Potential of national rail investments in France for mitigation of greenhouse gas emissions

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Targets for cutting French GHG emissions are ambitious: -75% 2050/1990 (« factor 4 »), but the country is on the right trend since 2006

Transports = 26 % of GHGE (sector nr 1), stable (≠ national trend)

GHGE mitigation is one of the few long term quantitative targets impacting the whole country and its activities

What contribution of the transport sector?

☐ Short / long distance transport?

☐ Rail and modal shift?

☐ High speed rail?

Evolution of French GHG emissions and specific targets set out for France

2.036 km of HSL in operation (28 % of EU’s total), starting 1981

+ 700 km in construction to be open until 2017

About 470 HS train sets running 139.5 M train-km
(2/3 performed on HSL)

54 billion pkm (58 % of passenger rail transport in France)

Competitiveness of the HS system based on:

- The geographical structure of the French territory, generating a concentrated and high demand of transport at the national scale and cutting costs per passenger
- SNCF’s innovations (yield management applied to rail, low cost subsidies…)

⇒ The most advanced high speed rail system in Europe … with still development potential (Toulouse, Côte d’Azur, etc.)
GHGE of HSR strongly varies from country to country, mainly depending on:

1) GHG content of energy supplied to rail operators (nuclear power: 80% of the French electricity supply)
2) Energy efficiency of rail operation. French HSR is despite speed as much as energy efficient per pkm than usual IC trains.

France is almost where HSR has the best advantage by GHGE on other transport modes

Mass transport system + Potential + Low carbon transport

= France as a very good place to invest in HSR for cutting GHGE
The contribution of high speed rail by mitigation of GHGE, backcasting methods

LET-Enerdata “Factor 4 study” (H. Lopez-Ruiz 2009) about needed conditions to cut GHGE by 75% until 2050 in transport (passenger & freight together)

Scenarios varying according to macro parameters (value of time, regulations, innovations…)

- HSR ridership should reach 157 to 186 Gpkm => X 3
- Investment in rail should be increased 6 times

Is this sustainable?
Where investments should be done?

Key figures per mode in various mobility scenarios in the LET-Enerdata “Factor 4 study”

<table>
<thead>
<tr>
<th>Investment / year bn€</th>
<th>Average 2008-2012</th>
<th>Pégase until 2050</th>
<th>Chronos until 2050</th>
<th>Hestia until 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td>10,7</td>
<td>21</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Rail</td>
<td>3,4</td>
<td>15</td>
<td>31</td>
<td>20</td>
</tr>
</tbody>
</table>

Source: Lopez-Ruiz, Crozet (2011)
Main rail infrastructure projects in France before *Mobilité 21* task force

**Main rail infrastructure projects proposed for the National Transport Infrastructure Scheme (SNIT, 2011)**

SNIT results directly from:

- Government’s engagement (“Grenelle” 2009) to build 2500+2000 km of new HSL
- Local pressures leading to a new HSL in each region

**Over 110 bn€ investments in new rail infrastructures**

(= 45% of investments in all planned transport infrastructures)

**Seen as unrealistic scheme:**

- RFF’s debt was already close to 30 bn€
- Actual investments in HSL (2008-2012) only 1.3 bn€/year

⇒ *Mobilité 21* task force to prioritize investments according to actual needs and available budget
Main rail infrastructure projects in France after *Mobilité 21* task force and new government’s orientations

- HSL in construction
- Project to start < 2030
- Project to start < 2050
- Project for internationalization: *Mobilité 21* (Nouveau Grand Paris, liaisons internationales...)

Diagram showing rail infrastructure lines and projects in France.
Impact of various long distance rail investment strategies on GHG emissions in France

Study by 3 independent experts Gérard MATHIEU, Jacques PAVAUX, Marc GAUDRY (2013) for Réseau ferré de France / Strategy department (follow up: S. Séguret) in association with
- FNE, the national federation of environment associations in France
- FNAUT, the national federation of public transport users
- ADEME, the state agency for environment and energy saving
Purpose and context of the study

Purpose:
- to set a global vision about the potential of GHGE mitigation of rail
  (≠ usual vision project by project)
- to calm down the debate about network development and new HSL
- to open strategic studies to stakeholders in need of objective information

Context:
- Study done between late 2010 to early 2013, after the government announced 4500 km of new high speed lines (Grenelle Environnement)

Title:
- « Evaluation de la contribution du réseau et de la politique ferroviaires à l’objectif du facteur 4 pour les déplacements des voyageurs à moyenne et longue distance »
Key features of the study

Scope: only long distance passenger traffic on the main interurban corridors

Massive data got from previous studies concerning infrastructure projects (mainly HSL) which have been never summed up together before

Study based on 4 contrasted scenarios of rail network development until 2050, determining in each scenario a HSL or a conventional line (with maximum speeds) for sections of 100 to 200 km of corridor

Only one macro-economic framework (transport policy and prices, competition, etc.), to point the impact of various investment strategies on the network

⇒ Main factor are the infrastructure features

Results per corridor have been anonymised, to focus attention on the development strategies and not interfere with project management
Methodology (1)

Socio-economic features:

- Energy price (oil barrel): $80 in 2010, $120 in 2020, $160 in 2050 (constant $)
- Costs of transport modes: air = rail; road: < rail until 2025 than > rail
- Load of transport vehicles: car: 1.82 pass/veh in 2012, 2.15 in 2050
- GHGE of transport modes (electric cars, green fuels, etc.) and construction of rail infrastructure (see RFF carbon footprint of Rhin-Rhône HSL)

<table>
<thead>
<tr>
<th>Year</th>
<th>Air *</th>
<th>Car **</th>
<th>High speed train ***</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>262</td>
<td>121</td>
<td>7</td>
</tr>
<tr>
<td>2030</td>
<td>220</td>
<td>96</td>
<td>7</td>
</tr>
<tr>
<td>2050 (1)</td>
<td>200</td>
<td>78</td>
<td>7</td>
</tr>
<tr>
<td>2050 (2)</td>
<td>200</td>
<td>71</td>
<td>7</td>
</tr>
</tbody>
</table>

* Including greenhouse effect of cirrus clouds and condensation trails (global warming potential => GHGE x 2)
** Including maintenance of infrastructure
*** Excluding construction and infrastructure operation

All other emissions included (life cycle emissions of vehicles, GHG content of energy, etc.)
1) Without electric car and with 75 % electricity from nuclear power or renewable energy
2) With 40 % of electric cars and 75 % electricity from nuclear power or renewable energy
4 « network orientations » representing various network development strategies:
- A1: active development of the HSL network (≈ equivalent to SNIT)
- A2: similar to A1 but with some mixed passenger/freight new lines
- B1: performance upgrade of the core network (including existing HSL) + some of the most pertinent new HSL
- B2: similar to B1 but with performance upgrade on all corridors mentioned in the national scheme SNIT 2011

Applying these network orientations on the 15 main corridors + 10 additional corridors or functionalities mentioned in the SNIT 2011

Traffic forecasts per corridor and mode related to scenario assumptions (main parameter: travel times)

Assessment of GHG emissions per corridor:
- of infrastructure works defined in the network orientations
- avoided thanks to modal shift from other modes to rail (including rail traffic induction)
2 parameters to compare the GHGE efficiency of development strategies:

- Amortisation period of GHG emissions due to infrastructure works, i.e. time needed the avoided GHG emissions reach the emissions of construction
- Average cost of avoided GHG emissions (€ / tonne)

Example of corridor Bordeaux – Toulouse :
Amortisation period varies strongly across corridors
From 5 to 50 years for passenger HSL

Amortisation time of GHG emissions due to infrastructure works on the 15 main corridors

Réal. J. Pavaux, in Mathieu, Pavaux, Gaudry (2013)
The point of carbon neutrality depends on when operation starts and on the carbon efficiency of the project.

Cumulative carbon footprint on time of 2 planned HSL in different corridors

Réal. J. Pavaux, in Mathieu, Pavaux, Gaudry (2013)
The point of carbon neutrality depends on when operation starts and on the carbon efficiency of the project.
Bilan carbone pour chaque année et pour la totalité des 15 axes dans l'orientation A1 entre 2015 et 2045

Results
Network orientation A1 (« full HSL scenario »)

Cumulative carbon footprint in the full scenario A1

Construction of the first new lines
First lines in operation, new lines in construction
HS network completed

Millions de tonnes de CO₂

Réal. J. Pavaux, in Mathieu, Pavaux, Gaudry (2013)
Traffic shift from air have a major impact on the carbon footprint of the planned HSL.

**Results**

**Network orientation A1 (« full HSL scenario »)**

Traffic shift from air have a major impact on the carbon footprint of the planned HSL.
Results
Network orientation A1 (« full HSL scenario »)

Cumulative carbon footprint in the full scenario A1

- Construction of the first new lines
- First lines in operation, new lines in construction
- HS network completed
Results
Network orientation A1 (« full HSL scenario »)

Cumulative carbon footprint for 3 various investment programs in A1

- All 15 corridors
- The 5 most efficient corridors
- The 3 most efficient corridors

2048: balance of the 3 most efficient corridors = all 15 corridors
2052: balance of the 5 most efficient corridors = all 15 corridors

Réal. J. Pavaux, in Mathieu, Pavaux, Gaudry (2013)
Results
Network orientation A1 (« full HSL scenario »)

Amortisation period of GHGE and cost of avoided GHGE on 10 different corridors

Réal. J. Pavaux, in Mathieu, Pavaux, Gaudry (2013)
## Results

### Key figures about network orientations A1 (« full HSL ») and B1 (the most likely scenario)

<table>
<thead>
<tr>
<th></th>
<th>A1</th>
<th>B1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of corridors</td>
<td>units</td>
<td>15</td>
</tr>
<tr>
<td>Total investment</td>
<td>bn€</td>
<td>82,6</td>
</tr>
<tr>
<td>GHG of construction</td>
<td>Million tons CO₂ eq.</td>
<td>24,9</td>
</tr>
<tr>
<td>Carbon footprint 2030</td>
<td>Million tons CO₂ eq.</td>
<td>4,6</td>
</tr>
<tr>
<td>Carbon footprint 2050</td>
<td>Million tons CO₂ eq.</td>
<td>-34,6</td>
</tr>
<tr>
<td>Carbon footprint 2060</td>
<td>Million tons CO₂ eq.</td>
<td>-64,3</td>
</tr>
</tbody>
</table>
Results

Key figures about network orientations A1 (« full HSL ») and B1 (the most likely scenario)

GHG emissions of infrastructure development on the main corridors in network orientations A1 and B1

Réal. J. Pavaux, in Mathieu, Pavaux, Gaudry (2013)
Results

Key figures about network orientations A1 (« full HSL ») and B1 (the most likely scenario)

Amortisation period of GHG emissions of infrastructure development in network orientations A1 and B1

- Some corridors get the same development in every scenario
- Some line upgrading are more efficient than new HSL
- Some line upgrading are less efficient than new HSL

Réal, J. Pavaux, in Mathieu, Pavaux, Gaudry (2013)
Results
Key figures about network orientations B1 (the most likely scenario) and B2 (B1 upgraded)

Amortisation period of GHG emissions of infrastructure development in network orientations B1 and B2

Disparity is much stronger among corridors than among network development strategies

Réal. J. Pavaux, in Mathieu, Pavaux, Gaudry (2013)
Results
Comparison of the 4 network orientations

In some cases, carbon amortisation can be shorter by optimising the existing line than building a new HSL.
Conclusions, some key figures

For comparable journeys within the study’s scope:

- Each air passenger-km contributes 36 times more to climate change than with HSL
- In 2030, the same ratio air / HSL will still be of 1/30
- For car, actual ratio of 1/16, will be 1/13 en 2030

By every network orientation, no positive cumulative balance before 2035/2040

Between 2015 and 2050, 30 to 35 MtCO$_2$ eq can be saved by building new HSL and upgrading the rail network, i.e.:

- $\approx$ 1 Mt par an (about 1% of the emissions of the total sector of transport in France)
- $\approx$ 0,2 % of French GHG emissions

After 2050, the net balance of the network development reaches about 3 MtCO$_2$ eq avoided every year, i.e.:

- $\approx$ 0,5 % of total GHG emissions of France in 2012
- $\approx$ 2 % of total GHG emissions of the transport sector (25 %)
- 200 % of actual GHG emissions of HSR
New HSL are mainly more GHG efficient than optimising existing infrastructure but not in all cases, depending mainly on the amount of traffic and the modal shift from air.

The 5 corridors with the best carbon footprint in every network orientations are:

1. Marseilles – Italy
2. Montpellier – Perpignan
3. Lyon – Turin (passenger & freight)
4. South Paris bypass (2)
5. Bordeaux – Toulouse

HSR investments in France cut massively GHGE

... but less than people usually think (this is not THE solution for mobility)

... and at a very high cost per avoided emissions compared with over solutions (optimise rail network use, urban planning, non motorised transport, low GHGE activities...).

Don’t burn all the cash on building HSL!
Thank you for your attention