Interreg Europe Smooth Ports Project

Nantes Saint-Nazaire Port Authority
(Grand Port Maritime de Nantes Saint-Nazaire)

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ASSESSMENT OF CO_2 AND OTHER ATMOSPHERIC EMISSIONS FROM THE ROAD NETWORK TRAFFIC IN NANTES SAINT-NAZAIRE PORT

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FOREWORD

The European Union is targeting the carbon neutrality by 2050 and is committed in an ambitious low-carbon economic policy.

The European Union set a the greenhouse gas (GHG) reduction goals with a target of reducing GHG emissions by at least 55% by 2030 compared to 1990 levels.

In the field of Port economy, the Smooth Ports Project aims at contributing to this long-term policy by focusing on the reduction of CO_2 emissions in Port areas due to the road traffic and the improvement of the traffic flows, delivering a sustainable performance to the Ports.

The Smooth Ports Project team agreed during the first semester of the Project (01/08/19 – 31/02/20) on a common methodology in order to assess these emissions. This work is this first step of the Project in order to draw-up a survey-cum inventory in each local situation.

For this purpose, the Port Authority of Nantes Saint-Nazaire (PP4 partner) commissionned in 2020 the Consulting Firm EGIS to carry out an assessment of the road traffic emissions on the public network of the Port of Nantes Saint-Nazaire area.

This document is largely based of this EGIS assessment[1], both in the results, the diagnosis and the proposals of further actions.

[1] *Grand Port Maritime de Nantes Saint-Nazaire - Evaluation des émissions atmosphériques des véhicules en zone portuaire – projet Smooth Ports (Interreg Europe) – 16 décembre 2020 – EGIS*

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1.1 - Subject of the assessment

The Smooth Ports project is part of the European Program INTERREG EUROPE. Lead by the Free and Hanseatic City of Hamburg and uniting six European partners, this Smooth Ports project aims at identifying public policies actions in order to reduce CO_2 related to road traffic in Ports.

- Free and Hanseatic City of Hamburg, Ministry of Economy and Innovation Port of Hamburg Marketing (Germany)
- Port Authority Network Northern Tyrrhenian Sea (Italy)
- Port of Nantes Saint-Nazaire Authority (France)
- Municipality of Monfalcone (Italy)
- Regional Administration Varna (Bulgaria)

"The Project SMOOTH PORTS aims to reduce CO2 emissions from port-related road traffic by improving regional policy instruments in a holistic manner.

To achieve these aims, SMOOTH PORTS wants to utilize the differences of the project partners' Ports through an exchange of effective tools and best practices. A key focus lies on finding optimal procedures for the clearance of the goods that are so vital for society and commerce – making their processing speedy and avoiding unnecessary burdens on environment and people. A further focus will be on the different approaches regarding Information and Communications Technology solutions for various traffic related Port activities as well as on the question what alternative fuels can power Port activities in the future."

source : https://www.interregeurope.eu/smoothports/

The Project goal is the mitigation of the consequences of the Greenhouse Gas (GHG) emissions and other atmospheric pollutants by three main ways:

- Improvement of cargo-related regulatory process in the Port
- Facilitation of use of alternative fuels in Port areas
- Increasing the use of digital tools in the Port areas

Thanks to a holistic approach, the Smooth Ports project aims at unify different independent measures in a same area in order to generate stronger impacts on the short and long term, and to maximize the investment value.

In the framework of this project, the goal of the Port Authority of Nantes Saint-Nazaire (GPMNSN) is to carry out a double assessment. First, it is a matter of assessing the road emissions of vehicles driving on the road network managed by the Port Authority. This road network includes all the public roads of the Port land. It excludes the private roads located in the Port terminals, logistics platforms or in the factories. The total length Port of this defined road network is about 55 km.

Secondly, the goal is to assess the impact of the solutions and projects contributing to the mitigation of emissions.

The third part aims at presenting the solutions in order to improve the input data related to the road vehicles driving in the Port area for future studies.

1.1.1 - Content of the assessment

The study includes:

- An assessment of the atmospheric emissions related to the current road traffic in the Port area (Port road network) – situation 2020
- An assessment of the impacts of solutions and underway projects aiming at mitigate these emissions – situation 2030
- Proposals of improvement in the measurement of traffic emissions

1.1.2 - Pollutants examined

The list of the pollutants taken into account:

Nitrogen oxides (NO_x) including Nitrogen Dioxide - NO2

Particulate matter (PM) PM10 and PM2.5,

Sulphur oxides (SO_x) including Sulphur Dioxide - SO_2

Carbon Dioxide - CO2

1.2 - Basic knowledge on atmospheric pollutants

Atmospheric pollutants are too numerous for being surveyed totally. Some of them taken into account for two main reasons:

- They characterize a kind of pollution (industrial, road, etc…)
- Proven effects on environment and/or on health

This paragraph successively reminds the sources and the effects of the main GHG and atmospheric pollutants.

- Greenhouse gases including Carbon Dioxide - CO2
- The other atmospheric (air) pollutants
  - Nitrogen oxides (NOx)
  - Particulate matter (PM) PM10 and PM2.5,
  - Sulphur Dioxide - SO2

According to the IAPH (International Association of Ports and Harbors) emissions methodology, the main climate change pollutants and air pollutant are the following.

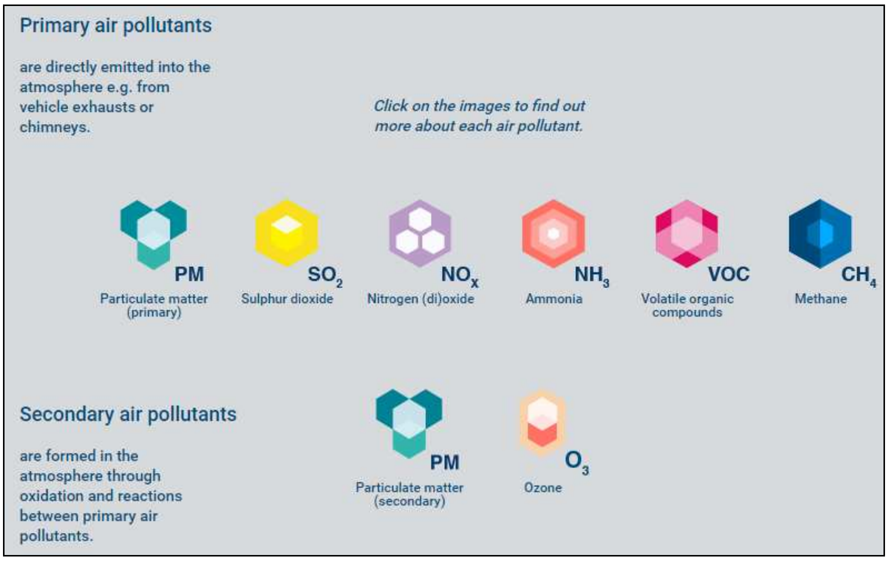
Figure 1-1 Port-related pollutants, sources and health and environmental effects (International Association of Ports and Harbors)

Climate change pollutant	Sources	Health and environment effects
Greenhouse gases (GHGs) that are typically emitted from Port-related sources include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Additional gases, which are not significantly emitted by maritime related sources or included in this inventory, contribute to climate change.	GHGs come from both natural processes and human activities. The primary Port-related GHG sources are from the exhaust from engines that power landside equipment and vehicles, marine vessels, non-renewable energy generation, other industrial and commercial sources that burn fuel.	Most climate scientists agree that the main cause of the current global warming trend is the human expansion of the 'greenhouse effect'. Warming results when the atmosphere traps heat radiating from Earth towards space. Certain gases in the atmosphere block heat from escaping otherwise referred to GHGs. Climate change results in extreme and unusual weather pattern shifts within the Earth's atmosphere.
Air pollutant	**Sources**	**Health and environment effects**
Oxides of nitrogen (NOx) is the generic term for a group of highly reactive gases; all of which contain nitrogen and oxygen in varying amounts. Most NOx are colorless and odorless	NOx form when fuel is burned at high temperatures, as in a combustion process. The primary Port-related NOx sources are from the exhaust from engines that power landside equipment and vehicles, marine vessels, non-renewable energy generation, other industrial and commercial sources that burn fuel	NOx can react with other compounds in the air to form tiny particles adding to PM concentrations. NOx can also bind with VOCs and sunlight to form ground level ozone or smog. NOx and VOCs are ozone precursors. Ozone is linked to shortness of breath, coughing, sore throat, inflamed and damaged airways, and can aggravate lung diseases such as asthma, emphysema and chronic bronchitis
Particulate matter (PM) refers to discrete solid or aerosol particles in the air. Dust, dirt, soot, smoke and exhaust particles are all considered PM. PM is typically categorized as Total PM (or just PM) or divided into two smaller size categories: PM10, which consists of particles measuring up to 10 micrometers in diameter; and PM2.5, which consists of particles measuring 2.5 micrometers in diameter or smaller. Diesel particulate matter (DPM) is a species of particulate matter important in some jurisdictions.	Airborne PM is a mixture of solid particles and liquid droplets generated in numerous ways. The primary Port-related PM sources are from the exhaust of engines that power landside equipment and vehicles, marine vessels, non-renewable energy generation, other industrial and commercial sources that burn fuel. PM can also be generated from large open areas of exposed earth or dirt roads, where vehicles and equipment can disperse PM into the air.	Fine particles are a concern because their very tiny size allows them to travel more deeply into lungs and enter the blood stream, increasing the potential for health risks. Exposure to PM2.5 is linked with respiratory disease, decreased lung function, asthma attacks, heart attacks and premature death.
Oxides of sulphur (SOx) is a group of colourless, corrosive gases produced by burning fuels containing sulphur.	SOx (a group of gases) is released when fuels containing sulphur are burned in the combustion process. The primary Port-related SOx sources is exhaust from engines that power landside equipment and vehicles, marine vessels, non-renewable energy generation, other industrial and commercial sources that burn fossil fuel.	SOx is associated with a variety of respiratory diseases. Inhalation of SOx can cause increased airway resistance by constricting lung passages. Some of the SOx become sulphate particles in the atmosphere adding to measured PM levels. High concentrations of gaseous SOx can lead to the formation of acid rain, which can harm trees and plants by damaging foliage and decreasing growth.
Volatile organic compounds (VOCs) are any compound of carbon (other than CO, CO_2, carbonic acid, metallic carbides or carbonates and ammonium carbonate) which participates in atmospheric photochemical reactions	VOCs are generated when fuel is burned in the combustion process. The primary Port-related VOCs sources are from the exhaust from engines that power landside equipment and vehicles, marine vessels, non-renewable energy generation, other industrial and commercial sources that burn fuel. In addition, liquids containing VOCs are used by numerous industrial and commercial applications, where they can volatilize into the air.	In addition to contributing to the formation of ozone, some VOCs are considered air toxics which can contribute to a wide range of adverse health effects. Some VOCs are also considered PM.

Source : page 4, *GEF-UNDP-IMO GloMEEP Project and IAPH, 2018: Port Emissions Toolkit, Guide No.1,Assessment of Port emissions.*

For the Directorate-General for Environment (European Commission), the main air pollutants are :

Figure 1-2 : primary and secondary air pollutants



Source: https://ec.europa.eu/environment/air/cleaner_air/

2 - Assessment of road emissions in the Port area

Chapter 2.1 – Methodology aims at presenting the set of data, hypothesis and softwares used in the framework of this assessment. The results of this assessment are part of chapter 2.2 – Assessment of road emissions.

2.1 - Methodology

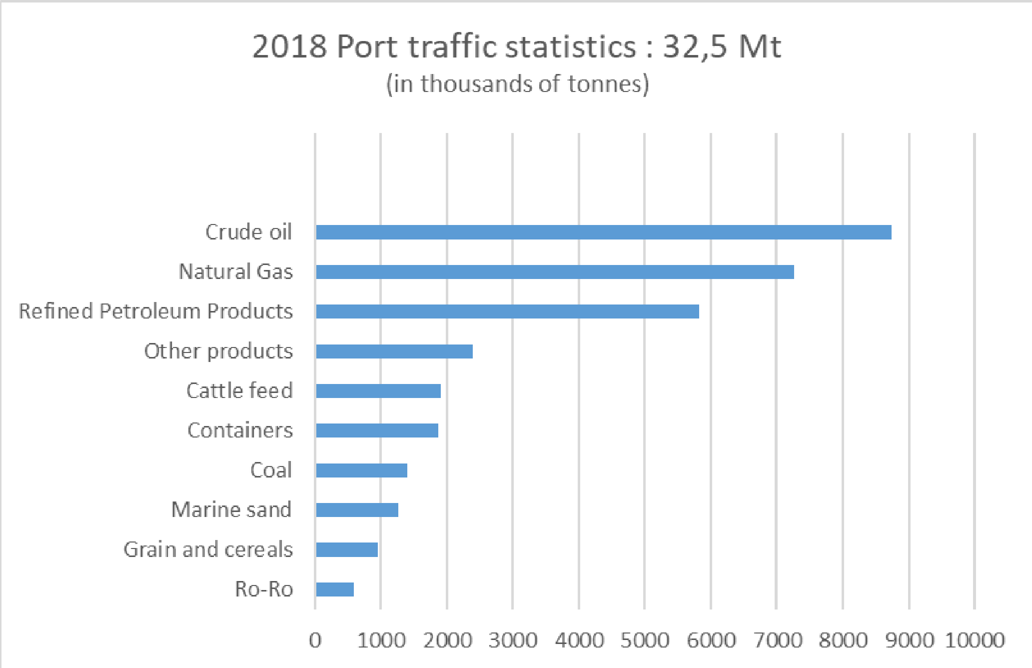
The Port sites of Nantes Saint-Nazaire spread over several sites, on the right and left banks of Estuary of the river Loire.

Figure 2.1 : Nantes Saint-Nazaire Port sites

Source: Port Authority of Nantes Saint-Nazaire

The year of reference for the cargo traffic in this assessment is 2018.

Figure 2.2 : Nantes Saint Nazaire Port traffic in 2018 by cargo category



Source: Port Authority of Nantes Saint-Nazaire

2.1.1 - Road network and Port-related traffics

Due to the lack of on-site vehicles flow measurement on the Port road network, the traffic data result from the conversion of cargo tonnages carried by road into a number of heavy trucks (Heavy Vehicles or HV) thanks a distribution rule. A set of hypothesis is established:

Due to the lack of accurate and consolidated data in the Port area, it was decided to determinate the road traffic by using the cargo transiting through the Port (GPMNSN). So, as key data, the Port Authority (GPMNSN) provided to the Consulting Firm Egis the annual cargo throughput for 2018 (reference year for the methodology of Smooth Ports project). These data are in tons.

These cargoes transiting through the Port use different transport modes: road, rail, river and other specific modes (as pipes or extra-gauge transport). Further to a batch of interview with the Port staff in charge of these issues in the Port, it was possible to produce an assessment of the tonnages carried by trucks (HV). These interviews were precious for qualifying the input data (tonnage carried by truck), for determining the rules of distribution, validating the hypothesis previously defined, and validate, from the field, the work carried out.

The distribution rule determines a truck type and its maximal load factor in relation with the carried cargo

Consequently, the number of trucks is the result of the tonnage of cargo divided by the maximal load factor. In order to simplify the calculation, one estimates that the trucks were full when loaded.

Furthermore, it was taken into account that that the truck was loaded for a leg and empty for the other (round trip).

The figures 1 and 2 present the Port road network by site (upstream : figure 1 – downstream : figure 2)

In order to ease the understanding and the analyzing of the results, all the road sections were divided in 9 groups corresponding to the 9 main Port sites:

Figure 2.3: the nine Port sites

Nantes (3 sites)	Montoir (5 sites)	Saint-Nazaire (1 site)
Cheviré	Multibuk (*multi-vrac)*	Saint-Nazaire
Roche-Maurice	Roro (*roulier)*	
Cormerais	Container (*conteneur*)	
	Roro and Container *(roulier et conteneur),* which matches to the road accessing to these two Port sites	
	Donges	

Due to the provision of the cargo tonnages by site, the assessment of the number of trucks has been established site by site. It means that the truck is supposed to drive on the whole site road mileage (Ex: 11.2 km for the multibulk site). The Port Authority provided an average distance (in km) for each site.

It is reminded account that only the truck traffic related to the Port cargo-related flows i taken into account in the assessment. Indeed, the major part of the truck traffic in the Port area of Saint-Nazaire is generated by the industrial activity of the site. This part is not accounted in this assessment.

Furthermore, the traffic of light vehicles is considered in the assessment for the sites of Cheviré (Nantes), multibulk, container / roro (Montoir) and Saint-Nazaire. In this latter place, the high number of production sites (factories, major shipyard), the employees go mainly to work by car and this reality has to be taken into account.

The table 1 presents the traffic data :

- The traffic is listed in **Annual Average Daily Traffic** (AADT). Due to the fact that the modelization of emissions of pollutants are calculated by times unit, the traffic data has to be expressed accordingly and smoothed on one year in order to obtain valuable results on a full year.
- **The selected speed is 30 km/h**, in accordance with the regulation on the public Port roads
- **The truckload was averaged at a 50 % level** taking into account the round trips of the heavy vehicles with a 100 % load factor one way and 0% the other one.
- The length of the average road driven distance and the total length of the road network of each site is equally listed.

It has to be underlined that the ISPS (International Ship and Port Facility Security) regulation applies to a major part of the Port area. This regulation strongly affects the traffic in the Port by multiplying the "stop and go" (control, security gates, etc.). This perturbed traffic favors the appearance of local "hotpoint" of "overemissions" of pollutants (linked to the braking cycles, engine on at stop, moving off, etc...). Nevertheless, due to the lack of more accurate details on traffic in the area in the scope of this assessment, this situation could not be correctly appreciated in this current assessment.

Table 2.1: Traffic data of the Port sites road network

Roulier = roro / *Roulier et conteneur* = roro and container / *Multi-vrac* = multibulk

Charge = cargo loading factor / *vitesse* = speed / *parcours moyen* = average distance

longueur totale = site road length

SITES	Saint-Nazaire	Roulier	Roulier et Conteneur	Conteneur	Multi-vrac	Donges	Cheviré	Roche Maurice	Cormerais	TOTAL
TMJA PL	62	90	1 024	934	689	115	281	81	33	**3 309**
TMJA VL	6 194	0	360	0	932	0	480	0	0	**7 966**
Nbre de PL annuel	22 630	32 850	373 760	340 910	251 485	41 975	102 565	29 565	12 045	**1 207 785**
Nbre de VL annuel	2 260 810	0	131 400	0	340 180	0	175 200	0	0	**2 907 590**
Charge PL (%)	50	50	50	50	50	50	50	50	50	
Vitesse (km/h)	30	30	30	30	30	30	30	30	30	
Parcours moyen (km)	3.5	2.5	1.5	3	6	2	7	0.5	0.6	**26.6**
Longueur totale (km)	8.2	7.4	1.3	10.3	11.2	2.9	10.7	0.8	1.0	**53.6**

Source : Egis

Source : Egis

Figure 2.4 : Port road network in Nantes (Cheviré, Roche-Maurice and Emile Cormerais)

Source : Egis

Figure 2.5 : Port road network in Donges, Montoir and Saint-Nazaire

2.1.2 - Assessment of the road emissions

2.1.2.1- Methodology

The road emissions are assessed by the Consulting Firm EGIS according to the COPERT methodology (**Computer Program to Calculate Emissions from Road Transport**) in its version COPERT 5. The initial version (V1) was designed at the beginning of this century.

The COPERT development is carried out by the company EMISIA SA commissioned by the European Environment Agency (EEA) in the framework of the European consortium **European Topic Centre for Air Pollution and Climate Change Mitigation**.

This methodology contains a library of unitary emissions factors, which express the pollutants quantities emitted by a defined vehicle, on a one-kilometer distance for a full year. These unitary emissions factors, expressed in g/km, are function of the vehicle category (light cars, light utility vehicles, trucks, bus, etc...) of its fuel (gasoline, gasoil), its engine capacity (or its total permitted weight for the trucks), its construction year (Euro norms) and its age, speed and traffic conditions.

In order to determine these unitary emissions, emissions measurement is carried out in laboratory for different driving cycles close to real conditions.

2.1.2.2 - Vehicles fleet

The vehicle fleets considered in this assessment are the COPERT ones of the 2020 and 2030 years. These fleets have been consolidated by the French institute IFSTTAR (The French Institute of Science and Technology for Transport, Development and Networks). The fleet is designed according to research activities of the beginning of 2000. Despite the regular updating, these fleets do not take into account all the political decisions (gasoil taxation for example) and societal events ("Dieselgate"case, fast current emergence of hybrid and full electric cars, etc…). For this reason, the available vehicle fleets in the database are not perfectly representative of these study perspectives and have to be used only for a **relative analysis of the emissions results.**

2.1.2.3 - Uncertainties taken into account

The assessment of road emissions is based on three specific factors each presenting a certain level of uncertainties:

- The Port road traffic taken into account has two levels of uncertainty : the relevance of periods and counting sites on one side and the use of types of driving profiles – have been presented in the previous paragraph (cf. 2.1.1 – Road network and traffic)
- The emission factors are uncertain or aggregated and are not sufficiently taking into account the local specificities of the Port area (weather conditions, topography and state of the road, etc…) or of the vehicle uses (maintenance, driving behavior, etc...).
- The vehicle fleet of the database is established with national data and do not consider the specificities of age, use depending of the geographical situation (For example: Paris and suburbs versus countryside). Furthermore, the forecasted fleets (2020 and 2030) refer to statistical facts but are often a posteriori modified by unforecastable trends, in policies and/or in society.

All these uncertainties should lead to a careful use of the defined values and to favor a relative analysis of the results instead of an absolute analysis.

Despite these existing uncertainties on the results, **the COPERT methodology is, up to now, the reference in terms of assessment of road emissions and its use forms the subject of a consensus on European level.**

2.2 - Assessment of road emissions for the initial situation

The road emissions have been assessed for each Port site at the current situation with the cargo volumes of year 2018 (cf. common methodology of Smooth Ports project).

The result of road emissions expressed in kg/day and kg/year are presented in table 2.

The emissions are calculated on Annual average daily traffic and take into account the working days.

The analysis of the road emissions on the Port road network reveals the importance of 4 sites : Cheviré, Container, Multibulk and Saint-Nazaire. These sites are the largest in term of Port activity with many vehicles trafficking.

Table 2.2 : daily and yearly emissions by site in the current situation (total traffic)

Total traffic = Heavy Vehicles + Light Vehicles

Emissions par jour		Sites									TOTAL
		Saint Nazaire	Roulier	Roulier Conteneur	Conteneur	Multi Vrac	Donges	Chevire	Cormerais	Roche Maurice	
Dioxyde d'azote	kg/j	9.25	0.31	0.70	4.44	5.40	0.15	2.29	0.01	0.03	22.6
PM10	kg/j	13.61	1.61	3.34	23.28	21.17	0.80	8.51	0.08	0.15	72.6
PM2,5	kg/j	4.34	0.45	0.94	6.50	6.02	0.22	2.43	0.02	0.04	21.0
Dioxyde de soufre	kg/j	0.275	0.015	0.033	0.222	0.231	0.008	0.095	0.001	0.001	0.9
Dioxyde de carbone	kg/j	10985	609	1318	8795	9172	303	3789	29	56	35 056

Source : Egis

Emissions par an		Sites									TOTAL
		Saint Nazaire	Roulier	Roulier Conteneur	Conteneur	Multi Vrac	Donges	Chevire	Cormerais	Roche Maurice	
Dioxyde d'azote	kg/an	3 377	112	255	1 621	1 970	56	836	5	10	8 243
PM10	kg/an	4 969	588	1 220	8 496	7 727	293	3 107	28	54	26 483
PM2,5	kg/an	1 584	164	342	2 373	2 198	82	888	8	15	7 654
Dioxyde de soufre	kg/an	100.3	5.6	12.1	81.0	84.3	2.8	34.8	0.3	0.5	322
Dioxyde de carbone*	t/an	4 010	222	481	3 210	3 348	111	1 383	11	20	12 795

Source: Egis

Due to the importance of the traffics of light vehicles in the following Port sites Cheviré, Container, Multibulk and Saint-Nazaire, their emissions are taken into account (cf : 2.1.1 – Road network and Port road traffics). The table 3 presents the emissions of the Port sites of Cheviré, Container, Multibulk and Saint-Nazaire with and without light vehicles.

The results put in light the importance of light vehicles in the emissions of pollutants. For each of these sites, the presence of light vehicles weights on global emissions, notably for the site of Saint-Nazaire where the light vehicles are numerous and sources of the majority of pollutants emissions.

Table 2.3: daily and yearly emissions by site in the current situation, by vehicle category (light or heavy vehicles)

Emissions par jour		Véhicules légers et Poids lourds				TOTAL	Uniquement Poids lourds				TOTAL
		Saint Nazaire	Roulier Conteneur	Multi Vrac	Chevire		Saint Nazaire	Roulier Conteneur	Multi Vrac	Chevire	
Dioxyde d'azote	kg/j	9.25	0.70	5.40	2.29	17.6	0.23	0.62	3.55	1.39	5.8
PM10	kg/j	13.61	3.34	21.17	8.51	46.6	1.23	3.23	18.62	7.26	30.3
PM2,5	kg/j	4.34	0.94	6.02	2.43	13.7	0.34	0.90	5.20	2.03	8.5
Dioxyde de soufre	kg/j	0.275	0.033	0.231	0.095	0.6	0.01	0.03	0.18	0.069	0.3
Dioxyde de carbone	kg/j	10985	1318	9172	3789	25 264	463	1219	7036	2743	11 462

Source : Egis

Emissions par an		Véhicules légers et Poids lourds				TOTAL	Uniquement Poids lourds				TOTAL
		Saint Nazaire	Roulier Conteneur	Multi Vrac	Chevire		Saint Nazaire	Roulier Conteneur	Multi Vrac	Chevire	
Dioxyde d'azote	kg/an	3 377	255	1 970	836	6 437	85	225	1297	506	2 113
PM10	kg/an	4 969	1 220	7 727	3 107	17 023	448	1178	6797	2650	11 073
PM2,5	kg/an	1 584	342	2 198	888	5 012	125	329	1898	740	3 092
Dioxyde de soufre	kg/an	100	12	84	35	232	4	11	65	25	106
Dioxyde de carbone*	t/an	4 010	481	3 348	1 383	9 221	169	445	2568	1001	4 183

**en tonne par an étant donné les quantités en présence*
Source : Egis

Source: Egis

Emissions assessment in the intitial situation

According to the hypothesis withheld in this study, the emissions of atmospheric pollutants at the initial situation (2020) on the Port road network scale are estimated at the following levels:

- **CO_2 : 12 800 t/year**
- **PM10 : 26.5 t/year**
- **NO_2 : 8.2 t/year**
- **PM 2.5 : 7.7 t/year**
- **SO_2 : 0.3 t/year**

According to the results, an issue appears concerning the traffic of light vehicles on Port road network in the Saint-Nazaire site whereas the trucks constitute the major traffic component in multibulk, roro, container and Cheviré.

Bottlenecks are reported in the Port Sites of Saint-Nazaire and Cheviré where the Port roads support Port related vehicles and other vehicles.

The analysis of pollutants emissions on the overall Port road network reveals that the sites of Cheviré, Container, Multibulk and Saint-Nazaire concentrate these emissions. These sites are the largest and many vehicles are trafficking in these areas.

2.3 - Assessment of road emissions for the future situation

The first part of this chapter is dealing with the assessment of the emissions for the future situation. The second part is delivering the projection of atmospheric pollutants for 2030 due to technological improvements and the effects of the use of Natural Gas (NG) in the vehicle fleet.

The third part presents only the light vehicles.

The fourth part takes into account the projects mitigating the atmospheric pollutants emissions and dealing with air quality in the Port area.

These projects are a different level of development.

The fifth part is dedicated to the future NGV (Natural Gas Vehicle) station in Montoir, to the opportunities it procures for NG supply or NG vehicle investment. This assessment is based on the commitments, secured by the public company *Sydela* (*Syndicat d'Energie de Loire Atlantique)*, of different companies for investing in NG vehicles.

In order to assess the environmental results of the NGV station, two different situations are considered in 2030. The first takes only into account the fleet supplied by the station and the second one, a 5 % truck fleet fueled by NG in 2030.

2.3.1 - Calculation of emissions in 2030 and comparison with the initial situation

Reminder: the methodology used for the calculation of emissions is presented in chapter 2-1.

It is important to notice that the calculation of these emissions is based on the same number of vehicles in 2030 than in 2020 (constant fleet). That means that the road traffics in 2020 (initial situation) and 2030 (future situation) are the same.

Due to this assumption, the technological improvements and the change of vehicle motorization are the only sources of the evolution of the atmospheric pollutants between 2020 and 2030.

The number of vehicles fueled by NG and supplied by the NGV station in Montoir is very low compared to the total number of trucks trafficking in the Port sites.

Due to this fact, the impact of these NG vehicles on atmospheric pollutants is negligible.

The results of road emissions in kg/day and in kg/year in the 2030 future situation is presented in table 4.

The evolution of road emissions between 2020 and 2030 is calculated in percentage. The most important impact (- 66%) concerns Nitrogen Dioxides, notably in relation with the technological improvements. The other pollutants deliver more limited benefits (from - 0.8% to – 6%).

Between the 2020 and 2030 situations, a consequent part of the vehicle fleet is due to renewed by new vehicles, mainly more environmental friendly (scrapping incentive, ecological bonus-malus, etc...)

The number of NG fueled heavy vehicles trafficking the Port area in 2030 has not be assessed at this stage and should be part of a specific approach.

Table 2.4: daily and yearly emissions by site in the future situation and comparison with the current situation

Emissions par jour		Sites									TOTAL
		Saint Nazaire	Roulier	Roulier Conteneur	Conteneur	Multi Vrac	Donges	Chevire	Cormerais	Roche Maurice	
Dioxyde d'azote	kg/j	4.76	0.05	0.14	0.68	1.51	0.02	0.69	0.002	0.004	**7.9**
	(EP-ER)/ER	-49%	-85%	-80%	-85%	-72%	-85%	-70%	-85%	-85%	**-65%**
PM10	kg/j	13.35	1.61	3.33	23.18	21.04	0.80	8.46	0.08	0.15	**72.0**
	(EP-ER)/ER	-2.0%	-0.4%	-0.5%	-0.4%	-0.6%	-0.4%	-0.7%	-0.4%	-0.4%	**-0.8%**
PM2,5	kg/j	3.96	0.43	0.89	6.15	5.67	0.21	2.29	0.02	0.04	**19.7**
	(EP-ER)/ER	-9%	-5%	-5%	-5%	-6%	-5%	-6%	-5%	-5%	**-6%**
Dioxyde de soufre	kg/j	0.25	0.02	0.03	0.22	0.23	0.01	0.10	0.001	0.001	**0.9**
	(EP-ER)/ER	-8.5%	0.3%	-0.4%	0.3%	-1.9%	0.3%	0.0%	0.3%	0.3%	**-3.1%**
Dioxyde de carbone	kg/j	10554	611	1317	8818	9102	304	3752	29	56	**34 543**
	(EP-ER)/ER	-3.9%	0.3%	-0.1%	0.3%	-0.8%	0.3%	-1.0%	0.3%	0.3%	**-1.5%**

Source : Egis

Emissions par an		Sites									TOTAL 2030	RAPPEL TOTAL 2020
		Saint Nazaire	Roulier	Roulier Conteneur	Conteneur	Multi Vrac	Donges	Chevire	Cormerais	Roche Maurice		
Dioxyde d'azote	kg/an	1 737	17	51	249	551	9	250	1	2	**2 867**	**8 243**
PM10	kg/an	4 872	586	1 214	8 462	7 680	292	3 087	28	54	**26 274**	**26 483**
PM2,5	kg/an	1 447	156	324	2 246	2 070	77	835	7	14	**7 177**	**7 654**
Dioxyde de soufre	kg/an	91.8	5.6	12.1	81.2	82.8	2.8	34.8	0.3	0.5	**312**	**322**
Dioxyde de carbone*	t/an	3 852	223	481	3 219	3 322	111	1 370	11	20	**12 608**	**12 795**

*en tonne par an étant donné les quantités en présence
Source : Egis

Source: Egis

Concerning the evolution of pollutants emissions during time, the analysis can be enlighted with the following elements, produced by the French organism CITEPA (*Centre Interprofessionnel Technique d'Etudes de la Pollution Atmosphérique)*:

- For the Nox (a road pollutant particularly noxious, especially in urban area), it is dealing with an important problem in France and the latest evolutions of the carmakers aim at reducing their emissions. It is a major axis of improvement because France regularly outnumbers the value limits (cf European regulation) of this pollutant in some regions. Concerning this situation, the European Court of Justice condemned French State in 2019 (24/10/2019) for "*non respect of the 2008/50/CE directive*" related at the Air Quality, and more specifically, for *"dépassement de manière systématique et persistent"* of limit values of concentration for NO_2.
- The SO_2 emissions, contrary to the Nox ones, which were problematic during the 90'20' years strongly decreased due to regulation evolution and technological progress, notably in the industrial sector.
- For the CO_2, the emissions of road transport have increased since 1990 due mainly to the increase of road traffic. The general trend since 2008 is bearing and benefits from the recourse of agrofuels, to the implementation of bonus/malus system for new cars, in order to facilitate the renewal of the car fleet by less "energy-greedy" vehicles.
- For the PM emissions, it appears that they are diminishing in all sectors. This decrease is due, for one part, by the improvement of "dedusting" techniques, notably in the steel industry, and for another part, by the improvement of technologies in the biomass combustion and the implementation of upgraded Euro norms in the road transport.

The table 5 presents the emissions of the Port sites of Cheviré, Multibulk, Roro/container and Saint-Nazaire with and without the light vehicles. The evolution of emissions by 2030 (2020 / 2030) is calculated in percentage.

Table 2.5 : daily and yearly emissions by site in the future situation by vehicle category (light or heavy vehicles) and comparison with the current situation

Emissions par jour		Véhicules légers et Poids lourds				TOTAL	Uniquement Poids lourds				TOTAL
		Saint Nazaire	Roulier Conteneur	Multi Vrac	Chevire		Saint Nazaire	Roulier Conteneur	Multi Vrac	Chevire	
Dioxyde d'azote	kg/j	4.76	0.14	1.51	0.69	7.1	0.04	0.09	0.55	0.21	0.9
	(EP-ER)/ER	-49%	-80%	-72%	-70%	-60%	-85%	-85%	-85%	-85%	-85%
PM10	kg/j	13.35	3.33	21.04	8.46	46.2	1.22	3.21	18.55	7.23	30.2
	(EP-ER)/ER	-2.0%	-0.5%	-0.6%	-0.7%	-1.0%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%
PM2,5	kg/j	3.96	0.89	5.67	2.29	12.8	0.32	0.85	4.92	1.92	8.0
	(EP-ER)/ER	-9%	-5%	-6%	-6%	-7%	-5%	-5%	-5%	-5%	-5%
Dioxyde de soufre	kg/j	0.25	0.03	0.23	0.10	0.6	0.01	0.03	0.18	0.07	0.3
	(EP-ER)/ER	-8.5%	-0.4%	-1.9%	0.0%	-4.4%	0.3%	0.3%	0.3%	0.3%	0.3%
Dioxyde de carbone	kg/j	10554	1317	9102	3752	24 726	463	1223	7055	2750	11 491
	(EP-ER)/ER	-3.9%	-0.1%	-0.8%	-1.0%	-2.1%	0.0%	0.3%	0.3%	0.3%	0.3%

Source : Egis

Emissions par an		Véhicules légers et Poids lourds				TOTAL	Uniquement Poids lourds				TOTAL
		Saint Nazaire	Roulier Conteneur	Multi Vrac	Chevire		Saint Nazaire	Roulier Conteneur	Multi Vrac	Chevire	
Dioxyde d'azote	kg/an	1 737	51	551	250	2 589	13	35	199	78	325
PM10	kg/an	4 872	1 214	7 680	3 087	16 853	446	1173	6770	2639	11 028
PM2,5	kg/an	1 447	324	2 070	835	4 676	118	311	1797	701	2 928
Dioxyde de soufre	kg/an	92	12	83	35	221	4	11	65	25	106
Dioxyde de carbone*	t/an	3 852	481	3 322	1 370	9 025	169	446	2575	1004	4 194

Source: Egis

2.3.2 - Calculation of emissions in 2030 with a 5% Natural Gas fuelled heavy vehicles

The calculation of the emissions in this chapter is based on the assumption that 5 % of the truck trafficking on the Port road network will be NG fueled in 2030 situation. This calculation takes into account the emissions reduction assessed by the French project Equilibre and by the French association *Gaz Mobilité*

https://www.grdf.fr/institutionnel/actualites/projet-equilibre-benefices-gnv

Due to the lack of available data for the SO_2, this latter factor is not taking into account in this chapter.

It is important to underline that the assessment of the emissions has been carried out with the same number of vehicles. Therefore, the main factors responsible of atmospheric pollutants emissions are:

- Evolution of the vehicle fleet (assessed by CITEPA). This evolution takes notably into account the renewal of the car fleet with the progressive removal of old vehicles with recent ones, normally less polluters
- The NGV marketshare in the truck fleet trafficking on the Port road network, with an hypothesis of a 5 % share in 2030

The light vehicles (LV) are equally been taken into account for the Port sites of Saint-Nazaire, roro-container, multibulk and Cheviré. Nevertheless, no hypothesis of change of motorization has been considered at this stage.

The table 6 presents the road emissions in kg/day and in kg/year in the 2030 future situation is presented in.

The first part presents the daily emissions by 2030 related to the Port road traffic with an assumption of the truck fleet NG fueled. These results are compared with the current (initial) situation: 2030 without NG (see table 4) and with NG. The most important impact, a – 4 % decrease, concern the PM, consistent with one of the benefit of NG compared to diesel oil. NO_2emissions are quite the same with – 0.2 %. CO_2 emissions diminish by -3%.

One remarks that the atmospheric pollutants emissions in the Port of Nantes Saint-Nazaire present no significant evolution due to the importance of light vehicles in this Port site.

According to the results, the atmospheric pollutants emissions decrease in 2030 situation thanks to the Natural Gas (NG).

Table 2.6: traffic emissions with a 5% heavy vehicles fleet NG fueled

Source : Egis

Emissions par jour		Sites									TOTAL
		Saint Nazaire	Roulier	Roulier Conteneur	Conteneur	Multi Vrac	Donges	Chevire	Cormerais	Roche Maurice	
Dioxyde d'azote	kg/j	4.76	0.05	0.14	0.67	1.51	0.02	0.69	0.002	0.004	**7.8**
	(EP-ER)/ER	*0%*	*-2%*	*0%*	*-2%*	*0%*	*-2%*	*0%*	*-2%*	*-2%*	***-0.2%***
PM10	kg/j	13.29	1.53	3.17	22.02	20.11	0.76	8.10	0.07	0.14	**69.2**
	(EP-ER)/ER	*0%*	*-5%*	*-5%*	*-5%*	*-4%*	*-5%*	*-4%*	*-5%*	*-5%*	***-4%***
PM2,5	kg/j	3.95	0.40	0.84	5.85	5.43	0.20	2.19	0.02	0.04	**18.9**
	(EP-ER)/ER	*0%*	*-5%*	*-5%*	*-5%*	*-4%*	*-5%*	*-4%*	*-5%*	*-5%*	***-4%***
Dioxyde de carbone	kg/j	10533	582	1260	8406	8772	290	3624	28	53	**33 547**
	(EP-ER)/ER	*0%*	*-5%*	*-4%*	*-5%*	*-4%*	*-5%*	*-3%*	*-5%*	*-5%*	***-3%***

Source : Egis

Emissions par an		Sites									TOTAL 2030 avec GNV	TOTAL 2030 sans GNV
		Saint Nazaire	Roulier	Roulier Conteneur	Conteneur	Multi Vrac	Donges	Chevire	Cormerais	Roche Maurice		
Dioxyde d'azote	kg/an	1 737	17	51	245	551	8	250	1	2	**2 862**	**2 867**
PM10	kg/an	4 849	557	1 155	8 039	7 342	277	2 955	27	51	**25 252**	**26 274**
PM2,5	kg/an	1 441	148	308	2 134	1 981	74	800	7	14	**6 906**	**7 177**
Dioxyde de carbone*	t/an	3 844	212	460	3 068	3 202	106	1 323	10	19	**12 245**	**12 608**

**en tonne par an étant donné les quantités en présence*
Source : Egis

Source: Egis

2.3.3 - Emissions of light vehicles in 2030

For the Port sites where the light vehicles is important (notably in the site of Saint-Nazaire), it is interesting to dissociate and to compare the emissions related to cars on one side and to heavy vehicles on the other site.

The table 7 presents, similar to the 6 one, the emissions of the Port sites of Cheviré, Multibulk, roro/container and Saint-Nazaire with and without the light vehicles in the 2030 situation in order to show the relative importance of emissions of each category of these vehicles.

The emissions evolution between the 2030 situation with and without NG is calculated in percentage.

The table 7 presents, as in table 5, the emissions in the Port sites of Cheviré, Multibulk, Roro/container and Saint-Nazaire with and without light vehicles in the 2030 situation, in order to underline the relative contribution of the two categories of vehicles. The evolution of Nitrogen Dioxide in the 2030 situation with or without NG is low, whatever the site considered.

The Port site of Saint-Nazaire presents the most important traffic in terms of light vehicles. Therefore, the impact of trucks fueled by NG on atmospheric emissions is low, whatever the pollutant taken into account.

Table 2.7: traffic emissions with a 5% heavy vehicles fleet NG fueled : HV and LV emissions

Source : Egis

Emissions par an		Véhicules légers et Poids lourds				TOTAL	TOTAL	Uniquement Poids lourds				TOTAL	TOTAL
		Saint Nazaire	Roulier Conteneur	Multi Vrac	Chevire	2030 avec GNV	2030 sans GNV	Saint Nazaire	Roulier Conteneur	Multi Vrac	Chevire	2030 avec GNV	2030 sans GNV
Dioxyde d'azote	kg/an	1 737	51	551	250	**2 589**	**2 589**	13	34	196	76	**319**	**325**
PM10	kg/an	4 849	1 155	7 342	2 955	**16 302**	**16 853**	424	1114	6431	2507	**10 477**	**11 028**
PM2,5	kg/an	1 441	308	1 981	800	**4 530**	**4 676**	112	296	1707	666	**2 781**	**2 928**
Dioxyde de carbone*	t/an	3 844	460	3 202	1 323	**8 829**	**9 025**	161	425	2455	957	**3 998**	**4 194**

*en tonne par an étant donné les quantités en présence
Source : Egis

Source: Egis

The table 8 presents the emissions share related to light vehicles and trucks in the Port sites of Cheviré, Multibulk, Roro/container and Saint-Nazaire. The results indicate that, whatever the pollutant considered, the emissions are for more than 90% due to light vehicles in the site of Saint-Nazaire. In the three other sites (Cheviré, Multibulk, Roro/container), trucks generate the most important volume of pollutants, except the Nitrogen Dioxide emitted by light vehicles.

Table 2-8 : emissions breakdown by vehicle category (5 % HV NG fueled)

Parts des véhicules légers et poids lourds dans les émissions en polluants	Véhicules légers				Poids lourds			
	Saint Nazaire	Roulier Conteneur	Multi Vrac	Chevire	Saint Nazaire	Roulier Conteneur	Multi Vrac	Chevire
Dioxyde d'azote	99%	33%	64%	70%	1%	67%	36%	30%
PM10	91%	4%	12%	15%	9%	96%	88%	85%
PM2,5	92%	4%	14%	17%	8%	96%	86%	83%
Dioxyde de carbone	96%	7%	23%	28%	4%	93%	77%	72%

Source : Egis

Source: Egis

2.3.4 - Presentation of projects

Two projects are presented in this report :

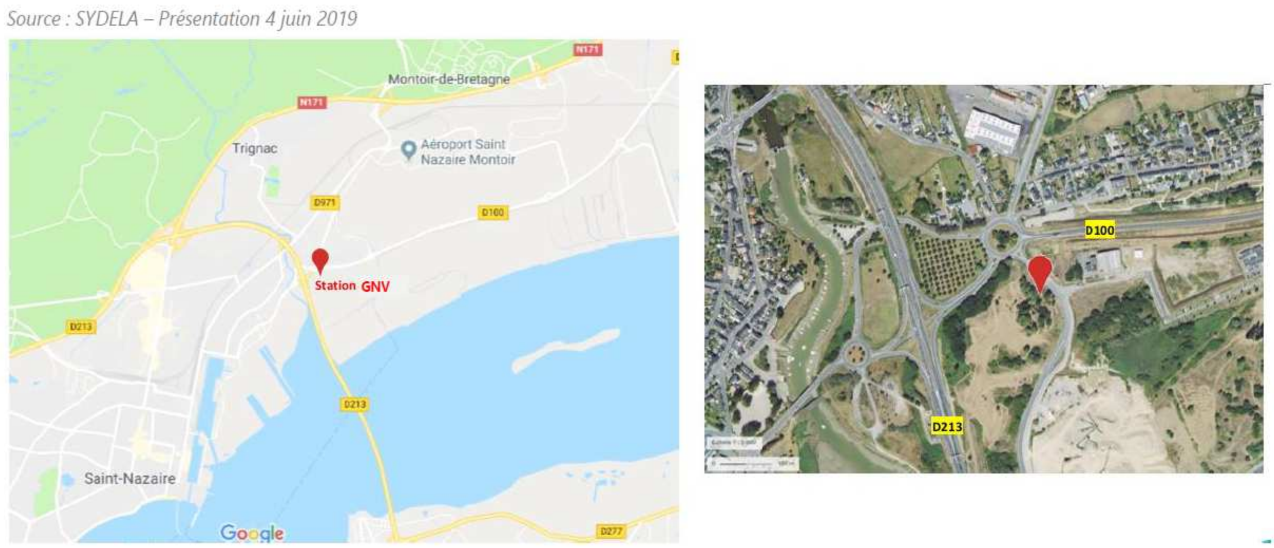
The NGV station in Montoir de Bretagne

The H2 approach

Project : NGV station in Montoir de Bretagne

The Syndicat D'Energie de Loire-Atlantique (SYDELA) is setting up a NGV station on the Port land in Montoir de Bretagne.

Figure 2-6 : NGV station in Montoir de Bretagne



Source : Sydela

This SYDELA project is targeting company fleets in by and aims at supporting the renewal of the company fleets by increasing the number of NG fueled trucks and decreasing the use of gasoil fueled trucks.

The SYDELA conducted a study in order to assess the impact of the NG station on the Port road traffic. The number of vehicles fueled by NG is assumed by customer and by customer type. The vehicles, which are only trafficking in the Port area, are classified in the category "Transport related to maritime and Port fields";

According to this SYDELA study, 4 vehicles fueled by NG and belonging to this category "Transport related to maritime and Port fields "are due to traffic at the opening of the station (2020) and at the future situation (2030).

Data are presented in the table 9 for 2020 and in table 10 for 2030.

Table 2.9: NGV station : users in the current situation

CLIENTS	TYPE DE VEHICULES	NOMBRE DE VEHICULES	KM/AN	HYPOTHESE GNV kg/100km	CONSO TOTALE t/an
Transporteur / Logisticien	Porteur (19t)	1	25 000	26	6.5
	Véhicule avec un PTAC inférieur à 3.5t	1	25 000	9	2.25
Collectivité	Porteur (7t à 19t)	1	10 000	26	2.6
	Véhicule utilitaire	8	10 000	13	10.4
Entreprise de gestion de déchets	Camion Ampliroll	2	60 000	29	34.8
Collectivité	Bus (12m)	2	65 000	53	68.9
Transporteur / Service de livraison	Véhicules utilitaires	1	30 000	13	3.9
Transport lié aux domaines maritimes et portuaires	Véhicule avec un PTAC inférieur à 3.5t	1	10 000	9	0.9
	Véhicule utilitaire	2	10 000	13	2.6
	Balayeuse aspiratrice	1	2 000	20	0.4
Autres clients de passage	Porteurs (26t, 32t)	2			65
TOTAL		22			198

Source: Sydela

Table 2.10: users in the future situation

CLIENTS	TYPE DE VEHICULES	NOMBRE DE VEHICULES	KM/AN	HYPOTHESE GNV kg/100km	CONSO TOTALE t/an
Transporteur / Logisticien	Porteur (19t)	1	25 000	26	6.5
	Véhicule avec un PTAC inférieur à 3.5t	1	25 000	9	2.25
Collectivité	Porteur (7t à 19t)	1	10 000	26	2.6
	Véhicule utilitaire	8	10 000	13	10.4
Entreprise de gestion de déchets	Camion Ampliroll	2	60 000	29	34.8
Collectivité	Bus (12m)	2	65 000	53	68.9
Transporteur / Service de livraison	Véhicules utilitaires	1	30 000	13	3.9
Transport lié aux domaines maritimes et portuaires	Véhicule avec un PTAC inférieur à 3.5t	1	10 000	9	0.9
	Véhicule utilitaire	2	10 000	13	2.6
	Balayeuse aspiratrice	1	2 000	20	0.4
Autres clients	Porteurs (26t, 32t)	15			492
TOTAL		35			625

Source: Sydela

Project: the H2 approach

Parallel to the NGV station project, the Port (GPMNSN) participates to the definition of new models of spreading hydrogen in the Port ecosystems in order to have a competitive supply of decarbonated fuel.

Ports concentrate many potential uses of hydrogen related to professional heavy mobility *(cf trucks)*, industry *(factories)* and energy production systems (*heat, power station).* Therefore they could welcome a comprehensive hydrogen ecosystem able to meet the requirements of the whole Port community.

The final objective for the Port (GPMNSN) is to carry out the developments required for supplying to road companies and manufacturers a service contributing to the reduction of their carbon print. The opportunities provided by hydrogen are effective and could become realities in the next years thanks to the setting up of an hydrogen station in the Port Industry area of Saint-Nazaire region.

Nevertheless, the hydrogen motorization is today not sufficiently matured for being quantified and implemented in the Port (GPMNSN). Therefore, the impact of this project is not taken into account in this study.

2.3.5 - Assessment of emissions of vehicles supplied by the Natural Gas station

The influence of the NGV station in Montoir de Bretagne does not limit to the vehicles trafficking on the Port road network. As presented in table 9 and table 10, vehicles of outside (*out the Port area*) clients and transiting vehicles are due to use this station. Referring to the tables, it is assumed that at the end of 2021, a 18 fleet vehicles are trafficking on the outside Port network and, for 2030, a fleet of 31 vehicles.

It is assumed that a vehicle driving cycle is a 150 km long roundtrip after fueled in the NGV station of Montoir de Bretagne.

In order to assess the NGV vehicles impact on the atmospheric pollutants emissions, the 150 km roundtrip is applicated for the 18 vehicles in 2020 and the 31 vehicles in 2030 in two situations. The first one is based on a gasoil use, the second one on a Natural Gas (NG) use. Furthermore, an average 80 km/h speed has been choiced.

The NG fueled trucks are not part of the IFFSTAR database regarding the vehicle fleets. Various documentary sources were used in this assessment for calculating the impact of NGV on atmospheric pollutants emissions from trucks, notably the web site *"Gaz et Mobilité"* and the "*Equilibre"* project.

Two important notions have to be differentiated:

- The emissions from "well to wheel" : they cover the emissions from the NG production to the NG use as fuel
- The emissions from "tank to wheel": they only take into account the emissions of the vehicle during its drive.

Then, for this study, the emissions are from "tank to wheel" and able the comparison of the trucks emissions, diesel and natural gas, trafficking in a 150 km radius from the NGV station of Montoir de Bretagne.

Figure 2.7: NGV station network

Source : SYDELA

According to the different studies, it appears that NG allow reducing the atmospheric pollutants emissions. Carbon dioxide CO_2 : a – 6.5% light decrease of emissions (from tank to wheel)

- Nitrogen oxides (NOx): For the "tank to wheel" scope, NG delivers more advantages than gasoil. Nevertheless, there are many variations according the traffic conditions of the trucks. An average of – 65 % decrease has been retained.

- Particulate matter (PM): quite a – 100 % reduction of the emissions fo the NGV compared to the diesel (gasoil) one. There is only residual particles emitted by the NG fueled trucks. As indicated in chapter 1.2.2.3, this residual particles presence is due to the pneumatic wear and tear, brakes, roadway and the throw-in the air of particles due the traffic.
- Sulphur Dioxides (SO_2) : no available data

It is important to keep in mind that the percentages are the averages of results of the Equilibre project and from documents sourced from "*Gaz et Mobilité*" website. It exists many uncertaintyties notably due to the traffic conditions and the type of vehicles. Nevertheless, these results allow at the end to report the global impact of NGV on atmospheric pollutants and of the trends in emissions evolutions between gasoil (diesel) and NGV.

Table 11 presents the results of emissions of NG fueled trucks and gasoil (diesel) fueled heavy vehicles trafficking in a 150 km (round-trip) radius around the Montoir de Bretagne station in 2030 situation. This table enlightens the differences of emissions on a daily and yearlys bases for the different assessed atmospheric pollutants.

Table 2.11: NGV station: HV emissions in a 150 km from the NGV station for the trucks supplied by the station (comparison Gas Oil / Natural Gas)

		2030	
Emissions par jour		Diesel	GNV
Dioxyde d'azote	kg/j	0.2	0.1
PM10	kg/j	8.1	6.1
PM2,5	kg/j	2.2	1.5
Dioxyde de carbone	kg/j	3936.8	3680.9

Source : Egis

		2030	
Emissions par an		Diesel	GNV
Dioxyde d'azote	kg/an	59	21
PM10	kg/an	2962	2241
PM2,5	kg/an	788	542
Dioxyde de carbone*	t/an	1437	1344

**en tonne par an étant donné les quantités en présence*
Source : Egis

Source: Egis

3- Proposal of improvement of input data

This study forms the first step permitting the Port (GPMNSN) to estimate the road traffics and related emissions. As presented in chapter 2, and due to the lack of traffic data both comprehensive and consolidated to the study area, various assumptions had to be set, with their part of uncertainty.

In addition, in order to give some perspectives to this first study, the consultant Egis briefly presents in the following paragraphs a set of solutions allowing the completion of required input data.

3.1 - Realization of a full-scale road traffic study

At the very beginning, it appears fundamental to carry out a traffic study on the area in scope in order to qualify the real traffic in term of types of vehicles (heavy vehicles, private cars, two-wheeled vehicles) and in term of volumes (how many vehicles and when).

Specialized firms generally carry out these traffic studies. Their costs depends notably of the size of the road network and of the specific requirements expressed by the clients.

A traffic study generally is carrying out in five steps:

1. Network definition: length and width of each road section, gradient, signposting (stop, traffic lights, etc…)
2. Analysis of existing traffics
    a. Realization of an in situ campaign. This latter uses different complementary processes
        - Manual counting
        - Automatic counting

        These two ways of counting allow both the traffic measurement on one road section, and concerning the automatic counters, these latter are now able to discriminate light vehicles and heavy vehicles.

        - Cordon line survey which allow to distinguish the traffics related to transit from the local ones and the origin and destination of each flow
        - Qualitative surveys which allow the user appreciation of the road network and the motives of his journey
        - The capture of the number plate of the vehicle

    b. Further to this counting campaign, the traffic is modeled. After the analysis of all the possible itineraries, the main itinerary for each trade between areas is determined. One's assumed that the user choose the itinerary in order to minimize the journey cost.
    c. Each road section is evaluated depending the duration of the journey, in the case of the local traffic (inside the study area) and for the transit traffic (vehicles trafficking through the study area).

3. The determination of road conditions: steady flow, bottlenecks, safety, journey duration, fuel consumption, pollution, etc.….
4. The assessment of the traffic evolution: if the study is part of the analysis of development projects (new roads or changes in traffic conditions), the evolution of traffic at different terms of the study (initial situation, without project situation, future situation (with project)) is to be calculated.
5. Assignment of traffics : at the end, from the modeled traffics, the individual traffic for each road section will be distributed on a coherent way according to the assumptions defined during the traffic study

3.2 - Implementation of traffic measurement devices

In addition to the traffic study described in the previous chapter, which allows:

- To define the traffic conditions in the initial situation thanks to a counting campaign and a traffic model
- To estimate the traffic conditions on future situations by taking into account the development projects

The consulting firm EGIS advises to the Port (GPMNSN) the implementation of counting systems in different strategic points of the study area. These counting systems deliver the following advantages:

- To dispose of a real-time situation of the road conditions in the Port area, and to register a consistent temporal chronicle in order to define robust Annual average daily traffic
- To put into light and to quantify the possible traffic bottlenecks (slowing downs, traffic jams) on a geographical and time base
- To verify the accuracy and coherence of the traffic study and, if necessary to allow it updating thanks to continuous measures

For these issues, there is different counting systems:

- Radar: it measures the speed of the vehicles passing in front of its cell. The informations are by this way "crosswatch-dated". This solution allow obtaining information on the average speed in the study area, which allow freeing, if necessary, of the assumption of regulatory speed limit. The radar equally allows watching the temporal variations of the traffic (daily, weekly variations, etc...). This allows sharpening the pollutants emissions conditions in the framework of emissions traffic study. **Radar tariffs depends on the typology (number of roadways and direction detected), in the region of several thousand euros each radar.**

Figure 3.1: measuring road traffic: radar device

Source: Egis

- **Counting from the road surface (mobile solution)** : specific cables are secured on the roadway and register the vehicles crossing. The information are therefore "crosswatch-dated". This solution allow to obtain information on the average speed in the studied area, which allow to free, if necessary, of the assumption of regulatory speed limit. It equally allows allows to watch the temporal variations of the traffic (daily, weekly variations, etc..). This allows to sharpen the pollutants emissions conditions in the framework of a emissions traffic study. This system allow to distinguish light vehicles from heavy ones, which allows to sharpen the Annual average daily traffic

Figure 3.2: measuring road traffic: surface cables mobile solution

Source: Egis

- **Permanent counting system under the roadway surface:** the counting loops (2 for each road direction are associated to a data collecting station and emit electromagnetic signals when metallic objects as vehicles cross. These signals from the vehicles are then processed in order to determine traffic data. The loop is set 7 cm (SIRETO standard) under the road coat.

Figure 3.3 : measuring road traffic: permanent solution

- **For these two solutions (counting from the road surface and permanent counting), tariffs are in the region of 2000 – 3000 euros (without tax) per counting point.**

4 - Conclusion

The carrying out of the assessment of atmospheric emissions in the road network of the Port of Nantes Saint-Nazaire enlightens the Port sites of Cheviré, Container, Multibulk and Saint-Nazaire. These sites are the largest and many vehicles are trafficking.

On Port sites of Cheviré, Container, Multibulk and Saint-Nazaire, the proportion of light vehicles is important, notably in Saint-Nazaire where cars are very numerous and generate quite all the pollutants emissions.

Emissions in the initial situation:

According to the assumptions taken into account in this study, atmospheric pollutants emissions in the Port road network are about:

For the main GES

- **CO_2 : 12 800 t/year**

For the atmospheric pollutants with healthy risks

- **PM10 : 26.5 t/year**
- **NO_2 : 8.2 t/year**
- **PM 2.5 : 7.7 t/year**
- **SO_2 : 0.3 t/year**

According to the results, an issue appears concerning the traffic of light vehicles on Port road network in the Saint-Nazaire site whereas the trucks constitute the major traffic component in Multibulk, roro, container and Cheviré.

Traffic disturbances (bottlenecks) are reported in the Port Sites of Saint-Nazaire and Cheviré where the Port roads support Port related vehicles and other vehicles.

The analysis of pollutants emissions on the overall Port road network reveals that the sites of Cheviré, Container, Multibulk and Saint-Nazaire concentrate these emissions. These sites are the largest and many vehicles are trafficking in these areas.

Emissions in the future situation:

According to the assumptions taken into account in this study, atmospheric pollutants emissions in the Port road network are about:

Hypothesis of a 5% vehicle fleet fueled by Natural Gas:

For the main GES

- **CO_2 : 12 245 t/year**

For the atmospheric pollutants with healthy risks

- **PM10 : 25.3 t/year**
- **NO_2 : 2.9 t/year**
- **PM 2.5 : 6.9 t/year**

Assumption of a 5% vehicle fleet fueled by Natural Gas

Therefore, according to the hypothesis taken into account, the putting into service of the NGV station of Montoir de Bretagne should have a positive impact on the reduction of emissions (see table 11) and should contribute to the necessary networking of the regional territory. These results will favor the use of GNV in the Port area, subject to promotion and incentive actions.

It is equally important to take into account the specific actions regarding the light vehicles traffic, which appears sizeable in four Port sites: Saint-Nazaire, roro, container, multibulk and Cheviré. The issue of air quality is not only due to road transport in heavy vehicles but equally due the people's use of private cars.

It has to be noticed that between the initial (2020) and future (2030) situation, the technological improvement of the vehicles is due to reduce pollutants emissions, notably Nitrogen Dioxide.

Regarding to the project of hydrogen "spreading" in the Port of Nantes Saint-Nazaire ecosystem, the hydrogren fuel motorization is not enough developed to be taken into account in this assessment.

Recommendations:

In order to improve the knowledge of emissions linked to Port of Nantes Saint-Nazaire sites, EGIS recommends the strengthening the quality of input data of real traffic conditions, thanks notably the carrying out of a comprehensive traffic study on the Port area, based on real counting (punctual or permanent) carried out by system as radar, electromagnetic loops or wired.

5 - Glossary

5.1 - List of figures

5.2 - List of tables

5.3 - List of abbreviations

English	Meaning	French	meaning
AADT	Annual average daily traffic	***TMJA***	*Trafic Moyen Journalier Annuel*
CARENE	The agglomeration **community** of the **Nazaire** region and the Loire estuary (**CARENE**) is an intermunicipal French structure in the department of Loire-Atlantique.	***CARENE***	*Communauté de l'Agglomération de Saint-Nazaire*
CH4	Méthane	***CH4***	*Méthane*
CITEPA	Technical Reference Center for Air Pollution and Climate Change CO2: Carbon Dioxide	***CITEPA***	*(Centre interprofessionnel technique d'études de la pollution atmosphérique)*
COPERT	COmputer Programme to Calculate Emissions from Road Transport (Air Pollutant and Greenhouse Gas Emissions Tool)	***COPERT***	*COmputer Programme to Calculate Emissions from Road Transport*
EEA	European Environment Agency	***AEE***	*Agence Européenne pour l'Environnement*
GHG	Greenhouse Gas	***GES***	*Gaz à Effet de Serre*
IPCC	Intergovernmental Panel on Climate Change	***GIEC***	*Groupe d'experts Intergouvernemental sur l'Évolution du Climat*
NGV	Natural Gas for Vehicles	***GNV***	*Gaz Naturel pour Véhicules*
GPMNSN	Nantes – Saint Nazaire Port	***GPMNSN***	*Grand Port Maritime de Nantes Saint-Nazaire*
H2O	Water steam	***H2O***	*Vapeur d'eau*
		HFC, PFC, SF6, CFC HCFC	*Famille des hydrocarbures fluorés*
IAPH	International Association of Ports and Harbours		
ISPS	International Ship and Port Facility Security	***ISPS***	*International Ship and Port Facility Security*
IFSTTAR	French Institute of Science and Technology for Transport, Development and Networks		*Institut Français des Sciences et Technologies des Transports, de l'Aménagement et des Réseaux*
N_20	Nitrous Oxide	***N_20***	*Protoxyde d'azote*
NOX	Nitrogen Oxides	***NOX (NO et NO2)***	*Oxydes d'azote*
O3	Ozone	***O3***	*Ozone*
HV	Heavy Vehicles	***PL***	*Poids Lourds*
PM10 PM2.5	Particulate Matter PM10, which consists of particles measuring up to 10 micrometres in diameter; and PM2.5, which consists of particles measuring 2.5 micrometres in diameter or smaller	***PM10 PM2.5***	*Particules fines en suspension de taille inférieure à 10 µm et 2.5 µm*
SO_2	Sulphur Dioxide	***SO_2***	*Dioxyde de soufre*
SYDELA	Departemental Syndicate for Energy Loire Atlantique	***SYDELA***	*Syndicat D'Énergie de Loire Atlantique*
LV	Light Vehicles	***VL***	*Véhicules Légers*
VOCs	Volatile organic compounds	***COV***	*Composés Organiques Volatils*
WHO	World Health Organization	***OMS***	*Organisation Mondiale de la Santé*