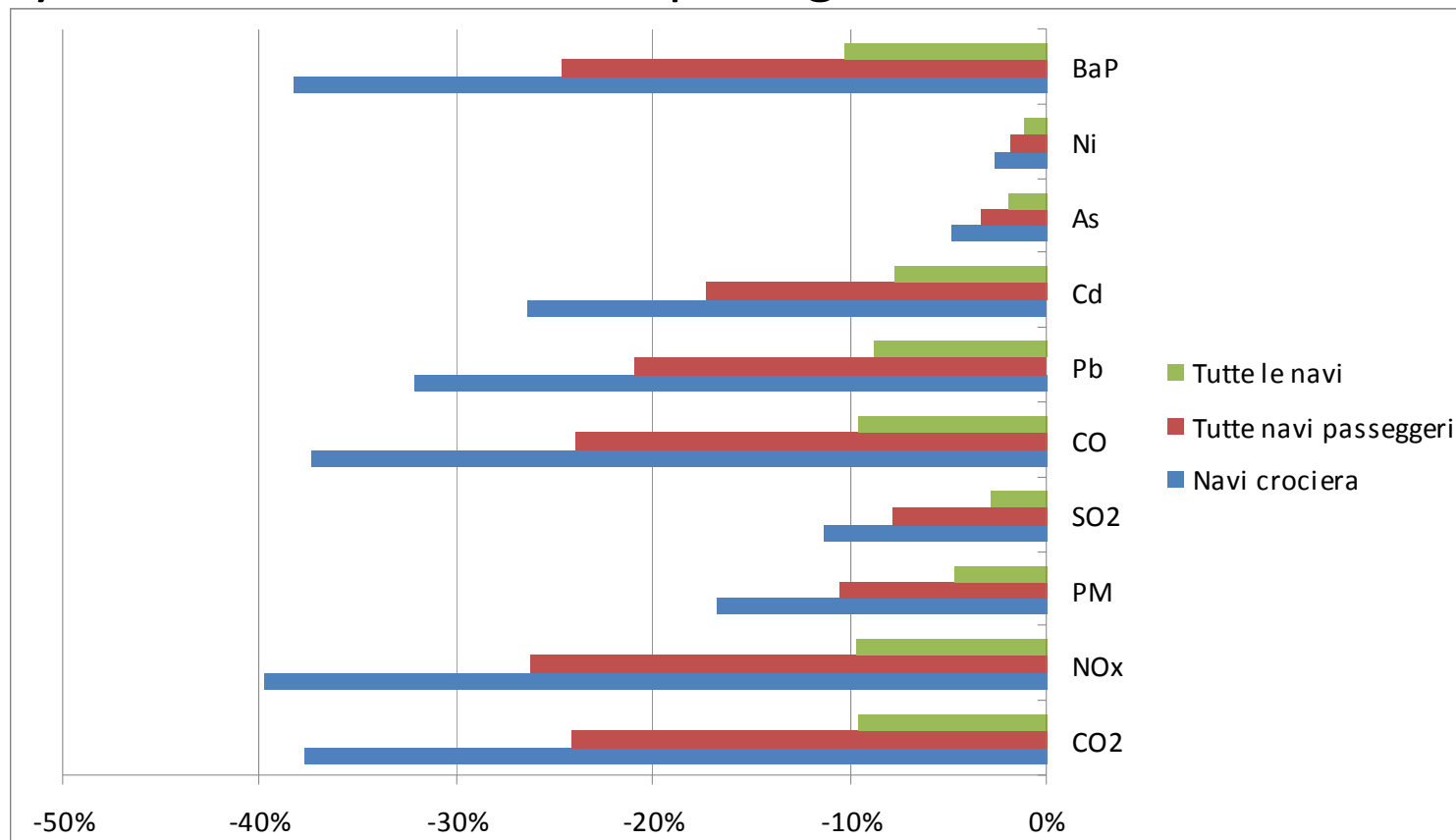


- Hotelling phase emissions represent the most relevant passenger ships contribution in Genoa study area → cold ironing is a highly effective mitigation action
- Expected impact on the total harbour emissions
 - 3% - 14% for NO_x emissions,
 - 6% - 11% for PM emissions
 - 4% - 14% for SO_x emissions

Other individual mitigation scenarios

e.g. Cold ironing, Venice

4 quays with OPS for cruise ships larger than 40 kGT



➤ Estimated impact on the total harbour ship emissions

- - 10 % for NO_x, CO, BaP, CO₂ emissions,
- - 5% for PM emissions
- - 3% for SO_x emissions

Conclusions & perspectives

- **Changes in emissions are usually around 20-40% for 2020-2025 with respect to 2013 in all ports, except for the port of Thessaloniki (increases up to 300% in 2025)**
- **LNG scenario is a very effective mitigation action**
- **Local scenarios for emission control (e.g. on-shore power supply/cold ironing) can effectively lead to important reductions on Ro-Pax and cruise emissions**

CAIMANs

Cruise and passenger ship Air quality Impact Mitigation Actions

THANK YOU FOR YOUR ATTENTION

Lead Partner: Environmental Protection Agency of Veneto Region ARPAV – Padoa (IT)
www.arpa.veneto.it

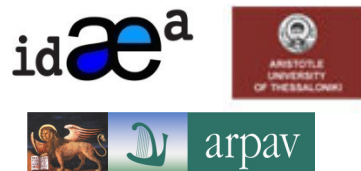
Partners:

University of Genoa, Department of Physics (IT) www.labfisa.ge.infn.it

Aristotle University of Thessaloniki (GR) <http://lap.physics.auth.gr>

AIR PACA – Air quality observatory (FR) <http://airpaca.org/>

Spanish Research Council - Institute of Environmental Assessment
& Water Research IDAEA (ES) <http://www.idaea.csic.es/>



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