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Impact study of the French BioNGV TER sector

Executive summary



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SUMMARY

1. Objectives and perimeters
2. Input data
3. Direct, indirect and induced impacts
4. Catalytic impact



Objectives and perimeters

Objectives: estimate the impacts of setting up a BioNGV railway sector in France

1

Determine the total activity generated by the establishment and operation of a BioNGV railway sector (employment, economic and environmental impacts)

2

Estimate the jobs on the outskirts of the railways maintained by the implementation of a solution improving the profitability of TER links

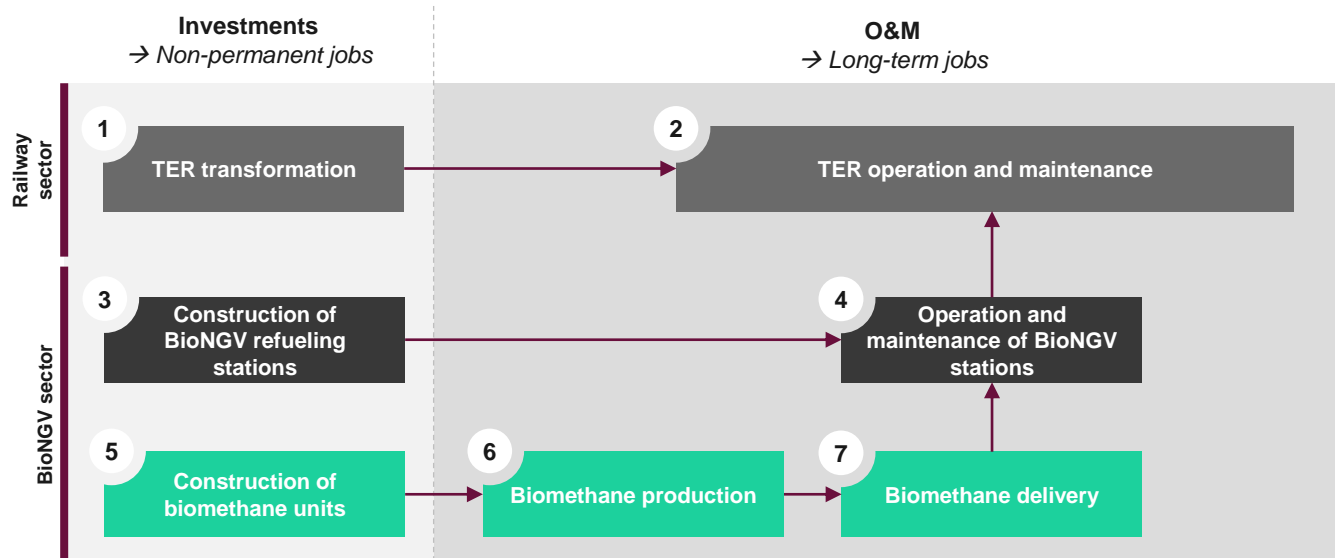
3

Quantify the potential for reducing CO₂, NO_x and particles pollution linked to retrofit trains to BioNGV

Scopes: the TER sector, from the establishment of the BioNGV TER to its maintenance by exploring the production and delivery of BioNGV

Diagram of the direct system studied

A system structured in 7 blocks around investments and expenses related to the establishment, operation and maintenance of the French BioNGV railway sector





Input data

A diversified TER fleet leading to varied transformation potentials

Existing diesel TER fleet							
Regions	B81500	B82500	X76500	X72500	X73500	X73900	Total
Auvergne Rhône-Alpes	40	28	26	16	82		192
New Aquitaine	51	10		23	53		137
Hauts de France		46	34	6	12		98
Great East		15	59		21	17	112
Bourgogne Franche Comté	39		5		39		83
Occitania	28			8	38		74
Normandy		9	14	14	25		62
PACA	26		9	17			52
Pays de la Loire			16	10	14		40
Center-Loire Valley	1			16	16		33
Ile-de-France		24					24
Brittany		8			15		23
Metropolitan France	185	140	163	110	315	17	930

Underlyings of train retrofit scenarios

1

A distance of less than 80km of non-electrified line would allow the circulation of TER with battery only, or 50% of dual-mode TER. For the other half, an alternative solution would be the hybrid battery-BioNGV model.

2

The frugal electrification of the line terminals would allow the batteries to be recharged, thus increasing the battery uses that could be made. This hypothesis leads to a reduction in the share of dual-mode TER convertible to BioNGV and bring it down to 25%

3

Technical interest of the material by the regions. The X72500 model appears to be a model that is not suitable for the regions.

4

A final alternative energy available in the short term and at a low cost is the TER B100. The regions producing biodiesel would potentially prioritize this energy, such as the Hauts-de-France, Grand-Est, Normandy, Bourgogne-Franche-Comté, Occitanie and PACA regions.

Rolling stock at BioNGV could reach 70% of the existing stock depending on the uses

Three scenarios were retained:

Low scenario

The producing regions of biogasoil prefer the deployment of B100 TER (diesel of 100% organic origin) rather than BioNGV trains.

In addition, frugal electrification, allowing the deployment of end-of-line recharging of TER BGC, limits the uses BioNGV at 25% on these models.

Park transformation rate:

33%

Intermediate scenario

100% diesel TERs are converted to BioNGV. For BGCs, frugal electrification makes it possible to consider the transformation or renewal of 25% of the existing fleet in BioNGV.

Park transformation rate:

61%

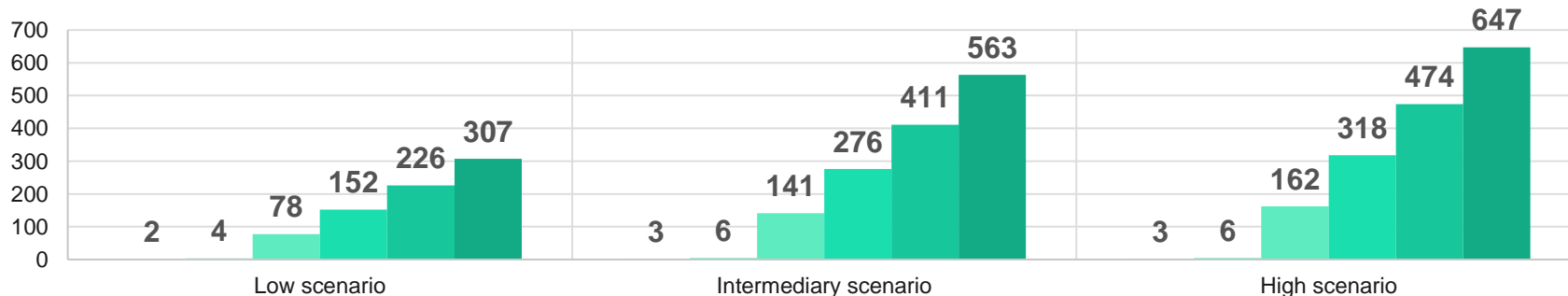
High scenario

The 100% diesel TERs are converted or renewed entirely at the BioNGV. For the BGC, frugal electrification does not take place, which makes it possible to consider 50% of these TER circulating in BioNGV.

Park transformation rate:

70%

Transformation trajectories at the national scale (sum of retrofitted TER)



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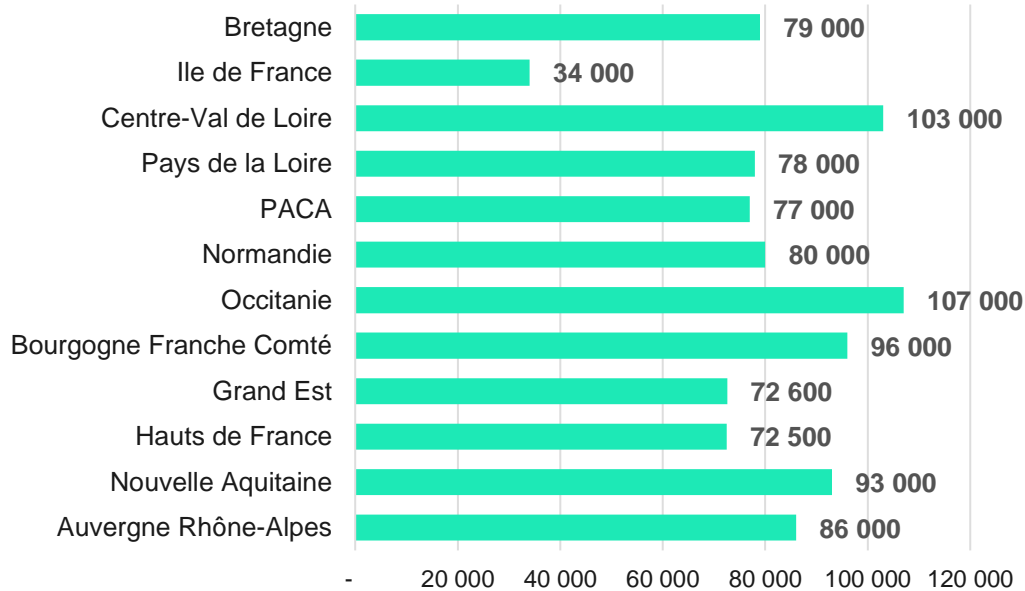
2025 2026 2027 2028 2029 2030

Source: Redoutey, The driving equipment of the SNCF, 2016

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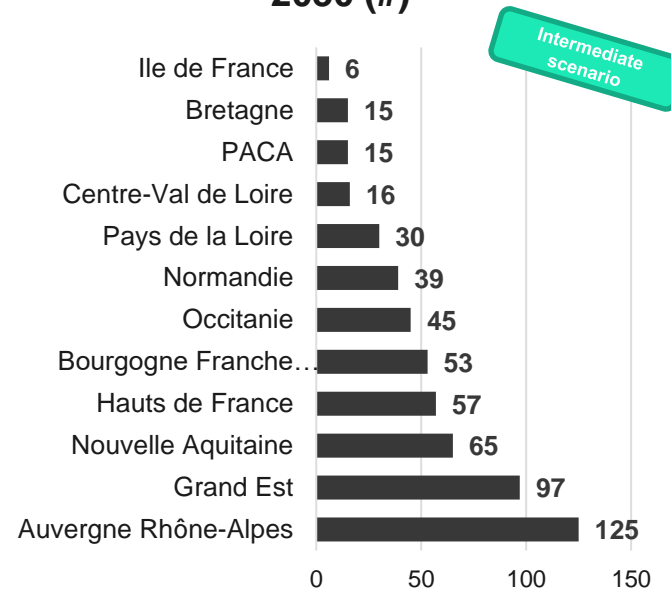
A distance traveled by TER and by region varying according to the network of the territory

Mean distance traveled per TER (in km)



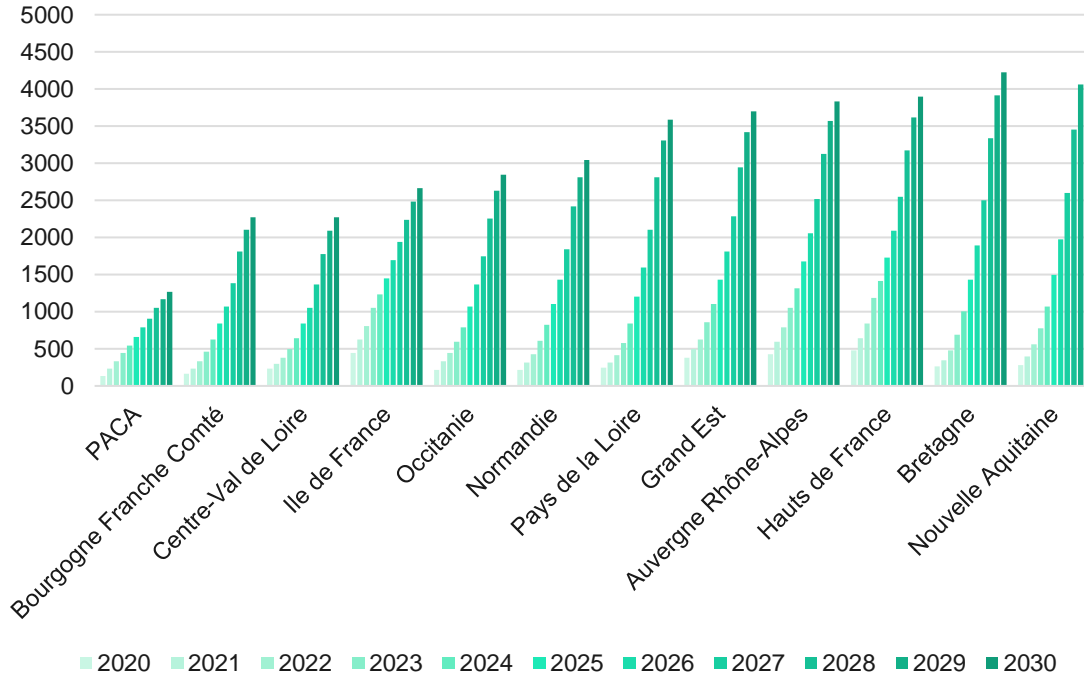
Source: ARAFER - 2016

TER retrofited in BioNGV in 2030 (#)



A consumption of BioNGV well below the production capacities of the regions

Annual injection of biomethane per region (in GWh)



Consumption rate of regional productions :

2025

PACA

(least productive region)

0.0%

Auvergne Rhône - Alps

(most consuming region)

0.1%

2030

PACA

(least productive region)

0.3%

Auvergne Rhône - Alps

(most consuming region)

3.3%

France

1.5%

TER benefit from the reduction of TICPE resulting in a difference of 13 € / MWh between TICGN and TICPE

Domestic Natural Gas Consumption Tax (TICGN)

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
€ / MWh	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23

Sources: Circular of August 27, 2020 relating to the Internal Tax on Natural Gas Consumption

Internal tax on the consumption of energy products (TICPE)

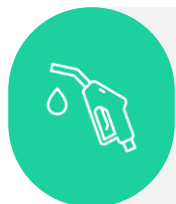
Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
€ /hL	18.82	18.82	18.82	18.82	18.82	18.82	18.82	18.82	18.82	18.82	18.82	18.82
€ / MWh *	18.82	18.82	18.82	18.82	18.82	18.82	18.82	18.82	18.82	18.82	18.82	18.82

* Calculated by taking an energy content of 10 kWh / L according to the order of May 2, 2012

Sources: 2020 Finance Bill

The BioNGV reduces emissions of pollutants such as CO₂, NOx or medium particles

Environmental data:



323
g CO₂/ kWh

Source: Base Carbone - ADEME



47.1 *
g CO₂/ kWh

Source: Base Carbone - ADEME

- 66% on NOx **- 95% on medium particles**

Source: CNG Bus Emission Roadmap - ICCT

Comparison of CO₂ emissions of a passenger between the car and the train:



Thermal car

193
g CO₂/km and per passenger

Source: Base Carbone - ADEME



Thermal TER

65
g CO₂/km and per passenger

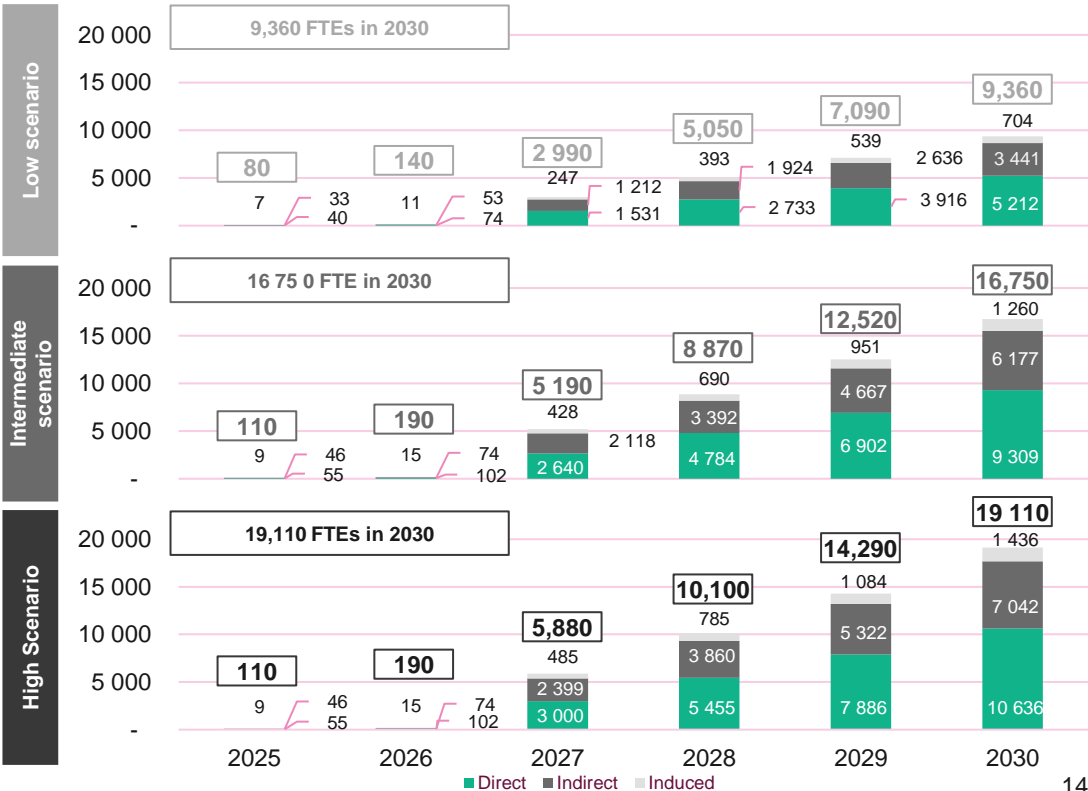
Source: Court of Auditors - for 80 passengers



Direct, indirect and induced impacts

The sector has a potential for job creation between 9,360 and 19,110 FTEs depending on the willingness of the regions to develop BioNGV

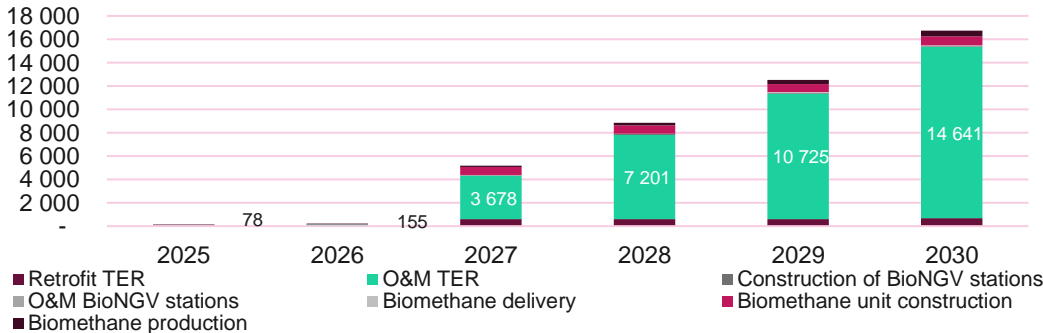
- In the low scenario, where the BioNGV **directly competes** with the **battery TER** and the **TER running at B100** (biodiesel produced in France), the number of jobs in 2030 reached **9,360 FTE** .
- The high scenario, in which the BioNGV TER **competes with the battery TER** but with more developed uses on dual-mode TER, allows to reach a number of jobs of the order of **19,110 FTE** in 2030.
- Finally, the **intermediate scenario** , on which will be detailed the characteristics of the jobs (sustainability, specificity BioNGV, occupational category of the job and geographical location) demonstrates the creation of **16,750 FTEs in 2030** .
- On all of these scenarios, 56% of jobs are generated by direct activity, 36% by indirect activity of suppliers and 8% by activity induced by remuneration.



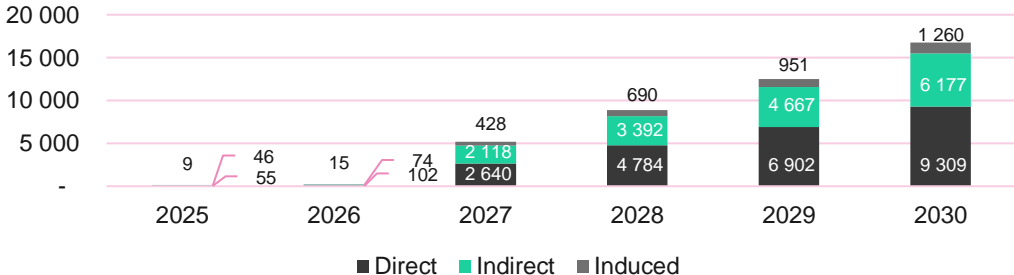
In 2030, the TER sector BioNGV will generate 16,750 FTEs, in particular through the operation and maintenance of TER

- The operation and maintenance of TERs takes a **prominent place** in the economic activity of the TER sector BioNGV representing more than **87% of jobs** generated
- **The construction of biomethane units and the transformation of TER at BioNGV** represents the two activities generating the most jobs with respectively **770** and **700 FTE in 2030**.
- The sector's overall activity grows from 2025 to 2030 thanks to a **double dynamic** :
 - **Acceleration of the number of TER transformed** per year which impacts the transformation but also the construction of fueling stations and the construction of anaerobic digestion units (cf transformation scenarios)
 - **Incremental activity** of operation and maintenance for all blocks according to this type of activity

Employment from 2025 to 2030 broken down by activities (in FTE)



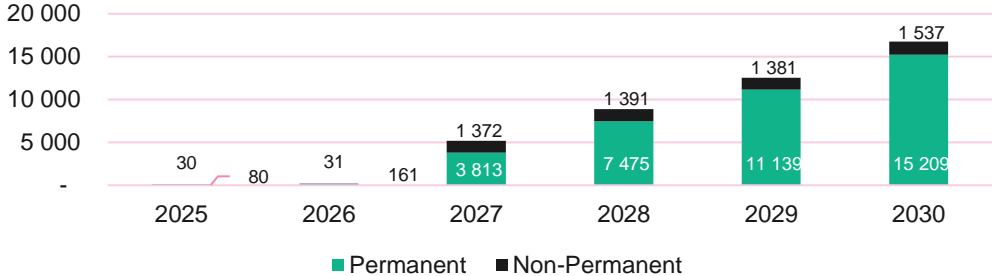
Employment from 2025 to 2030 broken down per impact (in FTE)



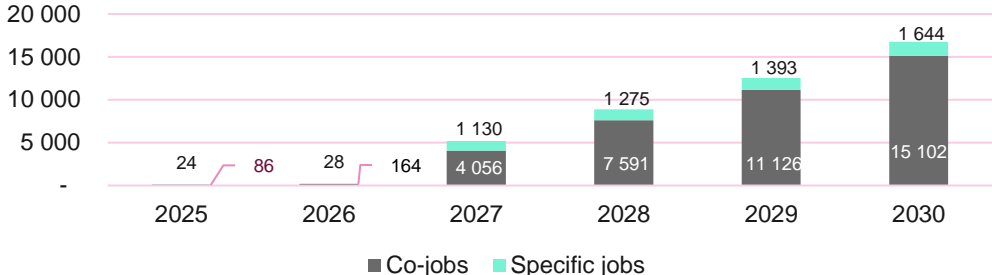
Jobs specific to BioNGV are generated by the establishment of production and supply infrastructure of BioNGV

- **Most of the FTEs** generated by the activity of the BioNGV TER sector are **permanent (91%)**. This long-term employment stems from operations and maintenance activities, be they TERs, refueling stations or even BioNGV production units.
- Non-permanent jobs are generated by construction activities and in particular **the construction of biomethane units representing 50% of these jobs and the transformation of TER 46%..**
- Likewise, all operations and maintenance activities **do not create additional jobs** compared to the diesel sector with the exception of biomethane production. This results in a small number of specific jobs created by the BioNGV sector. **90% of joint FTEs** between the two sectors and **10 % of specific FTE** to the BioNGV sector.
- **Specific jobs** to the BioNGV sector come from the **implementation of refueling stations** as well as **construction and operation of anaerobic digestion units** and some from **specific part of TER transformation related to BioNGV.**

Employment from 2025 to 2030 broken down by sustainability (in FTE)

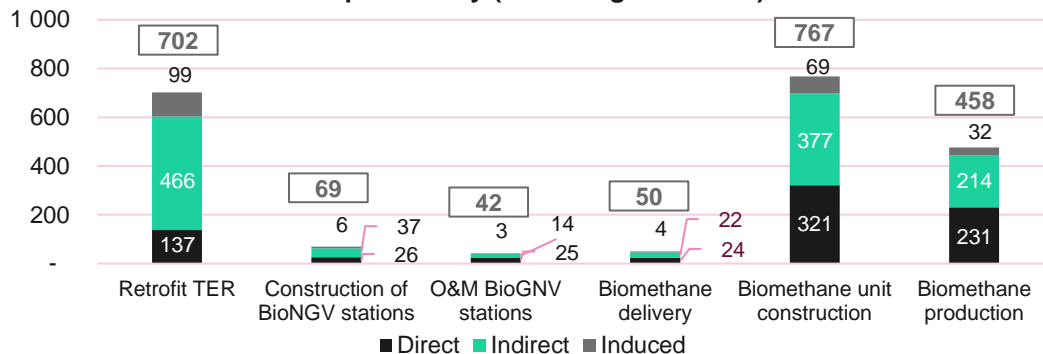


Employment from 2025 to 2030 broken down by specificity (in FTE)

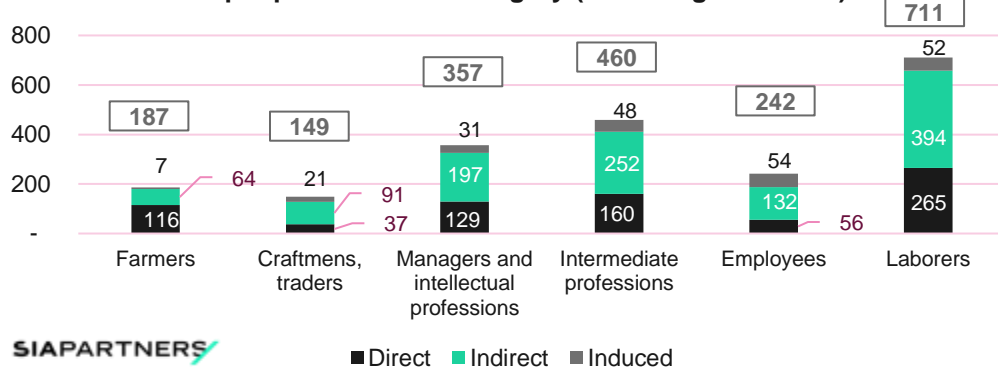


Apart from TER O&M, 2,110 FTEs are generated and distributed across all professional categories including farmers

FTE per activity (excluding TER O&M)



FTE per professional category (excluding TER O&M)

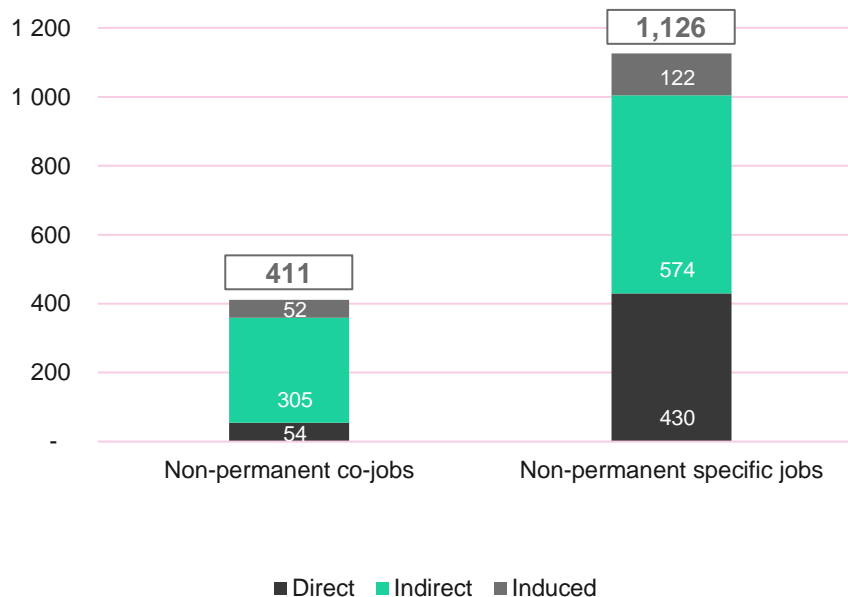


- Construction activities generate a lot of activity with suppliers and in particular the transformation of TERs, including **equipment supply** (engine, storage of BioNGV, control electronics, etc.). It **represents a large part of the activity generated**.
- BioNGV delivery and refueling, are not the blocks that generate the most activity in this sector
- The production of BioNGV makes it possible to achieve agricultural jobs demonstrating a good **distribution of jobs across different professional categories**
- The **managers and intellectual professions** are present in particular on all **study and engineering activities** linked to the transformation of trains in BioNGV but also to the establishment of BioNGV refueling stations or methanization units.
- Most of the jobs, especially **indirect**, are **workers**, because of the importance of **industrial activities** in the establishment of the BioNGV TER sector for the manufacture of equipments.

Of the non-permanent jobs, 73% are specific to the BioNGV against 10% only for all jobs

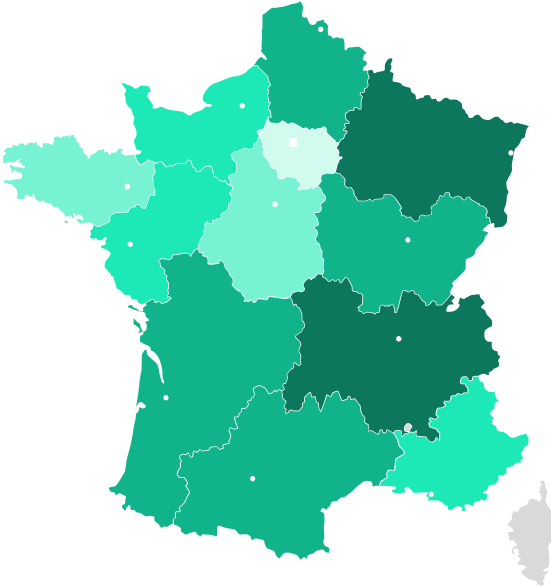
- The distribution between co -jobs and specific jobs is reversed on non-perennial jobs with **37 % of co -jobs** against **90% of co -jobs for all jobs generated**
- The co -non-perennial jobs are carried **only through the transformation of TER**
- Specific non-permanent jobs are carried by **three business segments** what are the construction of bunkering stations, the construction of anaerobic digestion units and the part specific to BioNGV of the transformation of TER:
 - **Construction of refueling stations** at BioNGV represent **69 FTEs in 2030** i.e. 6% of non-permanent jobs specific to the BioNGV railway
 - **The construction of anaerobic digestion units** represent **767 FTE** is 67 % of non-permanent jobs specific to BioNGV
 - **The retrofit TER** represented **291 FTE** i.e. 27% of non-permanent jobs specific to BioNGV

Broken down of non-permanent jobs by specificity (in FTE)

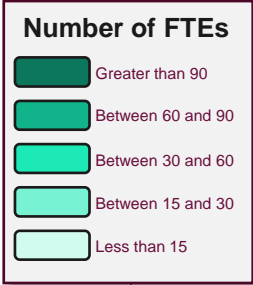
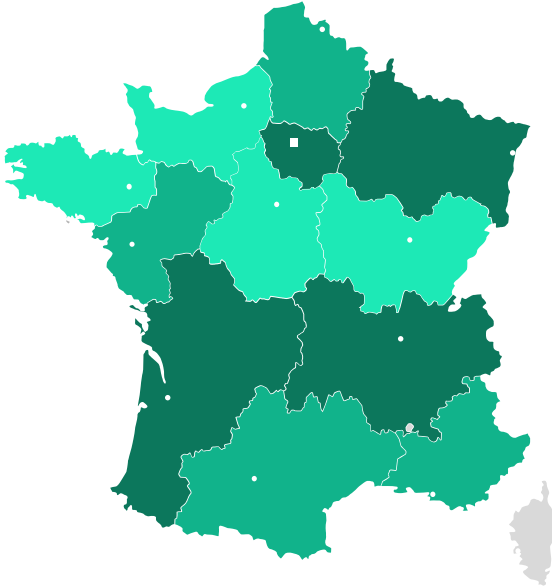


These direct jobs are concentrated in the regions that benefits from TER transformation workshops and diffused for the indirect.

Map of direct jobs linked to BioNGV railway, in 2030

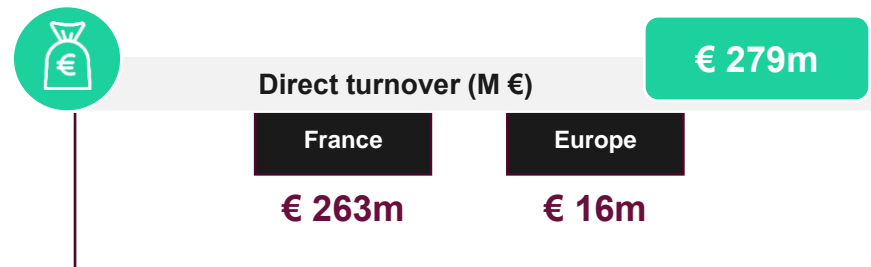
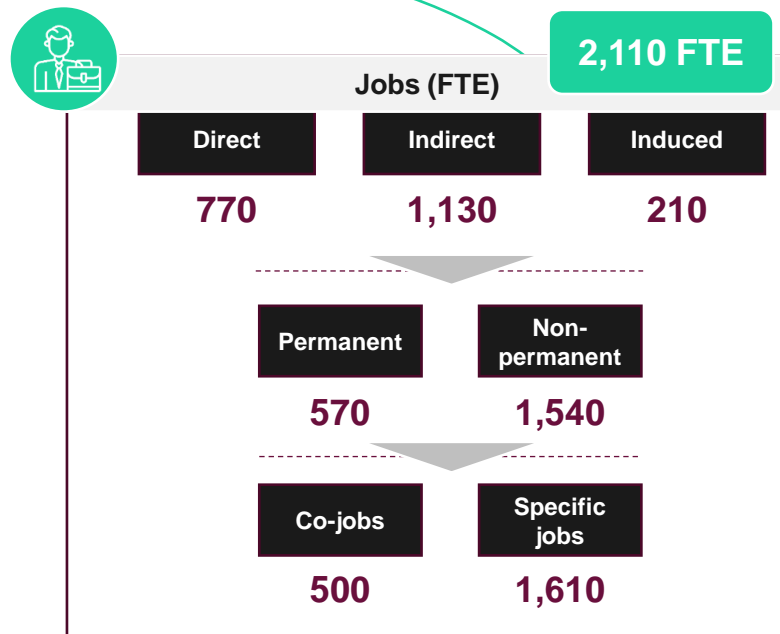


Map of indirect jobs linked to BioNGV railway, in 2030

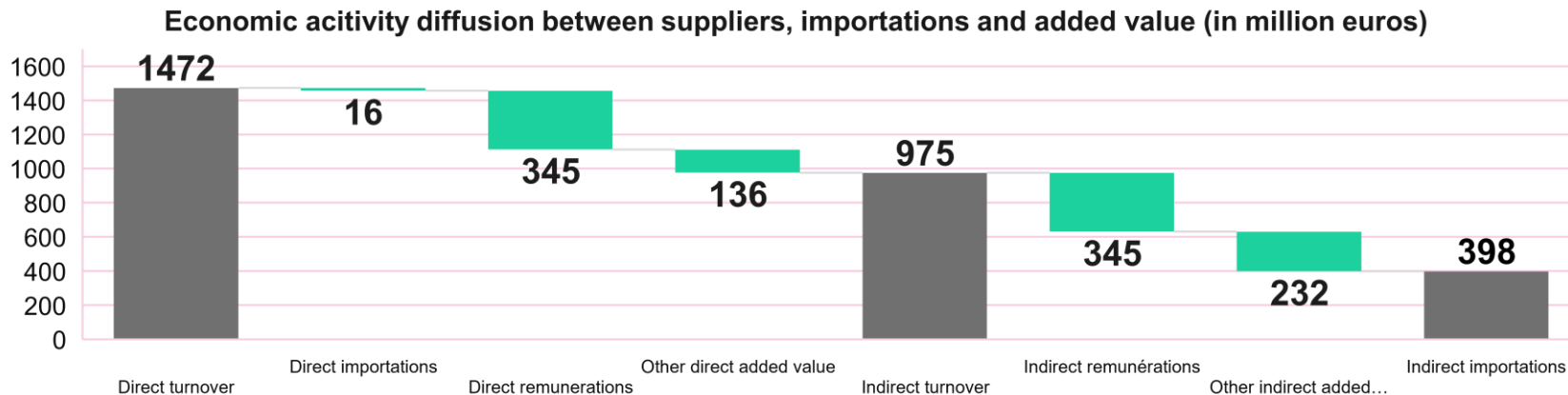


Indirect jobs are spreading over the territory in connection with the specializations of the regions. Regions with a strong industrial activity such as Hauts-de-France and Grand-Est benefit from this distribution. The Ile-de-France region, for its part, benefits from the concentration of digital companies, design offices and a large number of service companies as well as industrialists.

A small part of the direct activity is imported. These are the engines for BioNGV TER or compressors for fueling stations.



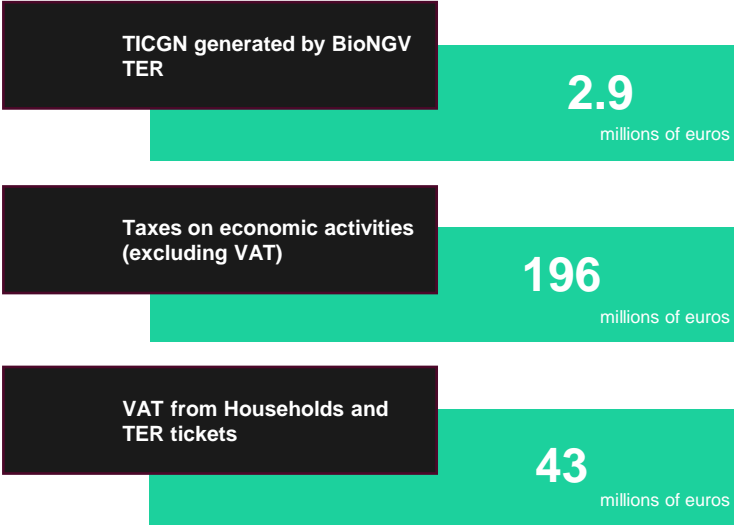
Of the 1,472 million euros of activity, 73% is distributed in the French economy. The rest is imports.



- The operation and maintenance of BioNGV TER represents **82% of turnover generated** by the BioNGV TER sector, generated in 100% on the French territory.
- Of the 279 million euros of direct activity remaining, only **a small part is imported** due to the absence, in France, of BioNGV engine manufacturers, conversion kit for motors or compressors for refueling stations.
- Engines at BioNGV are exclusively manufactured by **the German company MAN**, while the compressors are supplied by Italian and German companies.
- The BioNGV TER sector leads to a recourse to **the import of around 27% of direct activity**, mainly generated by providers.
- In France, the industrial sector uses **35% of imports** to meet the production needs of this sector (INSEE 2017).

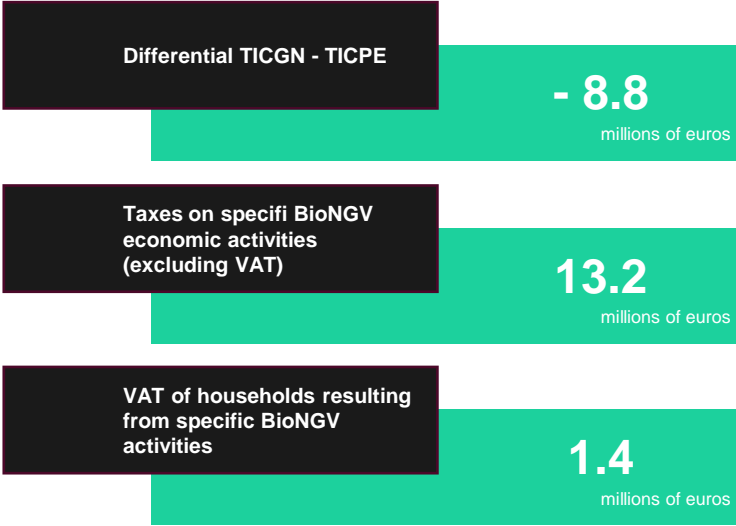
The losses linked to the TICGN - TICPE differential are offset by taxes on the additional activity generated by the BioNGV

All taxes generated by the activities studied in 2030



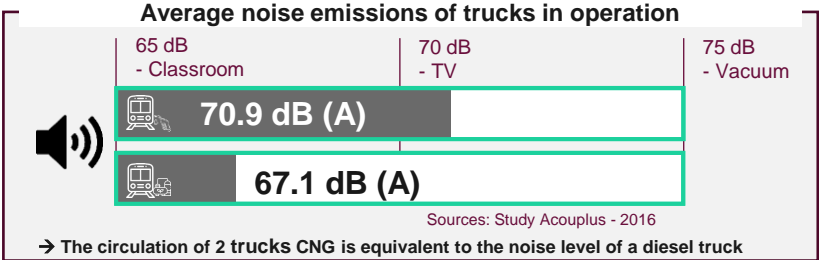
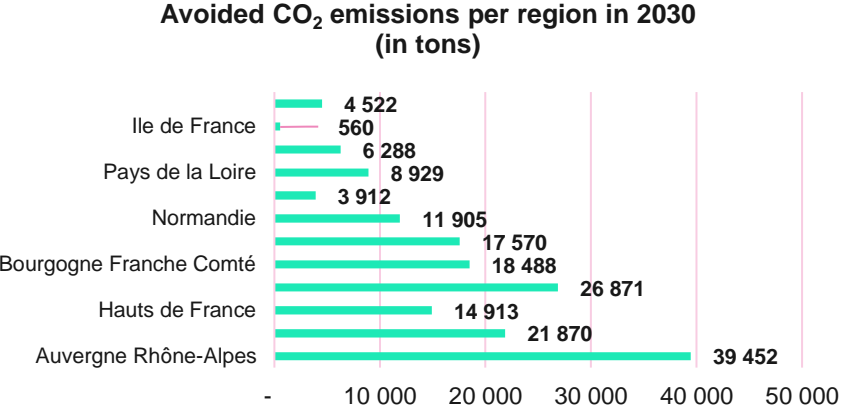
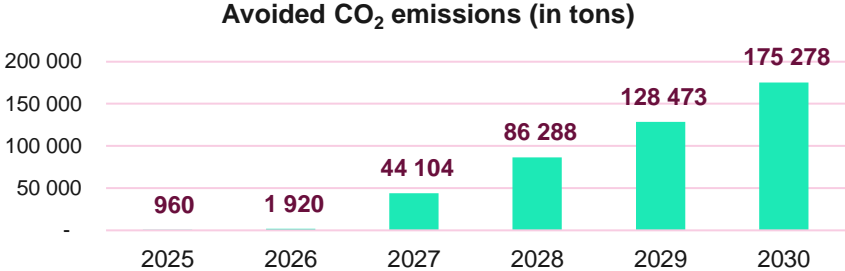
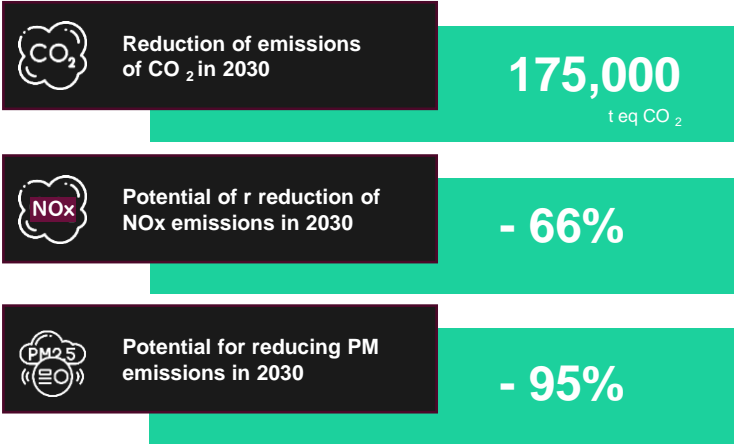
TOTAL + 241 million of euros

Net taxation of BioNGV railway in 2030



TOTAL + 5.8 million of euros

In 2030, the BioNGV TER will save 175,000 tons of CO₂ but also reduce local pollutant emissions by 95%





Catalytic Impact

Definition of the side effects of the BioNGV TER sector

The 3 identified side effects :

1 Railway jobs

The closure of a railway line can lead to the destruction of jobs around the operation, maintenance and modernization of rolling stock and infrastructure. This part attempts to assess this potential for maintaining jobs by setting up BioNGV TER.

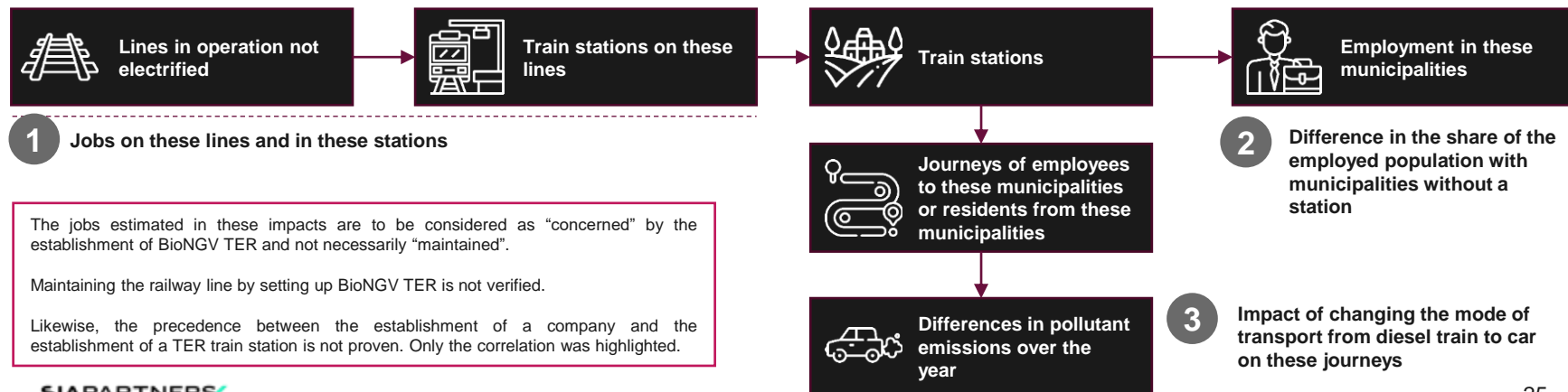
2 Other jobs

In addition, municipalities with a train station show a higher employment rate than municipalities without a station. The difference between these two types of municipalities can be understood as the development of local jobs made possible by the presence of a train station.

3 Environmental impact

Finally, people using the train will have to change their mode of transport to get to work if the line were closed, which would result in additional pollutant emissions related to the use of a car rather than taking a diesel train. This section estimates these emissions avoided by the implementation of BioNGV TER.

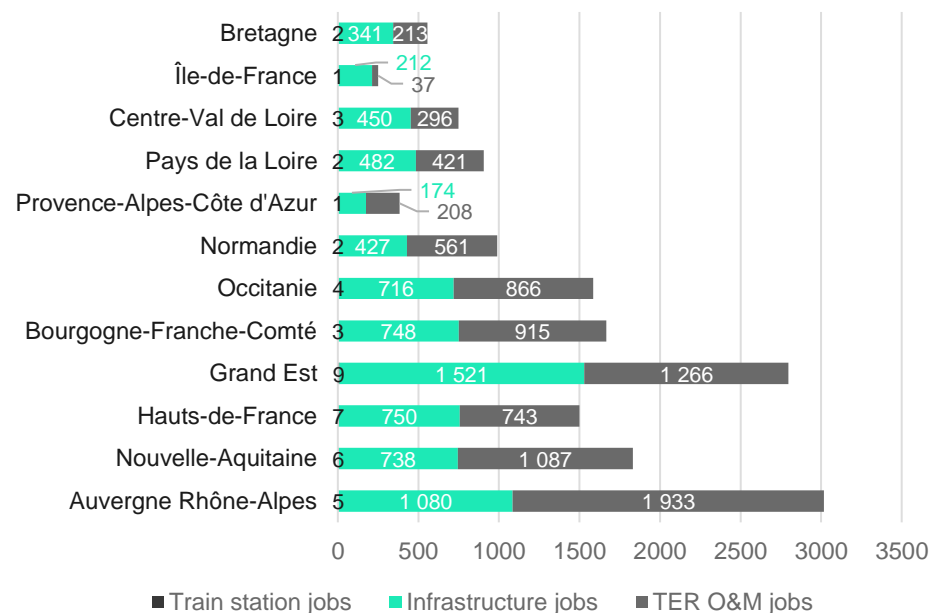
Stages of impact calculation:



Railway jobs concern the operation and maintenance of TERs as well as that of railway infrastructures allowing the circulation of TERs.



Geographical breaking down of railway jobs concerned by line closures (in FTE)



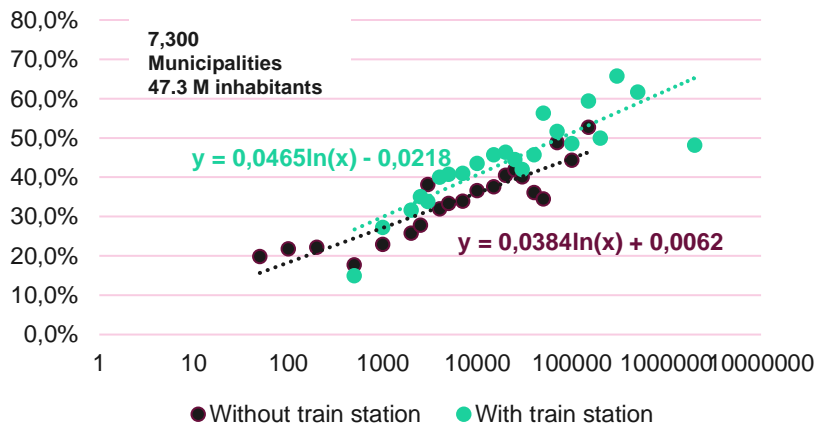
The presence of a train station in a municipality has a significant impact on the employment rate in the municipality of an urban or rural area.

Overall, the municipalities with a train station show a higher employment rate. Removing these stations could lead to the relocation of employment to a municipality with developed means of access. This correlation does not argue against the loss of a job but on the maintenance of local economic activity in the form of jobs.

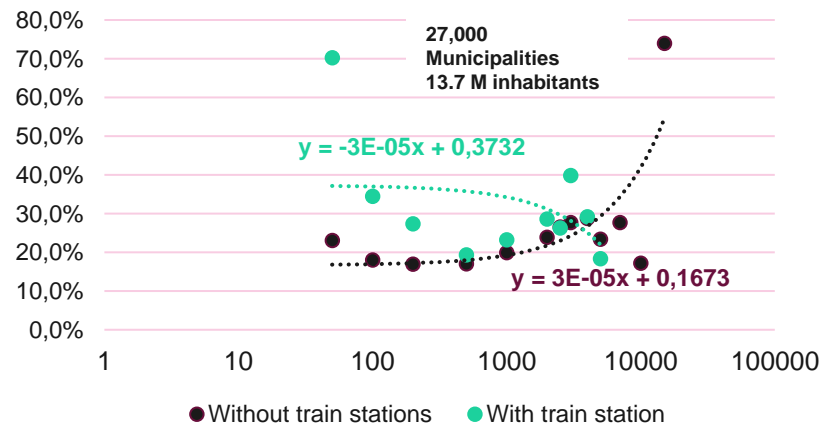
In urban areas, the more the size increases, the more the municipalities show a significant gap in terms of job location. For towns of more than 70,000 inhabitants, the smaller difference between employment rate is due to the fact that these towns are in large urban units served by other means of rail public transport than the TER (Boulogne-Billancourt, Montrouge, Neuilly-sur-Seine, Villeurbanne, etc.)

For municipalities outside of an urban area, the presence of a train station will have an impact on employment for the smaller municipalities more strongly than for the larger ones.

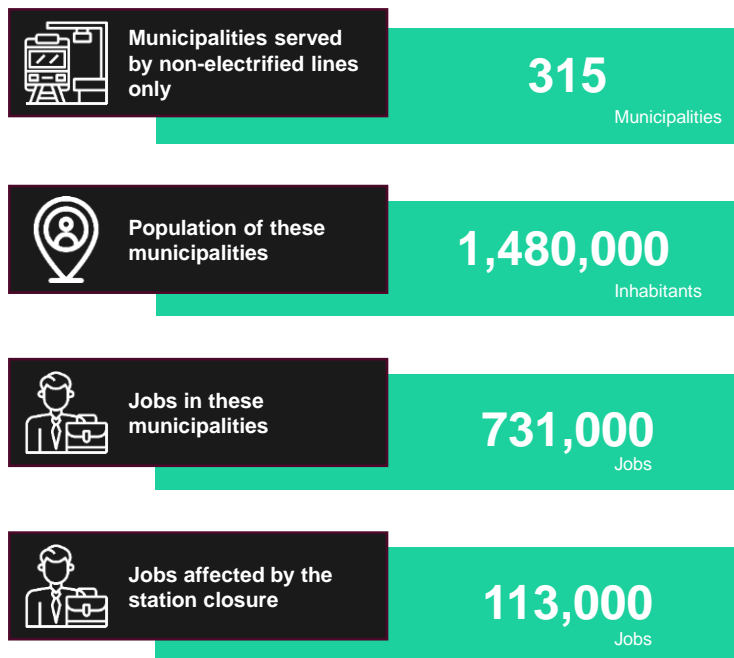
Comparison of employment rates in municipalities located in urban areas per population size



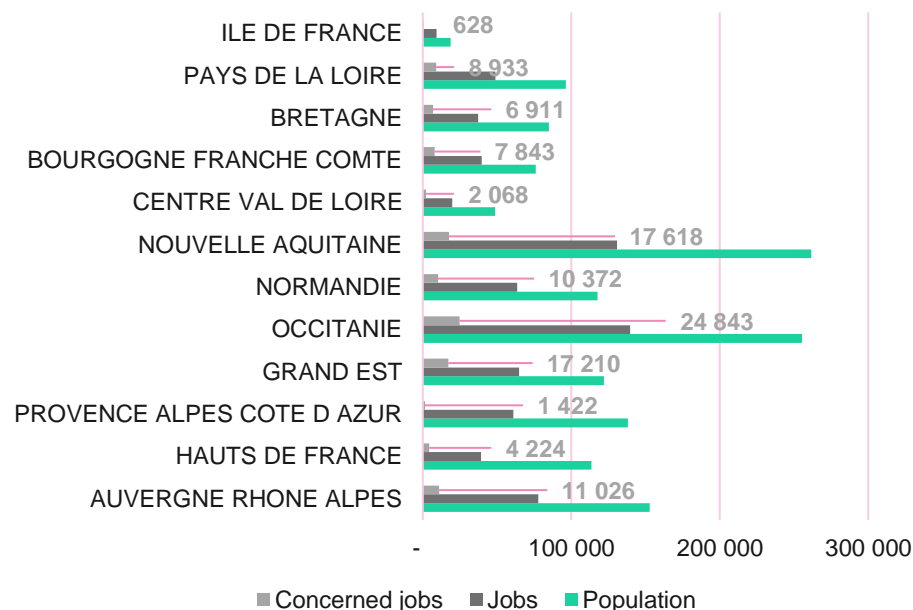
Comparison of employment rates in municipalities out of urban areas per population size



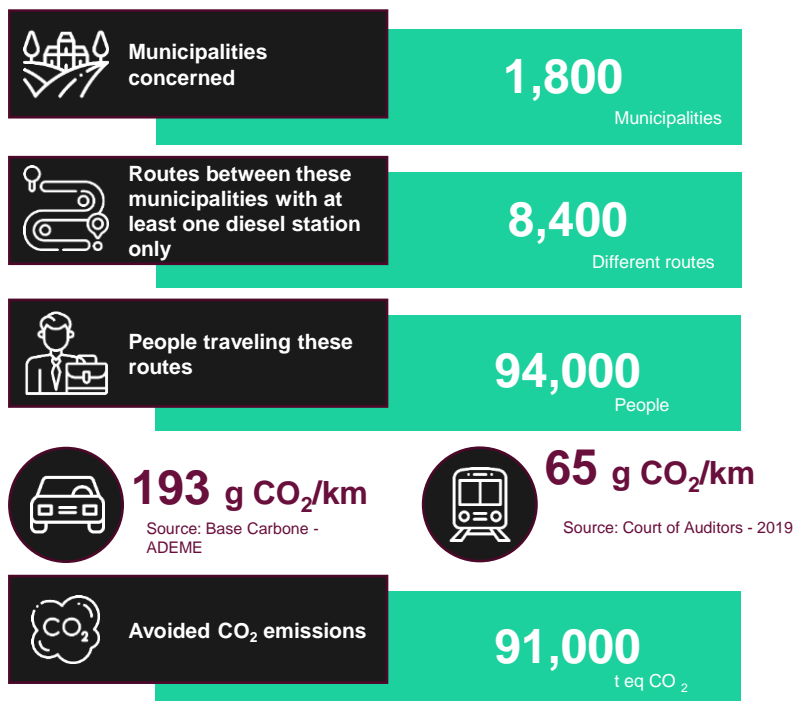
The closure of TER links in municipalities served by non-electrified lines only would affect nearly 113,000 jobs



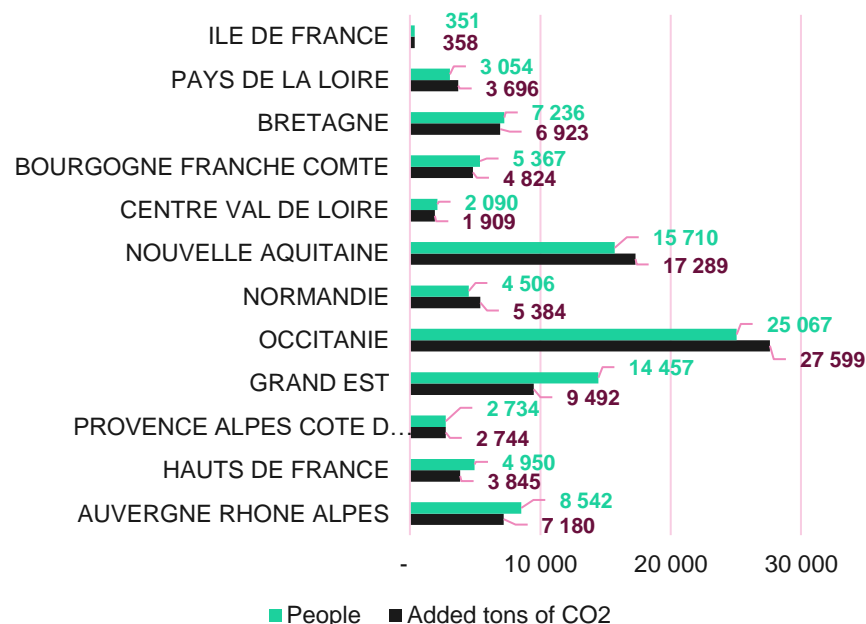
Geographical breaking down of impacts of train station closure in isolated municipalities



The closure of non-electrified links would entail the change of mode of transport for 94,000 people to get to their place of work, resulting in 91,000 t of CO₂ additional



Regionalisation of the environmental impacts of changing transport mode





Conclusion

Achieving CO₂ emissions reduction targets that the SNCF has set itself involves replacing the diesel engines in the TER, whether by converting these engines or renewing the fleet. The establishment of a BioNGV sector appears as a relevant short-term and low-cost solution to meet these objectives. This energy demonstrates the following strengths:

- Mature technology ready to be implemented on TER in the short to medium term
- 86% reduction in CO₂ emissions compared to diesel TER but also NOx and average particle emissions
- Savings of 55% on the fuel costs of a TER (65,000 euros per year) exceeding the additional costs of setting up the sector (220,000 euros per TER)
- Valorization of agricultural residues and other waste (household, industrial, agrifood, etc.) in a circular economy logic
- Production of a natural organic fertilizer (digestate), a by-product of anaerobic digestion which can be spread on agricultural land and thus replace chemical fertilizers
- Net job creation linked to the consumption of energy produced in France for engines very similar to diesel requiring little training for technicians
- Offers additional outlets to the anaerobic digestion sector which could create up to 50,000 jobs by 2030 in France



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