2018 Green Bond Report

Société du Grand Paris

Editorial

At the forefront of sustainable development

In December 2015, the eyes of the entire world turned to France as it hosted COP21. Heads of State, leaders of NGOs and prominent figures from the economy and trade unions all agreed to take concrete action to tackle the climate imbalance.

Four years on, the spirit of COP21 is still guiding the Grand Paris project. Over 130 worksites have been initiated to build the new metro network. The four new lines and 68 additional stations of the Grand Paris Express will connect all four corners of the Greater Paris region. The development will make it much easier for people to travel around the metropolitan area without having to go via the centre of Paris, opening doors to the wealth of culture, education, employment and entertainment opportunities the region has to offer.

The new transport network also offers a rare opportunity to change the way the city is designed. We aim to achieve a more harmonious balance in urban development, one that uses less space and resources.

As a public-sector programme manager that is focused solely on coordinating this unique project, the Société du Grand Paris channels all its energy into the Grand Paris, a metropolitan area that has a reputation for producing exciting ideas and blazing new trails. In becoming one of the leading drivers of green finance, the Société du Grand Paris remains true to its quest for transformation.

In less than 12 months, the Société du Grand Paris has issued three benchmark Green Bonds and a number of private placements for 50-year bonds totalling €5 billion. Beyond the success of the Green Bond programme, one of the few in the world to have been certified by both the Green Bond Principles and the Climate Bond Initiative, the present report, which draws on best practice, highlights that the Société du Grand Paris regularly undertakes comprehensive assessments of the environmental impact of the project. But above all, it demonstrates that urban transport operators and developers can and must apply new rigorous standards to stay at the forefront of sustainable development.

Thierry Dallard
Chairman of the Management Board of the Société du Grand Paris

Summary

The largest urban project in Europe

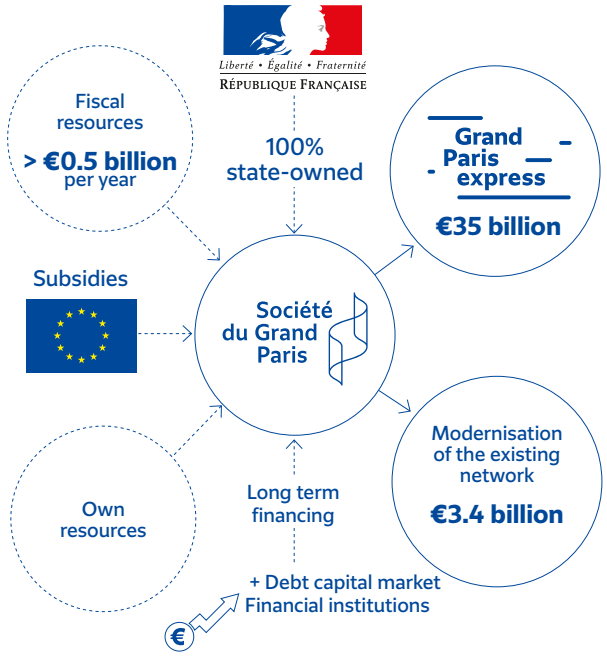
By building 200 km of new automated metro lines connected to the existing infrastructure, along with 68 additional stations, the Société du Grand Paris is working to develop the Greater Paris region and boost its appeal.

The Société du Grand Paris is a public establishment of an industrial and commercial nature (EPIC) wholly owned by the French State and created by the Grand Paris law of 3 June 2010. Its primary purpose is to "design and develop the overall plan for the set of infrastructure projects that make up the Grand Paris Express and oversee the construction of the lines, fixed structures and facilities, the construction and development of stations and interchanges as well as the procurement of the railway vehicles that will run on the network." **The four new Grand Paris Express lines (15, 16, 17 and 18), as well as the extension of Line 14 to the north and the south, will be connected to the existing transport network.**

As an "urban, social and economic project of national interest" that aims to promote "sustainable and inclusive economic growth driving job opportunities in the Greater Paris region", the Grand Paris programme seeks to boost the appeal of the region and maintain its competitive edge in relation to other major cities on the world stage.

With 200 km of new automated metro lines (effectively doubling the existing metro network) around the French capital as well as 68 additional stations along the network, the Grand Paris Express is the largest urban project in Europe. It will expand and unite the Greater Paris metropolitan area.

Société du Grand Paris funding



The environmental transition and urban transport

With projects geared to urban density and mixed-use development leveraging new hubs of large-scale public transport infrastructure, the Grand Paris Express will improve mobility throughout the Greater Paris region and help to considerably reduce greenhouse gas emissions.

Investing in urban public transport

In the European Union, 72.1% of GHG (greenhouse gas) emissions are generated by road traffic, compared with 14.1% from water transport, 12.4% from civil aviation and only 0.6% from rail transport according to 2010 figures published by the European Commission.

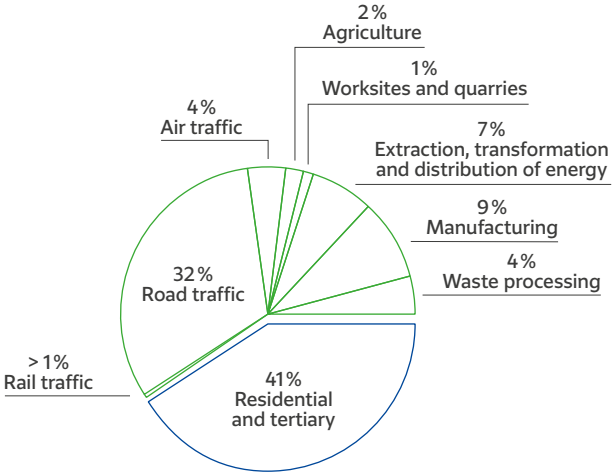
Nowadays, 75% of people live in places that present mobility challenges whilst also offering the main sources of economic growth and potential for innovation. Such urban concentration causes significant difficulties in urban and peri-urban areas, which often leads to people excessively relying on privately owned cars to travel into town centres due to urban sprawl, but also to make relatively short journeys within the town centre itself.

In France, analysis carried out by Insee backs up this data in terms of CO_2 emissions on an urban and peri-urban scale. It found that **98% of journeys do not exceed 80 km and remain concentrated around urban areas.** These statistics led the French President and Prime Minister to prioritise day-to-day transport over major long-distance projects.

Three quarters of people living in France travel to work by car and, due to a lack of cost-effective and reliable alternative solutions, they, like many users of public transport, face severe congestion-related issues.

In the Greater Paris region, 36% of GHG emissions are generated by transport, 32% of which from road traffic, according to statistics published by Airparif.

GREENHOUSE GAS EMISSIONS BY INDUSTRY IN THE GREATER PARIS REGION IN 2012[1]



ENHANCING MOBILITY

Metropolitan areas must therefore deal with significant local mobility challenges regarding:

- **accessibility:** each day, hundreds of thousands of cars enter urban areas, which are increasingly saturated, costing time and generating pollution
- **environment:** transport accounts for 30% of CO_2 emissions and pollutants
- **quality of life:** accidents, noise pollution and space, etc. reduce quality of life for people living in urban centres, which is why there is a need for modal shift from privately owned vehicles to public transport and environmentally friendly transport
- **public space management:** space must be shared between all forms of travel (environmentally friendly, public transport, privately owned vehicles and urban freight) and other uses (business activities, leisure spaces, etc.)

Therefore, investing in the construction of a clean mass transit network is a powerful and effective way of avoiding clogging up cities, guaranteeing a good level of accessibility in and around urban areas and reducing GHG emissions.

1. Source: https://www.airparif.asso.fr/etat-air/air-et-climat-bilan-emissions#ges

PROMOTING ATTRACTIVE AND SUSTAINABLE URBANISATION

In built-up areas where available space is a scarce resource, the amount of green spaces is expanding at a relatively slow pace. That is why, in the absence of measures restricting land use, we have witnessed new build projects naturally shift towards urban fringe areas and surrounding rural areas gradually make way for a suburban landscape.

It is well known that urban sprawl leads to a great many negative externalities. Counterurbanisation is in fact synonymous with the increasing use of agricultural and natural land, causing pressure on ecosystems and biodiversity. It increases the distance the population needs to travel and consequently the amount of greenhouse gas emissions due to people using their cars to commute. It also changes the type and location of buildings.

To accommodate the growing population and the increasing numbers of jobs concentrated in major cities and respond to the accelerating trend of single-person households, the housing stock must change to make a greater number of living spaces available in commercial buildings. The location of new-build projects in city centres (housing and offices), which are widely accepted as necessary, means the environmental and social impacts differ greatly depending on how far they are from public transport hubs and the density of construction.

In this context, the Grand Paris public transport network project represents a unique opportunity to accentuate this shift towards a new kind of urbanisation, which is more appealing and more sustainable, taking into account the constraints on energy consumption and commitments to reduce CO_2 emissions.

Grand Paris Express driving the energy transition

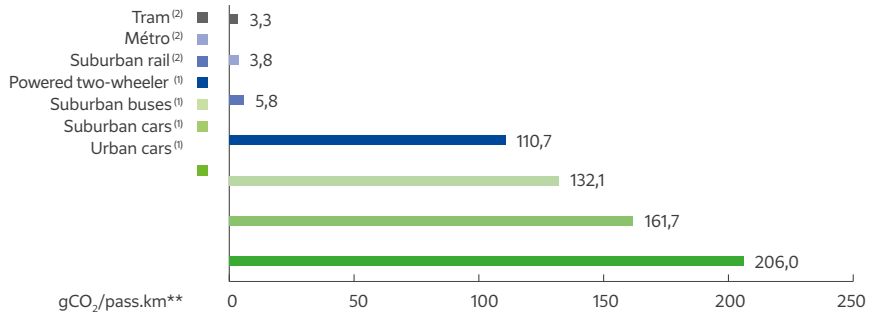
According to the most conservative estimates set out in the "Quantifying the carbon impact of projects" chapter in the present document (p24), the GHG emissions assessment will be positive from 2031. After this date, results will only improve. Therefore, between 2030 and 2070, when the infrastructure will be fully up and running, the project will avoid around 750,000 tonnes of CO_2 equivalent every year. These highly significant savings mirror the exceptional ambitions of the Grand Paris Express project

REDUCING THE GREENHOUSE GAS EMISSIONS OF THE GRAND PARIS

Due to the sheer number of people living and working in the area, the Greater Paris region is a major contributor of GHG emissions.

The Carbon Review published in 2012 by the French environment & energy management agency, Ademe, the emissions per kilometre travelled varied according to the means of transport used. For example, the metro generates significantly lower emissions (0.003 kg CO_2 eq./pass.km – kilogram of CO_2 equivalent per passenger per kilometre) than a car (0.35 kg CO_2 eq./pass.km). Furthermore, having fewer cars on the road could help to reduce congestion and therefore increase average speeds, thereby reducing overall vehicle consumption.

CO_2 emissions from urban and peri-urban passenger transport



*CO_2 emissions due to the production of electricity or extraction, refining or transport of fuel
** Grams of CO_2 per passenger-kilometre

Sources
(1) Deloitte on behalf of ADEME – Study on the energy and environmental efficiency of means of transport – 20/08 (2005 data)
(2) RATP – 2016
Scope: Mainland France (upstream phase + utilisation phase)

In the Greater Paris region, vehicles travel at a relatively low average speed, generally below that required for optimal consumption (approximately 35 to 45 mph). Increasing average speeds across the network would therefore help to get closer to this optimal level, leading to a reduction in the overall consumption of vehicles on the road according the MODUS and COPERT 4 models. Source DRIEA (MODUS model [Urban and suburban transport model] – DRIEA [French regional and interdepartmental division for infrastructure and urban planning]).

ENCOURAGING THE SWITCH TO PUBLIC TRANSPORT

While the Greater Paris region must tackle consistently high levels of congestion on its roads, the Grand Paris Express project, with 200 km of new automated metro lines and 68 additional stations, will be able to handle 2.25 million passenger journeys per day by 2030, connecting the major financial and research hubs in the region. These new lines are part of a wider plan to upgrade and extend the existing network, which includes extensions to the RER E (to the west) as well as several metro lines (Line 4 to the south, Line 11 to the east and Line 12 to the north), the construction of tramways and bus rapid transit systems, the modernisation of the RER and improvements to the suburban train network. Once completed, the Grand Paris Express will enable 90% of people in the Greater Paris region to live within 2 km of a station.

This will bring about considerable modal shift, encouraging people to use public transport instead of their cars. Socio-economic and environmental studies estimate the project will lead to an annual reduction in traffic of 2 billion vehicles per kilometre travelled, once the entire network is up and running (MODUS model [Urban and suburban transport model] – DRIEA [French regional and interdepartmental division for infrastructure and urban planning]).

The impact the Grand Paris Express will have on mobility in the Greater Paris region will help reach the greenhouse gas emission reduction targets set out in the law on the energy transition.

DEVELOPING THE CITY IN A BALANCED WAY

The development of a Greater Paris transport network is absolutely necessary to successfully ensure regional planning encourages the concentration of living spaces and economic activity around future stations, alongside other support measures designed to significantly reduce CO_2 emissions in the following ways:

- through the type of urban building, by increasing the density of residential and commercial buildings, which creates transport needs;
- through the energy efficiency of buildings, by encouraging renovation and construction/demolition work following project-related urban development. Such renewal of the built environment gives rise to more energy efficient buildings, which easily offset the energy costs induced by the construction of new-build projects;
- through the induced effects of land use on mobility in the Greater Paris region, by shortening journeys and facilitating a modal shift in favour of public transport with a planning strategy that combines urban density and mixed-use development built around new large-scale public transport hubs.

The shadow price of carbon

The monetisation of the environmental benefits identified and assessed by the CarbOptimum® software depends on the shadow price of carbon in terms of tonnes of CO_2 equivalent ($tCO_2eq.$). The socio-economic benefits of the Grand Paris Express project were quantified as part of the procedure to declare the various parts of the project as of public utility. This process was conducted using the shadow price of carbon applicable at the time the applications were drafted, i.e. the price of one tonne of CO_2 equivalent represented €32 in 2010, €100 in 2030 and €241 in 2050. In its conclusion, the report (filed in February 2019) appealed to the Prime Minister to take into account the changes over the last decade, which tend to place a much higher value on the shadow price of carbon. For example, €250 in 2030, which is likely to rise to €775 per tonne in 2050 (Alain Quinet: "The Value For Climate Action", France Stratégie, 2019). Applying the updated trajectory for the shadow price of carbon would double the monetary benefits generated by the Grand Paris Express as a result of the greenhouse gas emissions avoided (Alain Quinet, quoted report, page 134), boosting the socio-economic benefits of the project.

A model for green finance

As the first bond issuer to adopt a fully green EMTN programme, the Société du Grand Paris issued two bonds in 2018 that complied with the 2018 Green Bond Principles and were certified by the Climate Bond Initiative.

In 2018, the Société du Grand Paris hit a new milestone in the deployment of its finance model for the Grand Paris Express when it set up a €5 billion Green Euro Medium Term Note programme.

As such, it became the first bond issuer to adopt a fully green EMTN programme, issuing green bonds only and pledging to invest the same amount in its project and regularly communicate with investors regarding the progress of the Grand Paris Express as well as the ways in which it benefits the environment.

In 2018, the Société du Grand Paris, rated Aa2 by Moody's and AA by Fitch, issued two green bonds, one public and one as as private placement, for a total value of €1.770 billion.

- a 10-year €1.750 billion bond in October
- a 50-year €20 million bond in November

The bonds issued by the Société du Grand Paris comply with the 2018 Green Bond Principles and have been awarded Climate Bond Initiative certification from Sustainalytics. The Société du Grand Paris is also involved in the Finance for Tomorrow[1] initiative and the Corporate Forum on Sustainable Finance. This is the way in which the company intends to play an active role in defining the rigorous standards for green finance, contribute to debates and thinking in this area and over time forge a position as a benchmark in the transport industry, regional planning and the impact it has on urban development.

1. Finance for Tomorrow is an initiative set up by those involved in Paris' financial centre to promote sustainable finance in France and around the world. It helps to redirect financial flows towards the inclusive, low-carbon economy in line with the Paris Agreement and the UN SDGs (Sustainable Development Goals).
2. One year on from the Paris Green Bond Pledge, which stood out as one of the key achievements of the 2017 Climate Finance Day, 16 European companies (EDF, EDP, Enel, Engie, Ferrovie dello Stato Italiane, Iberdrola, Icade, Ørsted, RATP, SNCF Réseau, Société du Grand Paris, SSE, Tennet, Terna, Tideway and Vasakronan) have decided to come together to form the Corporate Forum on Sustainable Finance, also known as "the Forum". It aims to create a network that encourages businesses to constantly share their opinions and ideas. It brings together issuers of green bonds, who are committed to advocating and growing the market for sustainable finance, helping to effectively combat climate change and promote a sustainable and responsible society.

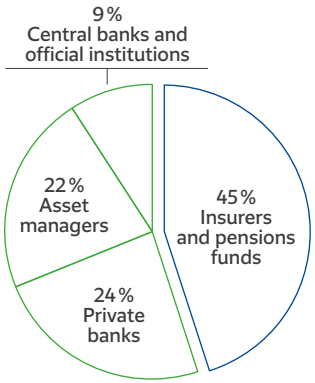
These transactions have helped to finance eligible projects that meet the criteria set out in the framework.
In 2018, all the bonds issued by the Société du Grand Paris qualified as green.

Transactions in 2018

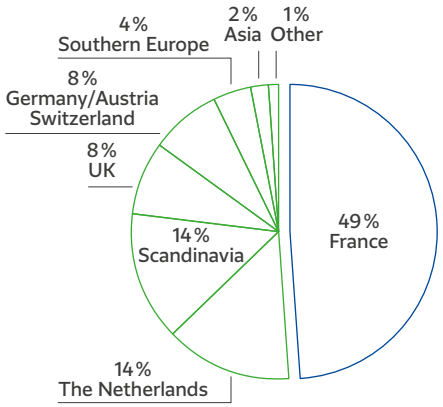
Transaction Summary		
Issuer	Societe du Grand Paris	
Rating	Aa2(Moody's / AA(S&P) / AA(Fitch)	
Final size	EUR 1 750 millions	EUR 20 millions
Isue date	10 October 2018	16 November 18
Settlement date	22 October 2018	26 November 18
Maturity date	22 October 2028	26 November 68
Tenor	10 Y	50 Y
Coupon	1,125 % annual	2,145 % annual
Spread	OATs + 24 bp	NA

Investors by type and geographic location
(First issue 1.125% in October 2018)

Investors by type



Geographical location



Investment directed solely towards the project

A major transport infrastructure project like the Grand Paris Express will have a huge impact on greenhouse gas emissions and must be built on solid management principles.

In terms of credit risk, the bonds issued by the Société du Grand Paris have all the characteristics of conventional bonds, as well as an additional obligation to publish reports, check funds are allocated to eligible projects and assess the environmental impact of the projects.

Principles of the programme

Due to the sheer number of people living and working in the area, the Greater Paris region is a significant contributor of greenhouse gas emissions. As a whole, the region generates 40.5 million tonnes of CO_2 equivalent each year[1]. The transport industry, households and the tertiary sector constitute the three main sources of emissions.

A major transport infrastructure project such as the Grand Paris Express has a strong impact on mobility as well as on urban development and the structure of the city. It will therefore have a major effect on greenhouse gas emissions.

The Société du Grand Paris has complied with the principles agreed by the Climate Bond Initiative as well as those in the Low Carbon Transport Eligibility Criteria (V1.0)[2]. Sustainalytics is tasked with ensuring compliance with the principles on behalf of the Climate Bond Initiative. The 2018 version of the certification awarded by Sustainalytics is available on the website of the Société du Grand Paris.

The Société du Grand Paris' programme is also aligned with the Green Bond Principles developed by ICMA[3] in 2018. The Second-Party Opinion, granted by Sustainalytics, confirms this alignment. The 2018 version of the Second-Party Opinion is available on the website of the Société du Grand Paris.

The Green Bond Framework drafted by the Société du Grand Paris also follows the work carried out by the TEG (Technical Expert Group) put together by the European Commission in 2018. The framework therefore adheres to the Taxonomy put forward by the TEG[4] as well as the DNSH (Do no significant harm) criteria. The 2018 version of the Green Bond Framework is available on the website of the Société du Grand Paris.

1. https://www.airparif.asso.fr/etat-air/air-et-climat-bilan-emissions#ges
2. The Low Carbon Transportation appendix is available on the Climate Bond Initiative website.
3. ICMA : International Capital Market Association.
4. https://ec.europa.eu/info/publications/sustainable-finance-technical-expert-group_en.

PROJECTS RECEIVING INVESTMENT

The Green EMTN programme is dedicated exclusively to financing the new automated metro lines of the Grand Paris Express.

Net earnings from green bonds issued is allocated to the funds invested by the Société du Grand Paris in the Grand Paris Express project, which represents the "eligible assets". These assets include all investments made in the current year and/or over the two years prior to the issue.

All investment in infrastructure and programme management of the new Grand Paris Express automated metro is eligible, including:

- the construction of the new lines and extension of existing lines – nearly 200 km of automated metro lines in addition to the 200 km of existing lines in the Greater Paris region
- the construction and development of 68 new stations and six operations centres

DETAILS OF ELIGIBLE ASSETS

Line 15 South
- 16 stations, all connected to the Greater Paris region transport network
- 22 municipalities involved across four departments
- 300,000 daily passenger journeys forecast
- 33 km of automated metro lines

Line 15 West
- 11 stations, 9 of which will be connected to the Greater Paris region transport network
- 20 km of automated metro lines
- 14 municipalities involved across two departments
- 600,000 daily passenger journeys forecast

Line 15 East
- 23 km of underground lines
- 12 stations connected to the RER, metro or tram system
- 675,000 local residents who stand to benefit
- 13 municipalities served across two departments: Seine-Saint-Denis and Val-de-Marne
- 300,000 daily passenger journeys

By 2030, Line 15 will form a 75-km long ring around the French capital.

Line 16
- 10 stations, 8 of which will be connected to the Greater Paris region transport network
- 16 municipalities involved across three departments
- 200,000 daily passenger journeys forecast
- 29 km of automated metro lines

Line 17
- 9 stations, 4 of which will be connected to the Greater Paris region transport network
- 13 municipalities involved across three departments
- 27 km of automated metro lines, 6 km of which will be elevated
- Between 130,000 and 160,000 passenger journeys forecast on days fairs are held
- Between 40 and 50 million annual passenger journeys forecast

Line 18
- 10 stations, 3 of which will be connected to the Greater Paris region transport network

- 13 municipalities involved across three departments
- 35 km of automated metro lines, 14 km of which will be elevated

Line 14 South

- 7 new stations, 5 of which will be connected to the Greater Paris region transport network
- 13 municipalities involved across three departments
- 300,000 daily passenger journeys forecast
- 14 km of automated metro lines
- 300 000 voyages prévus chaque jour
- 14 km de métro automatique

2018 allocation

The table below presents the allocation of Green Bonds issued in 2018 by eligible investment.

The "Green Bond scope" reflects the amount actually invested by the Société du Grand Paris in each of these categories. The "Green Bond allocation" corresponds to the allocation by category of net resources generated by the 2018 Green issue. The "Balance left to allocate" represents the amount of 2018 eligible investment that is still to be allocated to a Green Bond issue and therefore could be reused in 2019.

	Green Bond scope			2018 allocation			
In millions of euros	2016	2017	2018	Total	Break-down	Alloca-tion	Balance left to allocate
Pont de Sèvres / Noisy-Champs (Line 15 South)	206	794	1,006	1005	45%	795	211
Bilateral financing	0	700	300				
Noisy-Champs / Le Bourget RER / Saint-Denis Pleyel / Mairie de Saint-Ouen (Line 14 North, Line 16 and Line 17)	87	152	506	745	33%	588	156
Bilateral financing	0	0	0				
Le Bourget / Le Mesnil-Amelot (Line 17 North)	13	20	38	70	3%	55	15
Bilateral financing	0	0	0				
Pont de Sèvres / Saint-Denis Pleyel (Line 15 West)	24	31	50	105	5%	83	22
Bilateral financing	0	0	0				
Orly / Versailles (Line 18)	19	45	48	113	5%	90	24
Bilateral financing	0	0	0				
Saint-Denis Pleyel - Champigny (Line 15 East)	3	36	34	74	3%	58	16
Bilateral financing	0	0	0				
Olympiade Orly Line 14 South	29	53	45	127	6%	101	27
Bilateral financing	0	0	0				
Sub-total Grand Paris Express breakdown by line	**381**	**1,132**	**1,727**				
Total investment	**381**	**1,132**	**1,727**				
Sub-total bilateral financing	**0**	**700**	**300**				
Total net investment	**381**	**432**	**1 427**	**2,240**	**100%**	**1 770**	**470**

Fund management policy

Subject to French rules on public sector budget and accounts management (GBCP), the Société du Grand Paris is only able to temporarily invest the value of funds in euros raised through Green Bond issues in the Treasury account before such funds must be allocated definitively.

Grant Thornton assurance report

The allocation of funds to eligible projects is certified by the Statutory Auditors, Grant Thornton.

BELOW IS AN EXTRACT OF THE ASSURANCE REPORT SIGNED BY GRANT THORNTON. THE FULL REPORT IS AVAILABLE ON THE WEBSITE OF THE SOCIÉTÉ DU GRAND PARIS.

Responsibility of the Statutory Auditor

On the basis of our work, our responsibility is to provide a limited assurance conclusion on:

– whether the projects, in all material aspects, included in the report comply with the eligibility criteria set out by the Company in the Green Bond Framework;

– the correct allocation of funds raised through Green Bond issues and the amounts allocated to each project;

– the compliance of the temporary investment of funds raised through Green Bond issues. [...]

Conclusion

Based on the work performed, nothing material has come to our attention that causes us to believe that the Information* published in the "2018 Green Bond Report" is not presented fairly in accordance with the Guidelines.

*The Information

2-1) - b) Eligible projects (page 21) ;

2-2) Table of allocations (page 22) ;

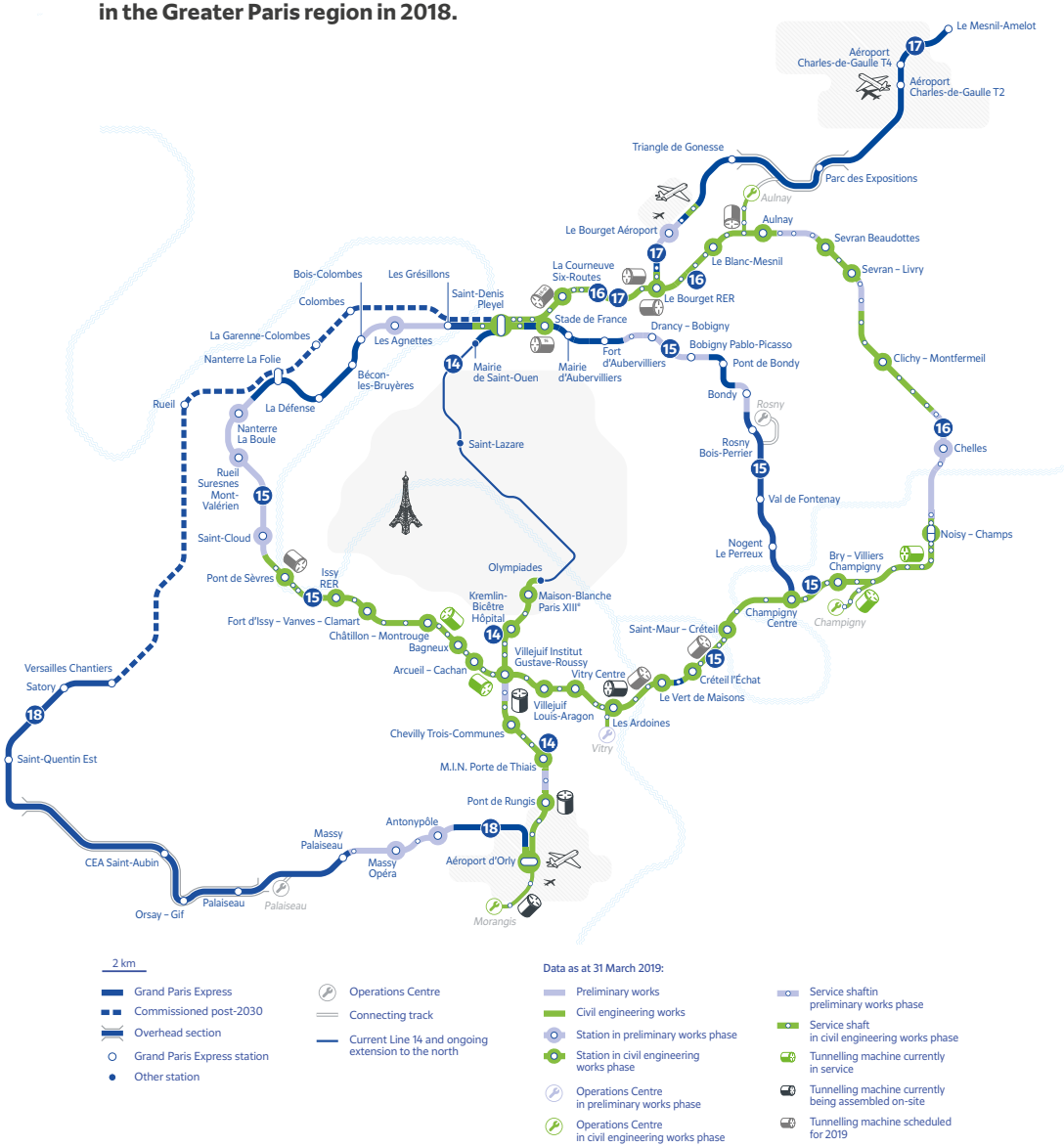
2-3) Description of the fund management policy (page 23).

Quantifying the carbon impact of projects

A specific method and tool have been designed to quantify the carbon impact of ongoing and upcoming projects related to the Grand Paris Express programme in an effort to minimise greenhouse gas emissions.

2018 projects

Over 100 projects were undertaken in the Greater Paris region in 2018.



As shown on the map of the Grand Paris Express printed on the previous page, in 2018 – the year when tunnel construction got under way – there were 65 civil engineering worksites and 35 preparatory worksites underway on Grand Paris Express Lines 15 South and 16, representing a total of 35 km of lines under construction.

Three tunnel boring machines were launched in 2018. The first, **Steffie-Orbival**, started to work in April 2018. In August 2018, the second tunnel boring machine, **Malala**, started work from the Rû de Nesle shaft in Noisy-Champs to the site of the Bry-Villiers-Champigny station. In November, a third machine, **Ellen**, was installed in the Hauts-de-Seine department at the Robespierre shaft site.

Impact and performance indicators

Indicateur de Perfomance	
Market share notified at end-2018	915 contracts worth €10.4 billion
Companies involved in worksites	1,967
	69% microenterprises and SMEs
Hours of work earmarked for the long-term unemployed	483,008 hours
Ancillary property projects awarded	9 projects
External relations with local residents	155 contractual documents covering local resident support opened
	834 apartment buildings and single-family houses receiving compensation
	94% agreements reached with local residents

Impact indicators	
Ex-ante estimate of greenhouse gas reductions (tCO_2 eq./year)	Between 28 and 51 million tonnes by 2070
Tonnes of land extracted	4 million since the start of the projects
	In 2018: 2,948,245 tonnes excavated (Line 15 South and Line 16)
Spoil recycling	3% since the beginning of the project
	In 2018: 1,060,058 tonnes recycled, i.e. 36%
	6% alternative transport since the beginning of the project
Offset	17.7 hectares restored in 2018 (forest offsets)
	6.57 hectares restored in 2019 (ecological compensation)

CarbOptimum® methodology

A specific method and tool have been designed to quantify the carbon impact of ongoing and upcoming projects related to the Grand Paris Express programme in an effort to minimise greenhouse gas emissions.

In order to highlight the positive impact of the projects funded by the Green Bond issues, the Société du Grand Paris has sought to quantify the impact these projects have on the efforts to reduce greenhouse gas emissions. In collaboration with Stratec, the Société du Grand Paris drafted a specific methodology setting out the principles and method to calculate the carbon impact of these projects.

The CarbOptimum® tool was developed to do just that. This carbon calculator was developed by the Société du Grand Paris by adapting and complementing existing methodologies in order to meet the needs of the project. It takes into account all direct, indirect, induced and avoided emissions. It takes a top-line approach, similar to that recommended by Ademe's Carbon Review and the GHG Protocol.

The carbon impact is calculated by comparing the carbon footprint (emissions generated by carrying out the projects) with avoided emissions (during the operational phase of projects).

The full methodology is available on the website of the Société du Grand Paris. The summary of the review and its conclusions are presented from page 31 and were produced in collaboration with Stratec, a design office specialising in mobility, transport economics, the environment and regional planning.

Overall conclusion

In 2018, a total amount of €1.1770 billion was allocated from a total debt estimated at €35 billion, which represents 5%.

By applying this percentage to the figures reached after updating CarbOptimum® in 2018, we obtain the following impact assessment*:

In millions of tonnes of CO_2 equivalent	Timescale: 2070	
	Total	2018 share
Lower case	-27.4	-1.4
Higher case	-51.3	-2.6

The date 2070 was chosen so the calculation reflects the duration of the assets of the Société du Grand Paris and the maturity of its most long-term debt (expiration date).

Over the years and annual reports, this range will undergo additional analysis and be monitored in order to reduce the degree of uncertainty and spread.

The top-line assessment of greenhouse gas emissions induced and avoided by the Grand Paris Express is obtained by adding the emissions generated by the various sources previously outlined – preliminary studies, construction, operation of the infrastructure, mobility and regional development.

The emissions cumulated year on year across the various sources for the lower case (scenario A) and the upper case (scenario B) are represented in the following schema:

* excluding refinancing

Cumulated emissions year per year, scenario A

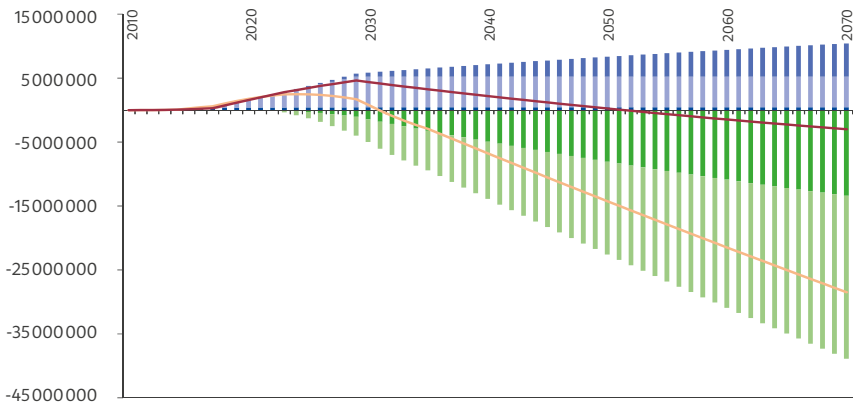


Figure 5
Chronological balance of the GHG emissions related to the Grand Paris Express project, according to scenario A, expressed in t CO_2eq (source: CarbOptimum, 2018)

Cumulated emissions year per year, scenario B

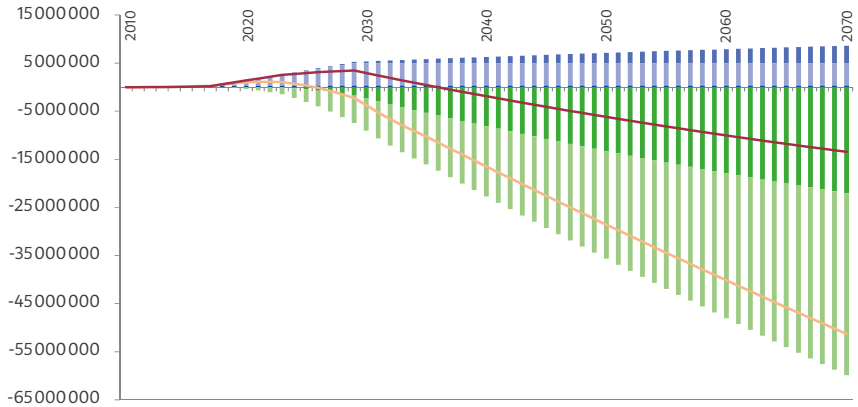


Figure 6
Chronological balance of the GHG emissions related to the Grand Paris Express project, according to scenario B, expressed in t CO_2eq (source: CarbOptimum, 2018)

- Territorial development
- Mobility
- GPE operation
- GPE construction
- Pre-construction studies and works
- Cumulative GHG emissions (including territorial development)
- Cumulative GHG emissions (excludig territorial development)

The balance of GHG emissions becomes positive from 2013 in Scenario A and becomes positive from 2026 in Scenario B. From this point onwards, the balance of GHG emissions of the project becomes increasingly positive. Indeed, between 2030 and 2070, **when the infrastructure will be fully operational, the project to avoid about 754,465 t CO_2eq per year according to scenario A, and 1,225,801 t CO_{2_e}q per year according to scenario B.** This reduction must be compared to the annual emissions of the Paris region, estimated at 40.5 billion t CO_{2_e}q per year , i.e. a reduction ranging between -1,8% and -3,0%. Beyond 2050, the balance will continue this positive trend and proves to be very positive over the life-span of the infrastructure.

In a general way, irrespective of the scenario, the balance is positive by 2050, i.e. only 20 years after the entering into service of the lines of the Grand Paris Express. In this way, **14.2 million of t CO_2eq** can be avoided according to scenario A, and **28.6 million of t CO_2eq** according to scenario B. In 2070, i.e. 40 years after the entering into service of all the lines, the avoided emissions will total **27.4 million of t CO_2eq** according to scenario A and **51.3 million of t CO_2eq** according to scenario B.

Globally, the Grand Paris Express project should drastically reduce the greenhouse gas emissions level. As such, it turns out to be a major lever in the fight against climate warming, represented in France by the "Stratégie Nationale Bas Carbone".

1. https://www.airparif.asso.fr/etat-air/air-et-climat-bilan-emissions#ges

Greenhouse gas emissions balance

Summary and conclusion of the balance 2018

The public transport network project Grand Paris Express (GPE) consists in the creation of a new automatic subway covering about 200 km and including 68 stations and 7 technical centers associated with the different lines. This network will connect Paris city to the major poles of development of the Paris region and will be closely linked with existing main transport lines. More than just a transport infrastructure project, the Grand Paris Express network is first of all an ambitious urban, social and economic project aiming at connecting the major strategic territories of the Paris region and promoting the sustainable, solidary and job-creating economic development of the capital region. The scope of this project is therefore very large, not only on a geographical level, as its impact is expected to cover the entire Paris region and beyond, but also regarding to the activity sectors, as it is expected to have effects on the mobility, the economy, the demography, the environment, etc.

This project will have a tremendous impact on the future developments of the Paris region, in its various economic, social and territorial dimensions. All these aspects will have a significant effect on the greenhouse gas (GHG) emissions.

OBJECTIVES OF THE PROJECT

The Grand Paris Express will have beneficial effects, not only on transportation but also on economic, social, territorial and environmental levels. It will help improving the quality of life by preserving natural and agricultural spaces and reducing pollution and nuisances. It will therefore guarantee a more sustainable development of Paris region.

Better transport provision

Today, 70% of the travelling within Paris region concerns trips between suburbs, and 80% of these trips are made by car, as there is no performant public transport alternative available. Indeed, people who want to travel from one suburb to another using public transport have generally no other way than passing through the center of Paris, which extends the travel time and saturates the lines of both the subway and the regional express network (RER).

1. Article 1 of the Law nr. 2010-597 of 3 June 2010 with regard to the Grand Paris

The Grand Paris Express project aims to improve the transport provision in order to:

- meet the transportation needs of people travelling from one suburb to another;
- reduce congestion on the most overloaded lines of the current network by allowing people to bypass Paris when travelling between suburbs;
- improve the access to the TGV (High Speed Train) railway stations and the airports (Roissy-CDG, Orly, Le Bourget) from every location in the region.

The project will provide better transport services and improve the quality and the comfort of public transports in Paris region, and thus lead to a modal shift from car to public transport.

Economic and urban effects

The Grand Paris Express transport network will foster the economic development of Paris region:

- by facilitating the access to territories that are currently poorly integrated in the metropolitan structure, and by connecting them to the region's major employment poles;
- by interconnecting the major activity poles which are economic growth generators for the region;
- by improving the territory's attractiveness, the functioning of the job and housing markets, and the exchanges between activities.

All these aspects are drivers of job creation and productivity gains for both companies and public services.

The subway should also contribute to a better development of the Paris conurbation. Indeed, the new provision of public transport will go hand in hand with urbanization of station neighborhoods, associating housing and employment. Accompanying measures will be implemented to provide a new dynamism to the surroundings of the Grand Paris Express stations and to control the urban spread. These policies include building control, urban parking, pricing of the public transport in favor of the GPE, more qualitative public spaces and intermobility. These accompanying measures will support a more compact conurbation structure as well as denser urban projects.

Participation in sustainable development

The GHG emissions per kilometer travelled in mass transit transport are largely inferior to the emissions produced by private cars. In this way, the modal shift, which might be significant with time, will lead to a global reduction of emissions linked to the travelling of Ile-de-France inhabitants.

GHG emissions related to housing and employment vary according to the density of the urban fabric and the quality of public transports. By opening up certain territories, by bringing inhabitants and jobs closer together and by promoting a denser urban fabric, the Grand Paris Express will also have a positive effect of the GHG emissions.

ENVIRONMENTAL APPROACH OF THE SOCIÉTÉ DU GRAND PARIS

In 2010, the Société du Grand Paris set up a strategic environmental assessment of the project. It has since been completed with many environmental, technical and socio-economic studies.
From the first steps of this environmental approach, the Société du Grand Paris decided to adopt construction methods adapted to each subway section, station and building, in order to turn the Grand Paris Express project into a major lever in the climate change mitigation policies.

The studies address all the environmental challenges of the new subway and its construction sites. This approach allowed to assess the foreseeable environmental effects of the project and to identify upstream the measures aiming to prevent or reduce the negative impacts of the subway, both during the construction and after when the subway will be operated.

The first environmental studies pointed out the various sources of GHG emissions and savings generated by the project, as well as the necessity to adopt a highly innovative approach to assess these effects. A consortium of independent engineering firms was therefore mobilized to develop a specific tool able to take into account the multiple impacts of the project and to assess in the most accurate way the GHG emissions linked to the Grand Paris Express.

A specific method, called CarbOptimum method was then developed, based as much as possible on the existing tools for assessing the GHG emissions of major projects, and the extensive research that has been conducted over the years on this topic. The elements available in the literature and the existing methodologies were used, although most of them needed to be adapted to the regional context of the Ile-de-France and the Grand Paris Express project. Indeed, their parameters used to calculate the impact were generally based on national or international averages and were related to the short-time economic and demographic effects of transport infrastructure projects, while the effects of the Grand Paris Express project will mainly be felt in the long or very long terms.

Compared to the existing methods, CarbOptimum tool provides a much more prospective vision of the GHG emissions and takes into account the evolutive character of the emissions factors. It allows to consider all the project phases and covers the period from the pre-studies until 20 or 30 years after the putting into service of the first subway lines. It is set up around five major topics: (1) Pre-construction studies and works, (2) Construction of the GPE, (3) GPE operation, (4) Mobility in the Ile-de-France and (5) Territorial development. The tool has been conceived to assess the emissions that have been produced and avoided year after year, allowing as such to visualize the changes over time.

ASSESSMENT OF THE IMPACT OF THE GPE ON THE GHG EMISSIONS

The Grand Paris Express project has already been the subject of several GHG emission balances, established for the needs of the different authorizations necessary for projects deemed to be in the national interest (called in France "déclaration d'utilité publique"). These assessments considered two scenarios differentiated by population and employment growth hypotheses.

The update undertaken in 2018 allows to take into account several new elements with regard to the retained perimeter, the construction techniques and the emission factors. It also considers two new scenarios, named A and B, that are based on various hypotheses related to the emission factor levels and the intensity of the effects of the Grand Paris Express project. Scenario A, considered as the lower part of the range is based on minimizing hypotheses while scenario B, considered as the higher part of the range, includes hypotheses that are probably more realistic and still cautious. Furthermore, both scenarios only consider the effects of the Grand Paris Express that are commonly recognized and quantified. Indeed, studies carried out by the Société du Grand Paris show that the Grand Paris Express could also generate a large number of indirect, long-term effects, more specifically with regard to the changing mobility behaviors and the ways of living and working. These long-term behavior changes have not been modelled precisely yet and therefore were not included in these balances, although these changes may involve considerable GHG savings in the long term.

PRE-CONSTRUCTION STUDIES AND WORKS

Several emission factors for tertiary services available in the literature, such as the factors proposed by ADEME and Defra methods, have been analyzed during the development and the update of CarbOptimum tool. These emission factors have also been compared to specific assessments to finally retain an emission factor of 110g CO_2eq per euro spent in scenario A, and of 68g CO_2eq per euro spent in scenario B. As the energetic efficiency of these services constantly improves, an annual reduction of 1% of these emissions has also been considered.
The budgets of the pre-construction studies and works include the expenses born by the Société du Grand Paris as well as the budget allocated to all the Grand Paris Express related studies, assigned to several independent engineering firms through public procurement (design and general contracting studies, environmental studies, legal services, etc.).
The most up to date estimations of the budgets allocated to the different studies and to the project management (about 3.85 billion euros, which represents about 10% of the global construction budget) have been used to assess the emissions in terms of tons of CO_2 equivalent. These emissions have been spread over the period 2010-2030, given the fact that a steering activity will remain in place until the complete entering into service of the GPE in 2030.

Based on these hypotheses, GHG emissions (expressed in tons of CO^2 equivalent) have been estimated at 419,935 t CO_2eq for scenario A and 259,596 t CO_2eq for B over the entire period considered (2011-2030).

GRAND PARIS EXPRESS CONSTRUCTION

Construction of major transport infrastructures produces large amounts of GHG emissions, not only in terms of organization of the construction site (travelling of workers, use of construction machinery and equipment, etc.) but also in terms of production and transportation of building materials: energy consumption on construction sites (electricity, combustion of fuel by the machinery and the power generators, etc.); depreciation of construction machinery; materials (especially concrete and steel whose production produces important GHG emissions); transportation of materials as well as evacuation and disposal of large quantities of excavated materials that will require the use of heavy load trucks, trains or barges which also produce GHG emissions; and finally, the 'home to work trips' of the construction site workers who will also produce GHG emissions when they travel by car or motorcycle.

1. Guide des emission factors V6.1, ADEME, 2010 et Base carbone mai 2019.
2. Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting.

Global GHG emissions linked to the construction, per category, scenario A

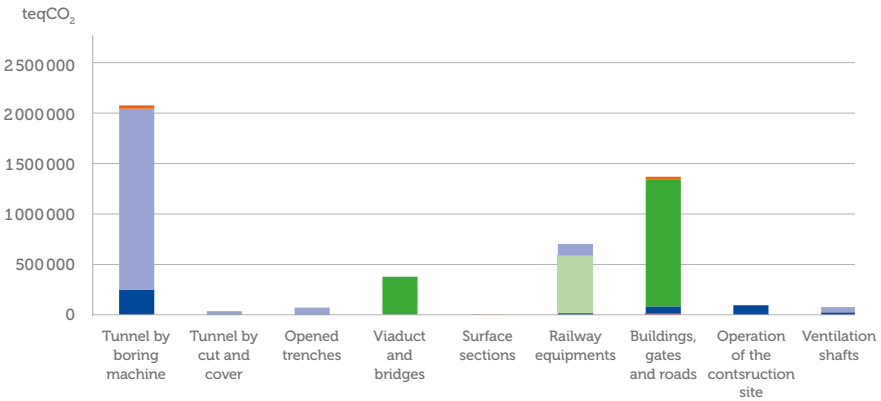


Figure 1
Global GHG emissions linked to the construction, per category, scenario A (source: CarbOptimum, 2019)

Overall, the construction phase will generate about 4,811,082 t CO_2eq (i.e. about 23,230 t CO_2eq per km of double-track railway) according to scenario A, and 4,618,100 t CO_2eq (i.e. about 22,299 t CO_2eq per km of double-track railway) according to scenario B. The table below shows the distribution of the GHG emissions per type of construction and material type, according to scenario A.

GRAND PARIS EXPRESS OPERATION

Operating the Grand Paris Express will generate significant flows of greenhouse gases. They will mainly concern energy consumption and all the inputs linked to the operation of trains and stations. These flows consist of the following components: the energy required to move the trains; the energy consumption of the buildings, more specifically of the stations (lighting, heating/cooling, natural ventilation, etc.) and the technical buildings (train storage areas, maintenance workshops, etc.); emissions produced by all management, marketing, monitoring and steering activities; and, finally, the emissions linked to the maintenance and the renovation of the infrastructure (railway, trains and buildings require constant and permanent maintenance throughout their life cycle, which includes the use of replacement parts, maintenance products, etc.).

The calculation of the annual emissions related to the traction of the subway lines is based on traffic hypotheses, totaling 265,830.000 train.km per year for all the lines together. For the period between 2021 and 2050, the emissions linked to the traction have been estimated at about 696.091 t CO_2eq for scenario A, and 470,562 t CO_2eq for scenario B.

Over the same period, scenario A evaluates that the energy consumption of stations and technical buildings will produce 113,720 t CO_2eq (i.e. 75,013 t CO_2eq produced by the stations and 38,708 t CO_2eq by the exploitation and maintenance centers); while scenario B assesses these emissions at 71,038 t CO_2eq.

The maintenance and management related emissions represent a substantial part of the emissions related to the operation of the infrastructure. For the period between 2021 et 2050, the total for all the lines together is 1,115,295 t CO_2eq according to scenario A. The budget is allocated as the infrastructure is gradually being opened, proportionally to the lines that have been put into service. Scenario B assesses the emissions at 689,455 t CO_2eq.

For the period between 2021 and 2050, the emissions produced by the renovation of the railway equipment and the buildings are estimated at about 1,185,223 t CO_2eq in scenario A and at 996,401 t CO_2eq in scenario B.

Scenario A assesses the global CO_2 emissions linked to the general operation of the infrastructure at 3,110,329 t CO_2eq. This covers the emissions produced by the traction of the trains; the energy of the buildings (stations, technical facilities, both in terms of electricity and heating); the renovation, including the management and maintenance activities. Scenario B evaluates these emissions at 2,227,456 t CO_2eq.

The figure below shows the distribution of the emissions related to the operation of the infrastructure per item, according to scenario A.

Annual emissions (t CO_2eq) related to the operation of the infrastructure, for lines, stations and maintenance centers, scenario A

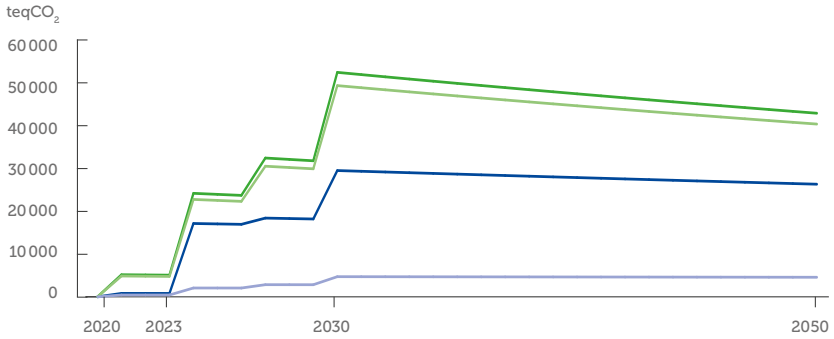


Figure 2
Annual emissions (t CO_2eq) related to the operation of the infrastructure, for lines, stations and maintenance centers, scenario A
(source: CarbOptimum, 2018)

- Traction
- Consumptions of the stations
- Management
- Renovation

It appears that renovations represent the highest contributor to GHG emissions followed closely by the management, steering and maintenance activities. Traction energy and the energy consumption of the stations and technical buildings rank third and fourth, to a lesser extent.

MOBILITY

The Grand Paris Express project will reduce the use of cars and will as such lead to a reduction of the GHG emissions. Based on traffic models results, scenario A considers a traffic reduction of 1,988 million of veh.km per year; scenario B considers a higher but likely reduction of 3,290 million of veh.km per year. The graph below shows the emissions that the project will avoid throughout time, according to scenario A. It points out the differences between the emissions related to the distances travelled and the emission linked to the speed of the vehicles.

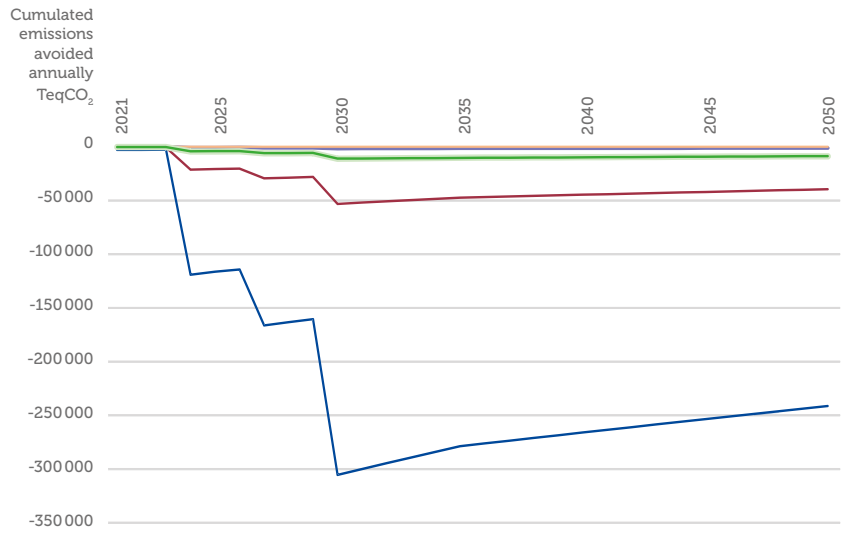


Figure 3
Annually avoided emissions (t CO_2eq) as a result of the beneficial effects of the GPE on road traffic, scenario A
(source: CarbOptimum, 2018)

- Distances travelled by cars
- Average speed of cars
- Distances travelled by motobikes
- Average spedd of motobikes
- Distances travelled by trucks
- Average speed of trucks

According to scenario A, when the entire network will be in operation, it will allow to save almost 400,000 t CO_2eq annually (-382,193 t CO_2eq in 2030). For the period between 2021 and 2050, the reduction in road traffic and better driving conditions would allow to save 8,078,899 of t CO_2eq.

Over the same period of time, scenario B assesses the avoided emissions at 13,298,166 CO_2eq.

TERRITORIAL DEVELOPMENT

The public transport network project 'Grand Paris' provides a unique opportunity of densification, linked to a greater attractiveness of the spaces located within the heart of the Paris conurbation, inducing as such a more attractive and sustainable urbanization that takes into account the energy constraints and the commitments made in terms of CO_2 emission reduction. CarbOptimum is based on a certain number of territorial forecasts provided by the "Land Use Transport Interaction" models used by the Société du Grand Paris, which allow to calculate the residential and commercial surfaces, needed to accommodate new residents and workers, as well as the hectares of wasteland, agricultural land or forests, saved from urbanization as a result of the GPE.

For the period between 2015 and 2050, the overall avoided emissions resulting from the beneficial effects of the Grand Paris Express on the territorial development, are assessed at -14,501,943 t CO_2eq

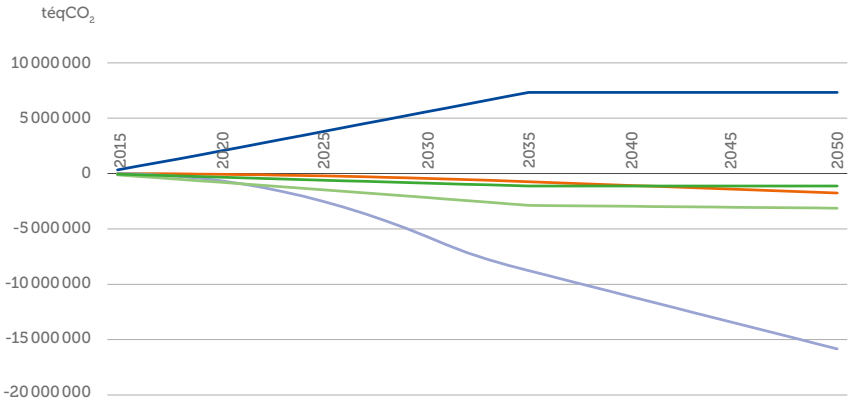


Figure 4
GHG emissions related to territorial development, cumulated throughout time, expressed in t CO_2eq, scenario A (source: CarbOptimum, 2018)

- Construction and renovation of buildings
- Change of land use
- Maintenance et operation of roads, networks and public services
- Site preparation for urbanization
- Heat consumption of buildings

according to scenario A, and -22,381,051 t CO_2eq according to scenario B. The graph below shows the emissions related to the effects generated by the territorial development as indicated in scenario A, in a cumulative way.

GLOBAL BALANCE OF THE GHG EMISSIONS RELATED TO THE GRAND PARIS EXPRESS PROJECT

The general balance of the GHG emissions produced and avoided by the Grand Paris Express, is obtained by adding together the emissions related to the different topics detailed above: pre-construction studies, construction, operation of the GPE, mobility and territorial development.
The table below shows the results of the balance by 2050 and 2070, according to hypotheses that have been retained.

Table 1: Results of the balance by 2050 and 2070, according to the scenarios, expressed in millions of t CO_2eq.

Accumulated emissions in 106 of t CO_2eq.	Time horizons	
Scenario	2050	2070
Scenario A	-14.2	-27.4
Scenario B	-28.6	-51.3

The graphs below show the cumulated emissions year per year according to the different items of scenarios A and B.

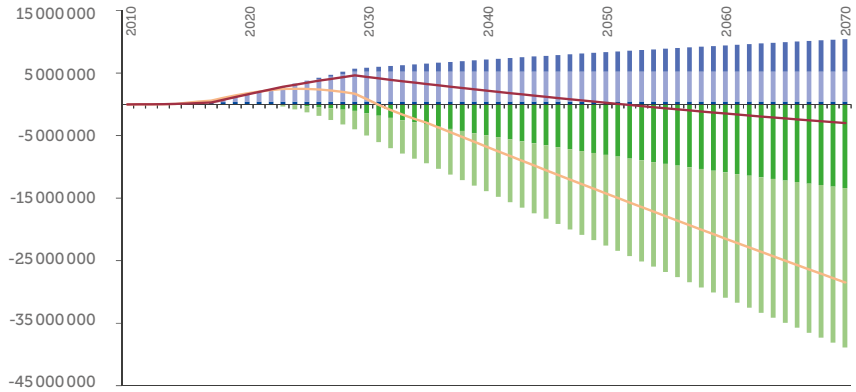


Figure 5
Chronological balance of the GHG emissions related to the Grand Paris Express project, according to scenario A, expressed in t CO_2eq (source: CarbOptimum, 2018)

- Territorial development
- Mobility
- GPE operation
- GPE construction
- Pre-construction studies and works
- Cumulative GHG emissions (including territorial development)
- Cumulative GHG emissions (excludig territorial development)

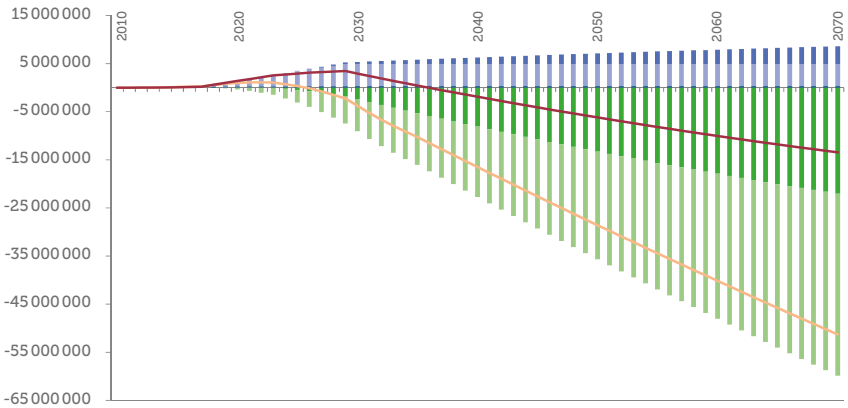


Figure 6
Chronological balance of the GHG emissions related to the Grand Paris Express project, according to scenario B, expressed in t CO_2eq (source: CarbOptimum, 2018)

- Territorial development
- Mobility
- GPE operation
- GPE construction
- Pre-construction studies and works
- Cumulative GHG emissions (including territorial development)
- Cumulative GHG emissions (excludig territorial development)

The balance of the GHG emissions becomes positive from 2031 in case of scenario A, and from 2026 in case of scenario B. From then onwards, the annual gains make the balance of the project increasingly positive. Indeed, between 2030 and 2070, **when the infrastructure will be fully operational, the project will allow to avoid about 754,465 t CO_2eq per year according to scenario A, and 1,225,801 t CO_2eq per year according to scenario B.** This reduction must be compared to the annual emissions of the Paris region, estimated at 40.5 billion t CO_2eq per year , i.e. a reduction ranging between -1,8% and -3,0%. Beyond 2050, the balance will continue this positive trend and proofs to be very positive over the life-span of the infrastructure.

In a general way, irrespective of the scenario, the balance is positive by 2050, i.e. only 20 years after the entering into service of the lines of the Grand Paris Express. In this way, **14.2 million of t CO_2eq** can be avoided according to scenario A, and **28.6 million of t CO_2eq** according to scenario B. In 2070, i.e. 40 years after the entering into service of all the lines, the avoided emissions will total **27.4 million of t CO_2eq** according to scenario A and **51.3 million of t CO_2eq** according to scenario B.

Globally, the Grand Paris Express project should allow to drastically reduce the greenhouse gas emissions level. As such, it turns out to be a major lever in the fight against climate warming, represented in France by the "Stratégie Nationale Bas Carbone".

1. https://www.airparif.asso.fr/etat-air/air-et-climat-bilan-emissions#ges

FOR FURTHER INFORMATION

All documents related to the Green Bond programme (Green Bond Framework, Second Party Opinion, Climate Bond Initiative Certification, Green Bond investor presentation, etc.) are available on the website of the Société du Grand Paris on the "Sustainable Finance" page.
https://www.societedugrandparis.fr/sgp/investisseurs#progfi

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