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Smart and Affordable Rail Services in the EU: a socio-economic and environmental study for High-Speed in 2030 and 2050

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Smart and affordable rail services in the EU: a socio-economic and environmental study for High-Speed in 2030 and 2050 – Technical Report 2

Executive summary

The modal shift of traffic to rail, from relatively more environmentally damaging modes, has been a key European transport policy topic in the last decades. High speed rail (HSR) in particular has been championed to spur this traffic shift. Consequently, the European Commission has set ambitious targets for the future levels of HSR traffic in Europe: a double of traffic by 2030 and a triple by 2050. Being predominantly present in western Europe, the current HSR network will be in need of an expansion of the network to in particular central and eastern Europe.

The market assessment (Technical Report 1) of this study showed the effects of an expansion of the HSR network to cover the entire Europe. An expansion of the network, while stimulating demand with the right policy and technology, would result in HSR demand increase considerably and acquiring the majority of the market share in its market of long-distance passenger transport.

This impact assessment (Technical Report 2) presents the impact of the network, policies and technological developments and the resulting traffic demand in the scenarios. By applying a Cost-Benefit Analysis (CBA) on the investment in constructing the networks, this report can conclude that an expansion of the HSR network and the introduction of other measures such as innovative railway technologies and competition in HSR market are likely to be highly beneficial to the European society. The HSR network is expected to yield a pecuniary benefit of € 400-447 billion for the 2030 scenario and € 561-836 billion in the 2050 scenario to the European society. The benefits would, hereby, outweigh the costs 5-10 times in the 2030 scenario and 2-4 times in the 2050 scenario. Moreover, the shift in traffic will greatly affect the CO2 emitted in the market for long-distance transport. In the 2050 scenario 5 billion t CO2 would be saved accounting for the infrastructure over the period under study.

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List of Abbreviations

B/C ratio	Benefit-Cost Ratio
CB	Costs and benefits
CBA	Cost-Benefit analysis
GDP	Gross Domestic Product
EU	European Union
EC	European Commission
ERTMS	European Rail Traffic Management System
EV	Electronic Vehicle
FUA	Functional Urban Area
HSR	High-speed rail
km	Kilometre
M	Million
MS	Member States
NPV	Net Present Value
pkm	Passenger Kilometre
UIC	International Union of Railways
UNECE	United Nations Economic Commission for Europe

1. Introduction

The European Commission (EC) has set out detailed targets for the future of High-Speed Rail (HSR) transport in its Sustainable and Smart Mobility Strategy, with the main objective to double HSR traffic by 2030 and triple it by 2050[1]. From a railway system perspective this can be enabled through either constructing new tracks or upgrading the current network by, for example, deploying European Rail Traffic Management System (ERTMS) on the network, as well as developing and purchasing new rolling stock. From a policy perspective, measures could be to stimulate competition or regulate the demand for competing modes. The European Union's (EU's) HSR policy stance is part of an overarching transport strategy: shifting more traffic onto rail.

The end goal of the EU's rail policies is to create a single European railway area, which allows for seamless travel for passengers and a barrier-free movement of goods across the EU. The creation of the single European railway area is spurred by regulatory measures such as the Railway Packages[2] and the Technical Specifications for Interoperability[3] which are harmonising the European railway systems and enabling considerable increase in railway traffic. In parallel with the EU's focus on promoting railway transport, several Member States (MS) are implementing measures to promote this mode of transport, such as the Rail Baltica[4] project connecting the Baltic MS by HSR and the initial planning for a brand new HSR network in Czechia[5] [6].

The rationale behind this objective is that rail transport has a smaller CO2 footprint, and it is overall more energy efficient. In terms of environmental impact, HSR emits considerably less CO2 than its competing modes[7]. Even once the emissions for constructing the infrastructure necessary to enable HSR transport and its direct emissions from operation over its lifetime are accounted for, HSR outperforms other modes[8]. Other studies estimate that the infrastructure emissions could be offset after 12 years due to traffic of passenger cars and aviation being shifted to HSR[9]. Moreover, HSR has created less noise pollution than the modes identified above[10].

Furthermore, HSR generates local economic benefits in addition to the environmental benefits. As an example, for the HSR Tours-Bordeaux High-Speed (HS) line it was estimated that it would generate 14,000 new jobs, 1.6 billion Euros

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[1] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (2020). *Sustainable and Smart Mobility Strategy – putting European transport on track for the future* {SWD(2020) 331 final}. Retrieved from EUR-Lex - 52020DC0789 - EN - EUR-Lex (europa.eu)

[2] European Commission (2022). Railway Packages. Retrieved from Railway packages (europa.eu)

[3] European Union Agency for Railways (2022). Technical Specifications for Interoperability. Retrieved from Technical Specifications for Interoperability | ERA (europa.eu)

[4] Rail Baltica (2022). *Rail Baltica – Project of the Century*. Retrieved from Rail Baltica Official Website | Rail Baltica

[5] Czech railway manager sets up high-speed rail unit | RailTech.com

[6] Both projects are included in the HSR network proposed and analysed in this study.

[7] International Union of Railways (2011). *High Speed Rail and Sustainability*. Retrieved from HSR_Sustainability_main_study_FINAL (apta.com)

[8] Tuchschmid, M., Martinetti, G. & Baron, T. (2011). *High Speed Rail: Fast track to Sustainable Mobility. Methodology and results of Carbon footprint*, International Union of Railways (UIC), Paris

[9] ADEME, RFF, SNCF (2009). *1er Bilan Carbone ferroviaire global*. Retrieved from Le bilan carbone de la LGV Rhin-Rhône.pdf (banquedesterritoires.fr)

[10] For more info see: see section 2.

in Gross Domestic Product (GDP) and 755 million in value added for the 3 regions covered by the line[11]. Other *ex post* assessments have estimated that HSR lines can increase regional GDP growth by 8,5% over six years compared to a scenario in which the HSR line is not built[12].

This report builds on the findings of the Technical Report 1, where a future European HSR network was mapped out (shown in figure 1). Applying the findings related to the specifications of the network and the passenger kilometres (pkm) travelled for the competing modes, this report assesses the impact of such networks on European society. As such, this report consists of a cost-benefit analysis of the HSR networks identified in Technical Report 1 and the related impact of the shifted traffic to HSR in terms of emissions, noise and similar[13]. This report, along with the Technical Report 1, is included in the final report and presentation.

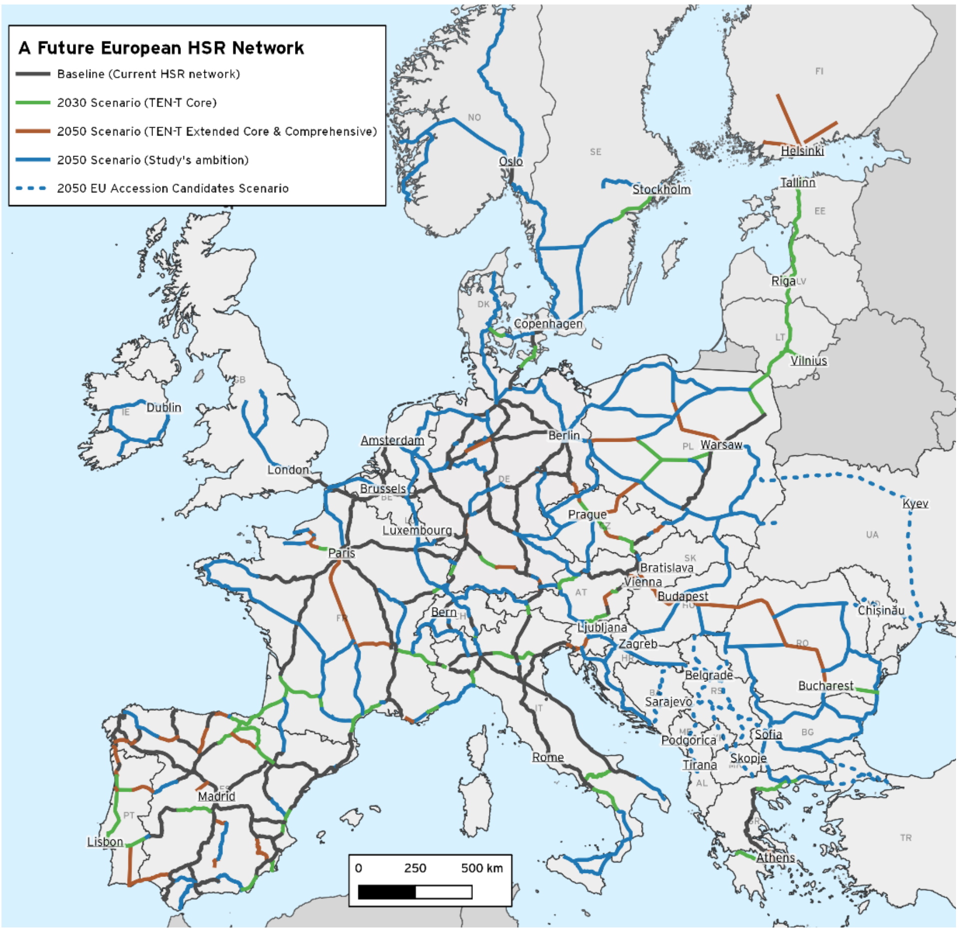

Figure 1: A Future European HSR Network[14]

[11] Fouqueray, E. (2016). Impact économique de la construction de la LGV SEA Tours-Bordeaux sur les régions traversées. *Revue d'Économie Régionale & Urbaine*, 2, pp. 385-416. Retrieved from https://doi.org/10.3917/reru.162.0385

[12] Ahlfeldt, G.M. & Feddersen, A. (2015). From Periphery to Core: Measuring Agglomeration Effects Using High-Speed Rail. *SERC Discussion Paper*, 172, p. 1-20, Retrieved from From Periphery to Core: Measuring Agglomeration Effects Using High-Speed Rail (repec.org)

[13] The report accounts for the external costs identified in the EU handbook on the External Costs of Transport.

[14] The 2050 scenario is split in two in the map: a brown denoting the TEN-T Extended Core and Comprehensive Network lines and a blue depicting the lines invented by the team to connect the major European cities.

The report addresses the subject matter in section 2 presenting the case for HSR and its positive impacts on society. Section 3 presents the methodological approach of the impact assessment including the main assumptions of the study. In Section 4 the focus then shifts on the findings of the impact assessment and the impact of the proposed HSR networks. Lastly, in section 5 the results are discussed, and from them, conclusions are drawn.

2. The case for HSR

Building a network of high-speed rail lines connecting the European continent would no doubt be a challenging, expensive and, overall, a monumental endeavour. Its geographical scope and high fixed costs prevent the private sector from fully funding the building of the infrastructure on its own. It is therefore important to explore what benefits citizens will enjoy by investing in such a transport system.

As the European Union faces secular stagnation, climate change, and struggles to prevent peripheral regions from drifting further apart economically, high-speed rail is a crucial instrument to help deal with each of these complex issues. Indeed, over the years, HSR has affirmed itself as a transport mode capable of providing a wide variety of positive externalities for society. This section will delve into the most relevant ones for the EU as a whole.

2.1 Labour mobility

Labour mobility, or lack thereof, has been recognised as a material obstacle to EU integration and shock absorption potential when compared to countries such as the United States. While part of it is due to cultural barriers, an increase in labour mobility can help Europeans overcome this impasse. The construction or improvement of transport infrastructure in itself decreases travel times and as they change, so do the spatial limits of the labour market. In turn, conventional neoclassical models, have shown that a reduction in regional disparities comes as a result of increased labour mobility (Guirao[15], 2017).

When housing prices are relatively high, workers tend to prefer commuting to wherever the productive capital is located instead of migrating (such is the case between former West and East Germany). Thus, improving labour mobility can address issues such as soaring rent prices and therefore inflation (Haas and Osland, 2014[16]). Moreover, it has already been shown that the building of HSR significantly improves accessibility from peripheral regions to larger cities, which enables more business communication and opportunities in the former (Wetwitoo and Kato, 2017[17]). It should be noted, however, that apart from construction effects, the available literature is not clear-cut on the impact of HSR on short-term effects on local productivity or long-term effects on the relocation of businesses and households and hence growth patterns. Economic effects of HSR may vary largely depending on factors such as city sizes, industry structures or distances from the periphery to the core (Blanquart and Koning, 2017).[18]

[15] Guirao, B., Lara-Galera, A. & Campa, J. L. (2017). High Speed Rail commuting impacts on labour migration: The case of the concentration of metropolis in the Madrid functional area. *Land Use Policy*, 66, pp. 131-140. Retrieved from https://isiarticles.com/bundles/Article/pre/pdf/87859.pdf

[16] Haas, A. & Osland, L. (2014). Commuting, Migration, Housing and Labour Markets: Complex Interactions. *Urban Studies*, 51 (3). Retrieved from https://journals.sagepub.com/doi/full/10.1177/0042098013498285

[17] Wetwitoo, J. & Kato, H. (2017). High-speed rail and regional economic productivity through agglomeration and network externality: A case study of interregional transportation in Japan. *Case Studies on Transport Policy*, 5 (4). Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S2213624X1730130X

[18] Blanquart and Koning (2017, p. 3) highlight that HSR may change the relative attractiveness of a region in the medium to long-term by driving businesses and households to relocate. However, the effects on the direction and growth remain uncertain and various. Whereas some studies point towards a polarization of economic activities in the city centers (be it because of the economic growth due to the HSR connection or because of the anticipated growth that attracts infrastructure investments), other studies highlight that HSR pushes relocation to the periphery and increases employment in rural areas to the detriment of the city centers (ibid., p. 9).

Heuermann & Schmiedera[19] (2018) further delve into the efficiency gains from reducing travel time and find that, in Germany, a decrease by one percent in travel time following the construction of a HS line raised the number of commuters between regions by 0.25%. This rise in commuter numbers was mainly the result of workers changing jobs from larger to smaller cities, which have become more easily accessible as a result of faster train connections. Finally, research from China's newly built HSR network shows that it provides the opportunity for potential sub-districts, especially those adjacent to regional core urban districts, to give rise to a horizontal and polycentric city network and promote regional integration (Xu et al.[20], 2019). This observation has been made, to a lesser extent, also in Europe, specifically in Spain (Shen et al.[21], 2016)

2.2 Emissions and energy efficiency

Being fully electric and possessing high energy efficiency per pkm efficiency due to its low rolling resistance, HSR represents the most sustainable mode of transport to connect European cities and citizens. Of course, provided a sustainable electricity production powering the rail network. Research such as that of Anderson[22]'s (2014) and De Xiao et al.[23] (2017) identify two channels through which HSR impacts emissions: a traffic substitution effect and an economic agglomeration effect. The substitution effect happens when travellers, who have the choice to travel via HSR, prefer it over more polluting alternatives. While agglomeration effects occurs due the reduced travel time between cities, effectively reducing the "distance" between cities.

Sun et al. (2020) and Li & Luo (2020) show that HSR helps curb pollution in cities located along the trains' route even during an economic expansion. Sun & Li[24] (2021) use a panel dataset of 274 cities in China from 2003 to 2016 to discover that the opening of HSR reduces emissions (2.4% on average), with this effect increasing over time.

Geurs & Van Wee[25] (2004) demonstrate that high-speed trains produce comparable emissions to cars and buses, yet even this calculation depends on the origin of the electricity consumed by the locomotive, with considerably lower emissions for renewable-powered trains. Recent trends, with for example the partnership

[19] Heuermann, Daniel & Schmieder, Johannes. (2019). The effect of infrastructure on worker mobility: Evidence from high-speed rail expansion in Germany. Journal of Economic Geography. 19. 335-372. 10.1093/jeg/lby019.

[20] Xu, J., Yhang, M., Yhang, X., Wang, D. & Yhang, Y. (2019). How does City-cluster high-speed rail facilitate regional integration? Evidence from the Shanghai-Nanjing corridor. *Cities*, 85, pp. 83-97. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0264275118305158

[21] Shen, Y., Zhao, J., de Abreu e Silva, J. & Martinez, L. M. (2016). Cross-City Comparison: Impacts of Madrid-Seville High-Speed Rail on Population Growth. *Urban Mobility Lab at MIT Conference Paper*. Retrieved from http://mobility.mit.edu/publications/2016/shen-cross-city-comparison-impacts-madrid-seville-high-speed-rail-population

[22] Anderson, M. L. (2014). Subways, Strikes, and Slowdowns: The impacts of public transit on traffic congestion. *American Economic Review*, 104, pp. 2763-96. Retrieved from https://www.aeaweb.org/articles?%20id=10.1257/aer.104.9.2763

[23] Xiao, D., Li, B. & Cheng, S. (2020). The effect of subway development on air pollution: evidence from China. *Journal of Cleaner Production*, 275. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0959652620341949

[24] Sun, L. & Li, W. (2021). Has the opening of high-speed rail reduced urban carbon emissions? Empirical analysis based on panel data of cities in China. *Journal of Cleaner Production*, 321. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0959652621031504

[25] Geurs, K. T., & van Wee, B. (2004). Land-use/transport Interaction Models as Tools for Sustainability Impact Assessment of Transport Investments: Review and Research Perspectives. *European Journal of Transport and Infrastructure Research*, *4*(3). https://doi.org/10.18757/ejtir.2004.4.3.4272

between Network Rail and EDF, indicate that partnerships between renewable energy providers and infrastructure managers will boost the transition towards zero well to wheel emissions HSR transport[26]. At the same time, Janić[27] (2016) estimates that average emissions by HS European train lies between 5.9 and 21 gCO2/s-km compared to cars' 120-140 gCO2/s-km. While a paper by Albate & Bel[28] (2010) confirms that high speed trains produce substantially less emissions than airplanes.

2.3 Productivity

Evidence from the economics literature points towards measurable increases in productivity following the building of high-speed rail lines. Investing in physical capital such a HSR infrastructure by itself increases capital per worker, increasing marginal returns to labour. At the same time, faster transport and a greater availability of it reduce the time cost of travel and fosters the sharing of knowledge and skills between individuals and firms. The increase in human capital, productive physical capital investment, and technological advancement contribute to long-term growth in productivity and hence GDP (Hayashi et al.[29], 2020).

In a research paper published in 2015, Ahlfeldt and Feddersen[30] find that following the construction of the high-speed rail line that connects Frankfurt am Main to Cologne, GDP rose by a total of 8.5% in the counties along the route when compared to a synthetic control of counties that were located elsewhere. The authors argue that the main channels of transmission of productivity to the peripheral regions operate through knowledge diffusion and labour market pooling, improved access to intermediated goods and consumer markets and, thus, Marshallian externalities[31].

Di Matteo et al. (2022) discovers that the building of the high-speed rail along the Milan-Bologna corridor increased the per capita value added (in the provinces connected by HSR) by 10%. Services and skilled manufacturing were the sectors most positively affected by the new infrastructure. Cascetta[32] et al. (2020) estimate that the building of 1'467 km of new high-speed lines in Italy decreased inequality and contributed to an increase in GDP per capita between 2.6% and (5.6% for areas located directly on the line) over ten years which, alone, far outweighed

[26] Network Rail (2022). *Network Rail signs solar power agreement with EDF Renewables UK in milestone step towards a clener and greener railway*. Retrieved from [Network Rail signs solar power agreement with EDF Renewables UK in milestone step towards a cleaner and greener railway - Network Rail]

[27] Janić, M. (2016). A multidimensional examination of performances of HSR (High-Speed Rail) systems. *Journal of Modern Transportation*, 24, pp. 1-21. Retrieved from https://link.springer.com/article/10.1007/s40534-015-0094-y

[28] Albalate, D. & Bel, G. (2010). *High-speed rail: Lessons for policy makers from experiences abroad*. Working Paper. Retrieved from https://www.ub.edu/irea/working_papers/2010/201003.pdf

[29] Hayashi, Y., Seetha Ram, K. E. & Bharule, S. (2020). Handbook on High-Speed Rail and Quality of Life. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3637158

[30] Ahlfeldt, G.M. & Feddersen, A. (2015). From Periphery to Core: Measuring Agglomeration Effects Using High-Speed Rail. *SERC Discussion Paper*, 172, p. 1-20, Retrieved from [From Periphery to Core: Measuring Agglomeration Effects Using High-Speed Rail (repec.org)]

[31] Business-enhancing factors that occur outside a company but within the same industry and geographical location.

[32] Cascetta, E., Cartenì, A., Henke, I. & Pagliara, F. (2020). Economic growth, transport accessibility and regional equity impacts of high-speed railways in Italy: ten years ex post evaluation and future perspectives. *Transportation Research Part A: Policy and Practice, 139*. Retrieved from https://www.sciencedirect.com/science/article/pii/S0965856420306510

the costs of building and maintaining the HSR. Similarly, Chen (2018) measures a 0.7% annual increase in Gross Regional Product (GRP) over a longer period of time.

HSR projects in East Asia also point towards a rise in productivity following the building of such infrastructure. In Japan, the earliest adopter of high-speed rail technology, both the share of HSR distance out of total trip distance and the share of HSR travel time out of total travel time have been proven to positively affect regional economic productivity, especially in peripheral urban areas (Wetwitoo and Kato[33], 2017). While in China, which currently has the longest and newest HSR network, Chen et al. (2016)[34] discover that the building of this infrastructure led to an 9.7% GDP growth over a ten-year period, while Yang et al.[35] (2019) find that the market access caused by HSR has had optimization effect on the resource allocation efficiency of both core cities and peripheral cities.

[33] Wetwitoo, J. & Kato, H. (2017). High-speed rail and regional economic productivity through agglomeration and network externality: A case study of interregional transportation in Japan. *Case Studies on Transport Policy*, 5 (4). Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S2213624X1730130X
[34] Chen, Z. (2018). Measuring The Long-Term Regional Economic Impacts of High-Speed Rail in China Using a Dynamic SCGE Model 1.
[35] Yang, X., Lin, S., Zhang, J. & He, M. (2019). Does High-Speed Rail Promote Enterprises Productivity? Evidence from China. *Journal of Advanced Transportation*, 2019. Retrieved from https://doi.org/10.1155/2019/1279489

3. Methodological approach

This section describes the methodological approach taken to assess the socio-economic impacts of the proposed HSR network of the market assessment presented in Technical Report 1. The methodological approach consists, mainly, of a cost-benefit analysis (CBA) of the proposed investment in the network, with additional features of estimating the CO2 emissions of the networks and the resulting traffic and lastly, the local economic benefits of HSR[36].

The output of the Technical Report 2 is the net benefits (in € and emissions saved) to the European society of the HSR network under a variety of measures and scenarios.

The study analyses the scenarios highlighted in Table 1 below. The shocks applied per scenario are described in detail in Technical Report 1-

Scenario	Description
Baseline (15.200 km)[37][38]	**Network comprised of lines in operation as per the revised TEN-T Network maps[39]** ▶ Includes dedicated HSR lines (250 km/h and above) and upgraded lines (200-250 km/h). ▶ There will be no infrastructure expansion for HSR or conventional rail. ▶ Infrastructure of other modes expected to increase in accordance with their forecasted demand increase, which means that the current use rates of the infrastructure of these modes will be conserved.
2030 scenario (20.500 km)	**Network comprised of lines in operation and lines to be completed as part of the Core TEN-T Network (by 2030)** ▶ Includes the baseline network and all lines with a scheduled finish date by 2030. Thus, the network in this scenario will be in operation by 2030. ▶ Includes dedicated HSR lines (250 km/h and above) and upgraded lines (200-250 km/h). ▶ Infrastructure expansion for other modes in accordance to demand increase. ▶ Additional population connected: ≈86 million.
2050 scenario (49.400 km)	**Network comprised of lines connecting all Functional Urban Areas (FUAs) (above 250.000 inhabitants) in Europe, in addition to the HSR lines forming part of the Extended Core TEN-T Network (2040) and the Comprehensive Ten-T Network (2050)** ▶ FUAs are defined as a city core and its commuting zone[40][41].

[36] The local economic effects have been estimated separately and has, hence, not been included in the results of the CBA. The CO2 emissions saved has been included both in the CBA alone as tonnes CO2 saved per pkm. This has been done to facilitate the comparison with the CO2 emissions of constructing the infrastructure.
[37] The length of the networks per scenario were measured using the Geographic Information System software, QGIS. Some differences with other sources may appear.
[38] Baseline forecast based on 2015 prices and 2% inflation rate.
[39] TEN-T Revision Council general approach: [Trans-European transport network: Council agreement paves way for greener, smarter and more resilient transport in Europe (europa.eu)]()
[40] Dijkstra, L., Poelman, H. & Veneri, P. (2019). The EU-OECD definition of a functional urban area. *OECD Regional Development Working Papers*, No. 2019/11. Retrieved from https://doi.org/10.1787/d58cb34d-en
[41] For a full list of the FUAs, see Appendix_all_fuas.pdf (oecd.org).

Scenario	Description
	▶ FUAs can either be departure and destination cities or stops along the line. FUAs are considered connected if a HSR line passes within a 20 km radius of the FUA. ▶ Lines will only be constructed as dedicated HSR lines with speeds of 250 km/h or above. ▶ Infrastructure expansion for other modes in accordance to demand increase. ▶ Includes planned lines not in the TEN-T Network such as HS2 in the UK. ▶ Population connected to the network: ≈216 million.
2050 EU accession candidate scenario (4300 km)	**Network comprised of a network connecting the main cities of the EU accession candidate countries** ▶ Lines will only be constructed as dedicated HSR lines with speeds of 250 km/h or above. ▶ Lines follow the current railway lines as per the TEN-T Interactive Map. ▶ Some lines, particularly in Serbia, will be completed before 2030. ▶ Assumed completed by 2050. ▶ Population connected to the network: ≈40 million.

Table 1: Overview of the scenarios[42]

3.1 Cost-benefit analysis

The CBA estimates the net benefits of constructing the HSR networks proposed by the study and the resulting passenger traffic. In essence, it compares the benefits in terms of travel time savings and external costs saved due to modal shift with the costs of constructing the HSR networks.

The socio-economic impact of the HSR network has been assessed in line with the European Commission's guidelines for CBAs on transport infrastructure[43].

The guidelines set out the following steps for the construction of the model:

- Baseline and policy scenarios.

Baseline and policy scenarios are set out in the market assessment presented in Technical Report 1. The scenarios are described in Table 1 above and in greater detail in the Technical Report 1.

To simulate future regulatory and technological developments, a series of shocks affecting the demand for passenger transport has been added. The results of the market assessment in pkm travelled per mode (and hereby the modal split) and the length of the HSR network (per scenario, until 2070) serve as the baseline for the CBA. The length of the period investigated in the study enables the estimation of

[42] An important disclaimer is to be made in relation to the 2050 scenario. The 2050 scenario includes (i) HS lines planned to be finalized after 2030 and (ii) additional HS lines envisaged by the study with the view to completing a comprehensive pan European HS network connecting all major EU cities. All lines in the 2050 scenario have been considered new construction, although some lines may be planned as upgrade of current lines.

[43] European Commission (2021). *Economic Appraisal Vademecum 2021-2027*. Retrieved from https://ec.europa.eu/regional_policy/sources/docgener/guides/vademecum_2127/vademecum_2127_en.pdf

the infrastructure's impact during most of its lifetime and for the effects to be seen as demand will pick up slowly rather instantly.

- Scope of costs and benefits associated with the project.

The costs and benefits related to the construction of HSR function within the framework of the EC's guidelines, the EC's handbook on the external costs of transport[44] and the EC's handbook on the costs of transport infrastructure[45]. Table 2 below presents an overview of the scope of the costs and benefits related to the HSR network and demand for passenger transport. The study has omitted the costs related to infrastructure maintenance since it operates under the simplifying assumption that track access charges are calibrated to offset the variable costs. The maintenance and operating costs, as well as the revenue per ticket sold, are therefore omitted for the other modes and all railway market participants (RUs, IMs etc.) as well.

HSR definition

This study applies the definition of Directive 2016/797 on the interoperability of the rail system within the European Union of what constitutes high-speed rail. Thus, HSR is defined as rail lines specifically equipped for speeds equal to or greater than 250 km/h and upgraded lines equipped for speeds in the order of 200 (200-250 km/h).

- Approach to quantification and monetisation of the impacts.

The cost and benefits have been monetised based on the estimations from the EC guidelines and handbook and are presented in further detail in the annex 1. The costs and duration of constructing a HSR line per KM are based on the European Court of Auditors review of the current HSR network[46] and the United Nations Economic Commission for Europe (UNECE) study on a Trans-European Railway High-Speed master plan study[47]. The ECA report has identified 10 HSR lines with an average cost of €10 M per KM, while the UNECE study assumes construction costs to be €12 M per KM. To account for any differences between initial and completion costs, this study assumes construction costs to be €16.5 M per KM[48]. A social discount rate of 4%, an 87% conversion factor for construction work and a residual value of 14% has been applied[49].

- Discount future costs and benefits to calculate the Net Present Value (NPV) and the benefit-cost ratio (B/C ratio).

[44] European Commission (2019). *EU Handbook on the external costs of transport*. Version 1.1. Retrieved from Handbook on the external costs of transport - Publications Office of the EU (europa.eu)
[45] European Commission (2019). *Overview of transport infrastructure expenditures and costs*. Retrieved from CE_Delft_4K83_Overview_transport_infrastructure_expenditures_costs_Final.pdf (cedelft.eu)
[46] European Court of Auditors (2018). *A European high-speed rail network: not a reality but an ineffective patchwork*. Retrieved from https://data.europa.eu/doi/10.2865/105814
[47] United Nations Economic Commission for Europe (2021). Trans-European Railway High-Speed Master Plan Study: Phase 2. Retrieved from 2017852_E_web_light+c1.pdf (unece.org)
[48] € 16.5 million per KM was also the completion cost per KM for the French LGV Est Européenne HSR line. See European Court of Auditors (2018). *A European high-speed rail network: not a reality but an ineffective patchwork*. Retrieved from https://data.europa.eu/doi/10.2865/105814
[49] European Commission (2019). *EU Handbook on the external costs of transport*. Version 1.1. Retrieved from Handbook on the external costs of transport - Publications Office of the EU (europa.eu)

Utilising the framework described above, the NPV and the B/C ratio are calculated. The two are defined as follows:

- The NPV is the difference between discounted total social benefit and social cost, valued at shadow prices, and is expressed in monetary values.
- The B/C ratio is the ratio between discounted economic benefits and costs.

For an economically viable project, the NPV must be positive while the B/C ratio must be greater than 1.

Category	Sub-category	Description
Costs	Capital costs	As a major infrastructure project, there are substantial capital costs associated with building a HSR network. The construction cost per km have been based on per km cost on previously completed HSR networks in the EU[50].
User impacts	Travel time	The decrease in travel times from expanding the HSR network will result in positive user impact as a result of the time savings for users switching to HSR from competing modes.
Societal impacts	Environmental impact	The impact on environmental outcomes: changes in greenhouse gas (GHG) emissions, air quality, and noise pollution. While these are considered to be 'non-tangible' impacts (i.e. there is no market price for any of these factors), a reduction in the incidence of any of these factors represents a welfare improvement for society.
	Safety	A mode switch is also likely to result in a change in the incidence of accidents, as rail is significantly safer than road. Any reduction in the number of transport-related accidents and fatalities therefore represents a welfare improvement for society.
	Congestion	The anticipated removal of a substantial amount of traffic volumes from the road, once HSR connections are operational, should have a positive impact on road congestion. This will have several benefits including reduction in journey cost and time for those who continue to travel by road as well as the associated external benefits (e.g. fewer GHG and local air quality emissions). The subsequent increase of rail traffic, on the other hand, isn't assumed to cause congestion negative externalities, thanks to the centralized traffic management on rail and the capacity of rolling stock and infrastructure.
	Noise	The noise of the given transport mode is included as well, measured in decibels. Noise emissions from transport has been a salient part of infrastructure investments and highly influential on public opinion.

Table 2: Overview of costs and external costs included in the study

[50] European Court of Auditors (2018). *A European high-speed rail network: not a reality but an ineffective patchwork*. Retrieved from https://data.europa.eu/doi/10.2865/105814

3.2 Local economic effects

The local economic effects of HSR are based on two *ex post* assessments of the effect of constructing and operating HSR lines[51].

The local economic effects of having an HSR line in operation for the given regions was identified by Ahlfeldt & Feddersen (2015) to be 8.5% GDP increase in comparison to having no HSR line operation. This increase was observed over a 6-year period. Similar studies for Italy have also found, although weaker, positive effects of HSR operations. Cascetta et al., (2020)[52] found that Italian national GDP per capita increased by 2.6% due to the operation of Italian HSR network, while areas directly located near the HSR network experienced up to 5.6% GDP par cap. growth. The local economic benefit has been applied to the FUAs and NUTS 3 regions covered by the proposed HSR networks and hereafter multiplied by the discounted factors for the following years. The GDP per FUA and NUTS 3 regions was sourced through Eurostat.

The regional economic effects of constructing a HSR network are based on the findings of Fouqueray (2016), for the HSR line between Tours and Bordeaux. The study estimates that the construction has generated 14,000 jobs, 1.6 billion Euros in production, and 755 million Euros in value added in the 3 regions involved in the construction. These findings are in line with previous estimations[53] [54] [55] [56]. The multipliers are 1,96 for production, 0,91 for Gross Value Added and 2,44 for jobs created. The jobs created has been rescaled to replicate the effects on jobs created by € 1 invested in the network. The effects per region was calculated by firstly, estimating length of the constructed HSR network per NUTS 3 region. Hereafter, the HSR line length per NUTS 3 region was multiplied with the construction costs per km. Last step was to multiply the construction costs per NUTS 3 region with the multipliers from above and 31%, which represents the share of the added value which had a direct effect in the region[57]. It should be noted that the economic effects of construction could be short-term and moreover have different effects on the regions covered by the network and the neighboring regions. To limit any additional assumption which may render the findings more uncertain, the study only focuses on regions directly covered by the HSR network i.e. regions where the HSR network runs through. The results are displayed for the entire EU but has been

[51] Ahlfeldt, G.M. & Feddersen, A. (2015). From Periphery to Core: Measuring Agglomeration Effects Using High-Speed Rail. *SERC Discussion Paper*, 172, p. 1-20, Retrieved from From Periphery to Core: Measuring Agglomeration Effects Using High-Speed Rail (repec.org)
Fouqueray, E. (2016). Impact économique de la construction de la LGV SEA Tours-Bordeaux sur les régions traversées. *Revue d'Économie Régionale & Urbaine*, 2, pp. 385-416. Retrieved from https://doi.org/10.3917/reru.162.0385
[52] Cascetta, E., Cartenì, A., Henke, I., & Pagliara, F. (2020). Economic growth, transport accessibility and regional equity impacts of high-speed railways in Italy: ten years ex post evaluation and future perspectives. *Transportation Research. Part A, Policy and Practice, 139*, 412 - 428.
[53] Wubneh, M. (2008). US Highway 17 and its impact on the economy of eastern North Carolina, *Report prepared for Highway 17 Association*, p. 48. Retrieved from https://www.wm.edu/as/publicpolicy/documents/prs/aed.pdf
[54] Lynch, T. (2000). Analyzing the economic impact of transportation project using RIMS II, IMPLAN and REMI, *Report prepared for the US Department of Transportation - Office of Research and Special Programs*, Retrieved from http://www.remi.com/uploads/File/Articles/article_339.pdf
[55] Cohen, I., Freiling T. & Robinson, E. (2012). The economic impact and financing of infrastructure spending, Report prepared for associated equipment distributors (AED), p. 49.
[56] Réseau Ferré de France (2010). Les retombées économiques et sociales du chantier, Les cahiers de la LGV Rhin-Rhône 1:60
[57] 31% is the estimation of the added value that was spent directly in the region as per the Fouqueray (2016) study.

estimated at regional level. This, admittedly, is a limitation in the estimations of the effect of the network. The limitation has been mitigated by applying different *ex post* assessment of the regional impact, both from different studies and for different regions, to act as a sensitivity analysis.

The estimation of local economic effects or wider economic effects[58] of large infrastructure projects are difficult to estimate correctly and as a result the findings are uncertain[59]. Moreover, when coupling the estimation of local economic benefits with a CBA there is a risk of double counting the effects[60]. Consequently, the local economic effects have not been included in the results of the CBA and will be presented individually by region and in total for the entire network[61].

3.3 CO2 emissions saved

The study includes the emissions of the transport modes as measured in CO2 in addition to the monetary value of the external costs. The emissions per transport mode accounts for both the emissions of the operation and the construction of the infrastructure. The emissions of the operation are measured in CO2 emitted per pkm and based on the emissions data of the CE Delft study on the external costs of transport and emissions for the construction of infrastructure from the International Union of Railways (UIC) study on the Carbon Footprint of High-Speed Rail.

The emissions related to the construction of the infrastructure covers the CO2 emitted over the entire lifespan of the infrastructure. The study hereby accounts for the emissions of the construction of airports, highways and HSR lines[62].

The study moreover assumes that alternative modes will limit their CO2 emissions in the future in tune with EC targets. For passenger cars and coach, it is assumed that the vehicle fleet gradually will become electrified reaching close to 100% electrification by 2050. This assumption is based on a ban on internal combustion engine cars being sold from after 2035 and then a 15-year period, where the vehicle fleet will be swapped out for Electric Vehicles (EV). For aviation it is assumed that starting 2040 short-distance hydrogen powered planes will start commercial operations and gradually account for most flights. The emissions for EVs and hydrogen planes are sourced through the EU handbook on the external costs of transport[63] and the International Council on Clean Transportation white paper on "Performance analysis of evolutionary hydrogen-powered aircraft"[64],

[58] This study applies local economic effects as it calculates at regional level. Other studies refer to the wider economic effects when estimations are carried out at a larger scale.
[59] Flyvbjerg, Bent (ed.), *The Oxford Handbook of Megaproject Management*, Oxford Handbooks (2017; online edn, Oxford Academic, 6 Sept. 2017).
[60] Hickman, R., Givoni, M., Bonilla, D. & Banister, D. (2015) *Handbook on Transport and Development*. Cheltenham, Edward Elgar.
[61] The limitations and uncertainties regarding the local economic effects are discussed in further detail in Annex 1.
[62] Infrastructure emissions are based on an estimation of the expansion of the infrastructure in the baseline as based on the demand.
[63] European Commission (2019). *EU Handbook on the external costs of transport*. Version 1.1. Retrieved from Handbook on the external costs of transport - Publications Office of the EU (europa.eu)
[64] International Council on Clean Transportation (2022). Performance Analysis of Evolutionary Hydrogen-Powered Aircraft. Retrieved from Performance analysis of evolutionary hydrogen-powered aircraft (theicct.org)

while numbers for EV registrations (used for the EV uptake) are sourced through ACEA[65].

Lastly, the energy mix delivering the electricity to power the trains (HSR and conventional rail) and charge the EVs have been assumed to decarbonise until net-zero emissions in 2050[66]. The energy mix for rail has been assumed to reach net-zero emissions in 2030 due to an increase in partnerships between energy providers and railway infrastructure managers[67][68].

[65] ACEA (2022). *Vehicles in Use Europe 2022*. Retrieved from https://www.acea.auto/files/ACEA-report-vehicles-in-use-europe-2022.pdf#page=14
[66] Based on the International Energy Agency's World Energy Outlook 2021 Net-Zero scenario. International Energy Agency (2021). *World Energy Outlook*. Retrieved from World Energy Outlook 2021 (windows.net)
[67] Network Rail (2022). *Network Rail signs solar power agreement with EDF Renewables UK in milestone step towards a cleaner and greener railway*. Retrieved from Network Rail signs solar power agreement with EDF Renewables UK in milestone step towards a cleaner and greener railway - Network Rail
[68] For a more detailed explanation see annex 6.

4. Findings

This section presents the findings of the impact assessment of the proposed HSR network and the applied shocks. The impact of the scenarios includes the NPV, B/C ratio, saved external costs and overall investments needed to realise the network. Moreover, the wider economic effects of the networks will be presented, and the CO2 emissions saved.

4.1 Financial benefits of the 2030 and 2050 scenarios

This section presents the main financial results of the investment in the HSR networks. It is presented both in the form of the net present value and the benefit/cost ratio[69]. Please note that the wider economic benefits are not included in the results below. Table 3 below presents the financial results with three different levels of construction costs.

While there is a wide gap between the demand for HSR in the 2030 and 2050 scenarios, the gap in net present value is not only minimal, but negative. Similarly, the benefit cost ratio is larger in the 2030 scenario. The results, which may seem surprising, are instead the logical consequence of building infrastructure which will yield benefits over a long timeframe. The scope of the model is only limited to a 2070 horizon, while the infrastructure will be viable, and hence yield benefits, for a much longer horizon.

The B/C ratio in the 2030 and 2050 scenarios are in addition both above 1. In the 2030 scenario the B/C ratio is 5-10 and in the 2050 it is 2-4. The investment in constructing a comprehensive EU-wide HSR network will yield a high B/C ratio. The high ratio could be due to this study applying a very long-term outlook, where the effects of both the new infrastructure and the emissions related to operation and construction for the modes in the HSR market. Secondly, the significantly lower external costs of HSR results in considerable net benefits over the projects as HSR acquires nearly half of the modal share in its market.

Construction costs (Avg.)	Scenario	Construction cost (bn €)	NPV (M€)	B/C Ratio
12 €M per KM[70]				
	2030	63	447.488	10
	2050	410	836.670	4
16.5 €M per KM[71]				
	2030	87	431.527	7,6
	2050	546	748.594	3
25 €M per KM[72]				
	2030	132	400.734	5
	2050	855	561.433	2

Table 3: Financial results of the CBA

[69] Explained in the methodology section.
[70] Based on the construction costs in United Nations Economic Commission for Europe (2021). Trans-European Railway High-Speed Master Plan Study: Phase 2. Retrieved from 2017852_E_web_light+c1.pdf (unece.org)
[71] € 16.5 million per KM was also the completion cost per KM for the French LGV Est Européenne HSR line. See European Court of Auditors (2018). *A European high-speed rail network: not a reality but an ineffective patchwork.* Retrieved from https://data.europa.eu/doi/10.2865/105814
[72] Average final construction costs audited by the ECA in European Court of Auditors (2018). *A European high-speed rail network: not a reality but an ineffective patchwork.* Retrieved from https://data.europa.eu/doi/10.2865/105814

The NPV and B/C ratio are summarised in the table 3 above. In total, the construction of the 2050 scenario would cost € 410-855 billion. In comparison the total current European highway network has had an estimated cost of € 638 billion[73] in construction costs.

Although it has not been included in the models of the study, the investment in constructing the HSR network and the consequent economic impact of the construction and operation will benefit the railway sector as a whole. It would benefit railway market actors such as rolling stock manufacturers and railway equipment suppliers, in terms of added jobs and revenue[74].

Figure 2 and 3 below depicts the evolution of the externalities saved for the 2030 and 2050 scenario due to the modal shift in traffic to HSR. It has to be noted that fewer shocks are applied in the 2030 scenario than the 2050 scenario. Hence, why more external costs are saved in figure 3 and why the kinks appear greater in figure 2.

In the 2030 scenario (Figure 2) two main events stand out. Firstly, the completion of the 2030 scenario network in 2030 leads to increased saved external costs due to the traffic shift. Secondly, around 2040 an increase in the highway toll is applied increasing the saved external costs considerably.

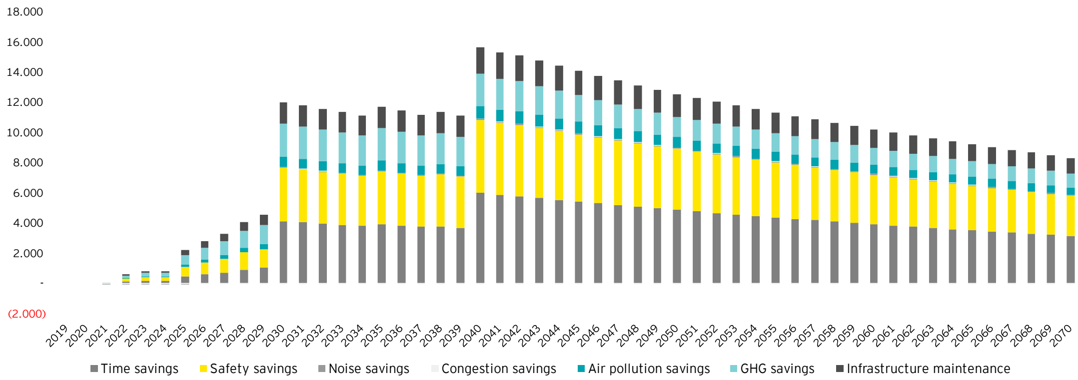

Figure 2: Externalities saved in M € - 2030 scenario

In the 2050 scenario (Figure 3) the construction of the HSR infrastructure and its related effects are visible through the increase in saved external costs from 2036 and forward. Notably, the increase in HSR traffic and decrease in demand for competing modes leads to considerable time savings. The decrease from 2040 and onwards is both due to the increasing modal share of HSR and the gradual decarbonization of the transport system.

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[73] Total highway length was 74970 km in 2019 according to the UNECE and the cost per km of highway on average € 8.5 million according to the French Conseil général des Ponts et Chaussées and Contrôle général économique et financier.
[74] Microsoft Word - RDG Benefits of the railway upgrade plan final (raildeliverygroup.com)

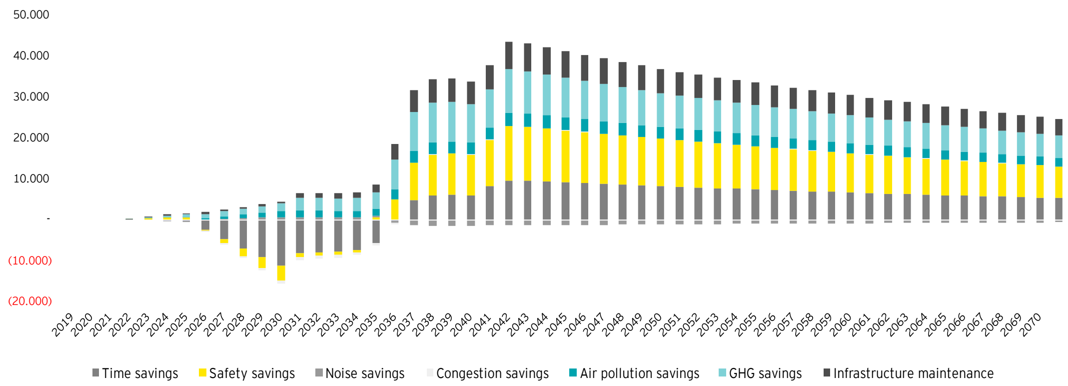

Figure 3: Externalities saved in M € - 2050 scenario

4.2 Wider/local economic benefits

This section will present the wider/local economic benefits of the construction of the HSR networks and operation of HSR services on the network once construction has been completed. The methodology behind the estimations is explained in greater detail in the methodological section above. The results are shown in a range due to the uncertainty highlighted in the methodological section. In addition, a range (70% effect and 130% effect) for the multipliers have been used for the construction and two different estimations on the effect of operations. Table 4 below highlights the total wider economic effects per scenario[75].

Scenario	Incremental production from construction (€ BN)[76]	Incremental GVA from construction (€ BN)[77]	Incremental job-years from construction ('000)	Incremental GVA from operations (€ BN)[78]
2030 scenario	20 (-30%) 29 (100%) 38 (+30%)	9 (-30%) 13 (100%) 17 (+30%)	264	115-174
2050 scenario	130 (-30%) 184 (100%) 238 (+30%)	60 (-30%) 85 (100%) 110 (+30%)	1549	313-484

Table 4: Total wider economic effects per scenario

While there is a considerable difference in the results based on the multipliers applied, it remains clear that the return on investment in the HSR networks will outweigh the construction costs greatly. The results below are summed up from all the local economic effects per NUTS 3 region and the first row depicts the results of the two scenarios together. As can be witnessed by table 4 the 2030 and 2050

[75] Sum up from the estimations per NUTS 3 region.
[76] 100% based on Fouqueray, E. (2016). Impact économique de la construction de la LGV SEA Tours-Bordeaux sur les régions traversées. *Revue d'Économie Régionale & Urbaine*, 2, pp. 385-416. Retrieved from https://doi.org/10.3917/reru.162.0385. The two other serve as a range of 70% or 130% of the impact.
[77] Same as above.
[78] High range based on Ahlfeldt, G.M. & Feddersen, A. (2015). From Periphery to Core: Measuring Agglomeration Effects Using High-Speed Rail. *SERC Discussion Paper*, 172, p. 1-20, Retrieved from From Periphery to Core: Measuring Agglomeration Effects Using High-Speed Rail (repec.org) and low range based on Cascetta, E., Cartenì, A., Henke, I., & Pagliara, F. (2020). Economic growth, transport accessibility and regional equity impacts of high-speed railways in Italy: ten years ex post evaluation and future perspectives. *Transportation Research. Part A, Policy and Practice, 139*, 412 - 428.

scenario are estimated to create around 1.8 million job-years due to construction of the network scenarios.

4.3 CO2 balance of the scenarios

This section presents the impact in terms of CO2 emissions of the study's scenarios. As can be seen from the figures below and the accompanying figures in annex 3, the increased shift to HSR in the 2030 and 2050 scenarios and conventional rail from aviation and passenger cars coupled with a rapid decarbonization of the power supply for rail, will be key in decarbonizing the transport market in which HSR competes. A total of 1.5 billion t CO2 will be saved in the 2030 scenario while the 2050 scenario will save a total 5 billion t CO2 as compared to the baseline by 2070, where aviation and passenger cars will increase their modal shares.

Figure 4 below depicts the net saved CO2 emissions in the two scenarios as compared to the baseline[79]. As can be seen the emissions from infrastructure will be greatly offset by the traffic shifted to HSR. The parts where the graph flattens indicates when the infrastructure is constructed. The construction of the 2030 scenario would emit 13 M tonnes CO2 and the 2050 Scenario 63 M tonnes CO2 over the period of the study[80].

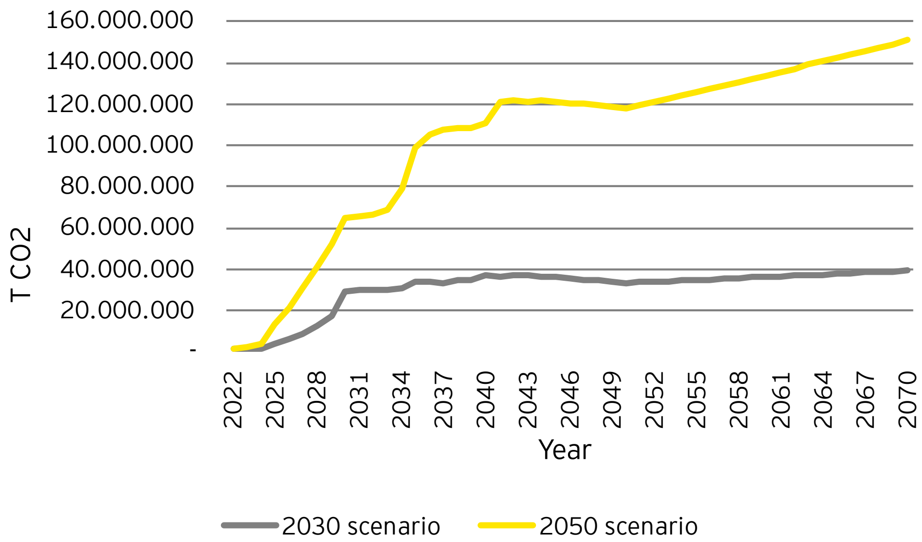

Figure 4: CO2 emissions and pkm per scenario for all modes

Figure 5 below provides an insight into the benefits of the 2050 scenario as compared to the 2030 scenario as it delivers a more CO2 efficient transport market. By 2070 there will be travelled 54.500 pkm per T CO2 emitted while it is 16.400 t CO2 in the 2030 scenario and 12.000 in the baseline.

[79] At 58 t CO2 per km per year for HSR construction. At 200 t CO2 per km per year, a total of 4.87 bn t CO2 would be net saved in the 2050 scenario and 1.48 bn t CO2 in the 2030 scenario.
[80] At 58 t CO2 per km per year for HSR construction. At 200 t CO2 per km per year, a total of 48 m t would be emitted in the 2030 scenario and 211 m t CO2 in the 2050 scenario.

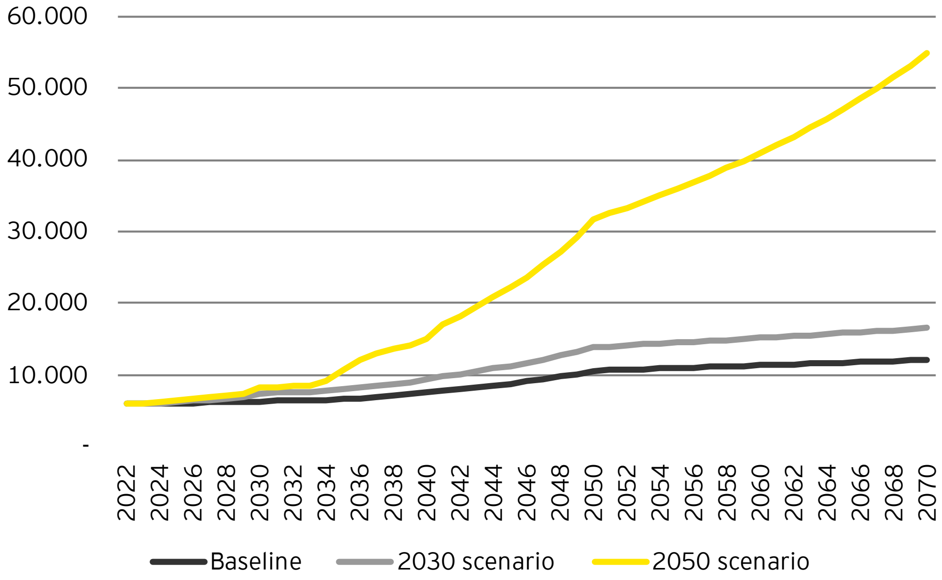

Figure 5: pkm travelled per T CO2 emitted (per scenario) for all modes

5. Conclusion

This section will provide a conclusion of the impact assessment of the future HSR networks.

The Technical Report 2 has assessed the impact on the European society of constructing a new and extended HSR network in Europe (presented in Technical Report 1). The impact assessment was carried out for the four network scenarios: a baseline where the current HSR network would not be extended; a 2030 scenario of the lines currently under construction estimated to be complete by 2030, a 2050 scenario connecting all European FUAs and an extended 2050 scenario which connects the EU accession candidate and potential candidate countries. The impact assessment was carried out by performing a CBA of the investment in the HSR network. In addition, the impact assessment estimated the net emissions saved from the construction and mode shift and lastly, the local/wider economic benefits of the construction and operation of the HSR networks.

To recap, the market assessment (Technical Report 1) showed that HSR traffic would account for the majority of traffic by 2070 for the 2050 scenario. The increased traffic and modal share of HSR, as a result of the extended network and the demand shocks, would provide substantial benefits to the European society. The benefits arise as a result of the highly efficient functionality of HSR as compared to other modes of transport. These benefits are linked to HSR having considerably lower externalities such as low CO2 emissions, air pollution, noise, while being a safe mode of travel for the passengers. Hereby, a modal shift to HSR will be paramount in combatting climate change and meet the climate targets of the Paris agreement and the European Commission.

If realized, the two scenarios will result in a significant amount of saved CO2 emissions. ***The 2030 scenario will save a total of 1.5 billion tonnes CO2 by 2070 while the 2050 scenario will save a total of 5 billion tonnes CO2 by 2070***, still accounting for the embedded CO2 emissions of constructing the HSR network. The traffic shifted to HSR will result to a substantial amount of saved external costs, which witnessed by the positive NPV and B/C ratio makes the investment in the HSR networks highly cost-effective. **The 2030 and 2050 will respectively yield a pecuniary benefit of € 400-447 billion and € 561-836 billion to the European society. This means that the 2030 scenario will yield benefits 5-10 times the costs and the 2050 scenario 2-4 times the costs of the HSR network.** As a result, this study can conclude that investing in the construction of a comprehensive European HSR network, while implementing sound policies and deploying the next generation of railway technologies is expected to be highly beneficial to the European society and economy. Moreover, the HSR network will come to the benefit of the entire world due to the substantial tonnes of CO2 saved.

Future research should focus on expanding the structural models created by EY and academic researchers and test new shocks and scenarios. The possible inclusion of other variables and timeframes and the use of suitable econometric estimation methods can further increase both the plausibility and the accuracy of the models. Any future HSR lines should in addition be accompanied by its respective appraisal.

6. Annex

Annex 1: Limitations of the study

Uncertainties are related to the estimates of costs and benefits in this study are built on the results of other reports and assumptions that jointly contribute to a level of uncertainty around the CBA results. Overall conducting appraisals of large construction projects is difficult and estimations of the costs and benefits are often over and underestimated, respectively. The overestimation of costs has been partly taken into account by providing the results at different avg. costs per km based on *ex post* construction costs. The economic benefits of construction or operations have inherent uncertainties since it's difficult to single out the effect of construction or operation from other factors which have an effect on economic indicators. This has to some extent been taken into consideration by sensitivity testing by applying different estimations of economic effects. Moreover, there are uncertainties related to monetising the externalities of transport[81]. Lastly, given this study's European geographical scope it has been difficult to take into account local specificities which may affect the results. Hence, more detailed studies per country are suggested.

Annex 2: Table of external costs (on avg.) of transport. CE Delft (2019)

	Passenger Transport											
	Road						Rail			Aviation*		
	Pass car - petrol	Pass car - diesel	Pass car - total	Bus	Coach	MC	High speed Train	Electric tot pax	Diesel tot pax	Short - passenger	Medium- passenger	Long-passenger
Cost category	€-cent/pkm	€-cent/pkm	€-cent/pkm	€-cent/pkm	€-cent/pkm	€-cent/pkm	€-cent/pkm	€-cent/pkm	€-cent/pkm	€-cent/pkm	€-cent/pkm	€-cent/pkm
Accidents	4,5	4,5	4,5	1,0	1,0	12,7	0,1	0,5	0,5	0,04	0,01	0,00
Air Pollution	0,33	1,18	0,71	0,8	0,7	1,12	0,00	0,01	0,80	0,30	0,13	0,06
Climate	1,2	1,1	1,2	0,5	0,4	0,9	0,0	0,0	0,3	2,39	1,85	2,24
Noise	0,5	0,6	0,6	0,4	0,2	9,0	0,3	0,8	1,4	0,46	0,11	0,01
Congestion	4,2	4,2	4,2	0,8	0,8	0	0	0	0	0	0	0
Total	**11,6**	**12,4**	**12,0**	**3,7**	**3,5**	**24,5**	**1,3**	**2,6**	**3,9**	**4,26**	**2,81**	**3,22**

* *average of 33 EU airports*

Table 5: External costs of transport. CE Delft 2019

Annex 3: Externalities included in the study

Externalities are referred to as "the effect of production or consumption of goods and services imposing costs or benefits on third-parties which are not reflected in the prices charged for the goods and services being provided"[82]. In the context of transport, six types of externalities are considered: climate, air pollution, noise, accidents, infrastructure wear, time savings linked to road congestion.

Climate Impact. Due to the fact that the effects of climate change are global, long-term and have risk patterns that are difficult to anticipate, identifying the costs associated with these effects is rather complex. Transport results in emissions of

[81] For a full discussion see the EU Handbook on External Costs in footnote 77.
[82] OECD (2021). *Glossary Of Industrial Organisation Economics and Competition Law*. Retrieved from https://www.oecd.org/regreform/sectors/2376087.pdf

CO_2, N_2O and CH_4 (methane), all of which are greenhouse gases contributing to climate change. Therefore, the climate costs of transport need to be included[83].

Air Pollution. The emission of air pollutants can lead to different types of damages. Most relevant and probably best analysed are the health effects due to air pollutants. However, other damages such as building and material damages, crop losses and biodiversity losses are also relevant.

- **Health effects**. The inhalation of air pollutants such as particles (PM_{10}, $PM_{2.5}$) and nitrogen oxides (NO_x) leads to a higher risk of respiratory and cardiovascular diseases. These negative health effects lead to medical treatment costs, production loss at work (due to illness) and, in some cases, even to death.
- **Crop losses**. Ozone as a secondary air pollutant (mainly caused by the emission of NO_x and VOC) and other acidic air pollutants (e.g. SO_2, NO_x) can damage agricultural crops. As a result, an increased concentration of ozone and other substances can lead to lower crop yields (e.g. for wheat).
- **Material and building damage.** Air pollutants can mainly lead to two types of damage to buildings and other materials: a) pollution of building surfaces through particles and dust; b) damage of building facades and materials due to corrosion processes, caused by acidic substances (e.g. nitrogen oxides NO_x or sulphur oxide SO_2).
- **Biodiversity loss.** Air pollutants can lead to damage to ecosystems. The most important damages are the acidification of soil, precipitation and water (e.g. by NO_x, SO_2) and the eutrophication of ecosystems (e.g. by NO_x, NH_3). Damages to ecosystems can lead to a decrease in biodiversity (flora & fauna) [83].

Noise Pollution. Traffic noise is generally experienced as a disutility and is accompanied by significant costs. Noise emissions from traffic pose a growing environmental problem due to the combination of a trend towards greater urbanisation and an increase in traffic volumes. Whilst the increase in traffic volume results in higher noise levels, the increase in urbanisation results in a higher number of people experiencing disutility due to noise. As a result, the costs of traffic noise are expected to grow in the future despite potential noise-reducing improvements in vehicles, tyres and roads[83].

Accidents. Accidents occur in all forms of traffic and result in substantial costs, consisting of two types of components: material costs (e.g. damages to vehicles, administrative costs and medical costs) and immaterial costs (e.g. shorter lifetimes, suffering, pain and sorrow). The EU Handbook on External Costs of Transport has laid out monetary value of each life, light injury and serious injury alike that occurs and modelled this as € per pkm for each transport mode. This is thus taken as the most adequate source[83].

Congestion. Congestion is a condition where vehicles are delayed when travelling. In particular, a congestion cost arises when an additional vehicle reduces the speed of the other vehicles of the flow and hence increases travel time. Road congestion

[83] European Commission (2019). *EU Handbook on the external costs of transport*. Version 1.1. Retrieved from Handbook on the external costs of transport - Publications Office of the EU (europa.eu)

cost can be defined on the basis of a speed-flow relationship in a given context, for example at an urban or inter-urban level[84].

Infrastructure wear. The cost of infrastructure wear is not covered in the EU Handbook on External Costs of Transport, although it is covered in the socio-economic Impact of the Transport Sector by the Swedish Transport Administration[85]. It is defined as deterioration of infrastructure and is directly related to maintenance costs. There is a non-negligible difference between modes in their footprint on the general infrastructure that is maintained with public funds[85]. While the study assumes the infrastructure maintenance covered by track access charges for railway actors, it includes infrastructure maintenance costs at modal level.

Annex 4: Shocks applied per scenario

The table below presents the shocks applied per scenario. A more detailed description can be found in Technical Report 1.

Shock	Baseline scenario	2030 Scenario	2050 Scenario
Infrastructure (HSR)	0	1	1
Competition (HSR and rail)	0	0	1
Aviation fuel tax	0	0	1
Aviation ticket tax	0	1	1
Short Haul flight ban	0	0	1
Gasoline price increase	0	1	1
Shared Mobility	0	0	1
Bus Liberlization	0	0	1
Impact of S2R technologies	0	0	1
Highway tolls	0	1	1

Table 6: Shocks included in the model scenarios

[84] Externality descriptions taken from European Commission (2019). *EU Handbook on the external costs of transport*. Version 1.1. Retrieved from [Handbook on the external costs of transport - Publications Office of the EU (europa.eu)](#)

[85] Swedish Transport Administration (2020) *ASEK - Guidelines for cost-benefit analysis in the transport sector* https://www.trafikverket.se/for-dig-i-branschen/Planera-och-utreda/Planerings--och-analysmetoder/Samhallsekonomisk-analys-och-trafikanalys/asek-analysmetod-och-samhallsekonomiska-kalkylvarden/ (retrieved from IMPACT-2)

Annex 5: CO2 emissions from operations in the three scenarios

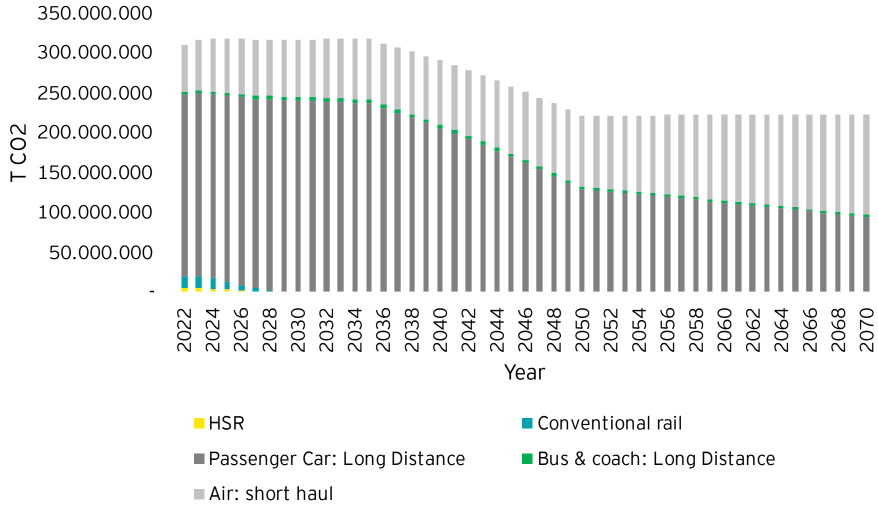

Figure 6: Baseline - CO2 emissions in t CO2 (operations only)

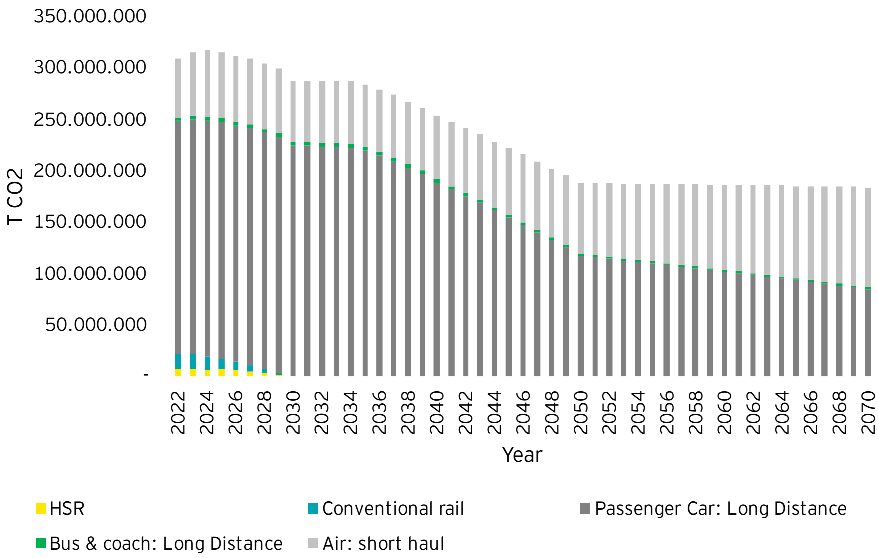

Figure 7: 2030 - CO2 emissions in t CO2 (operations only)

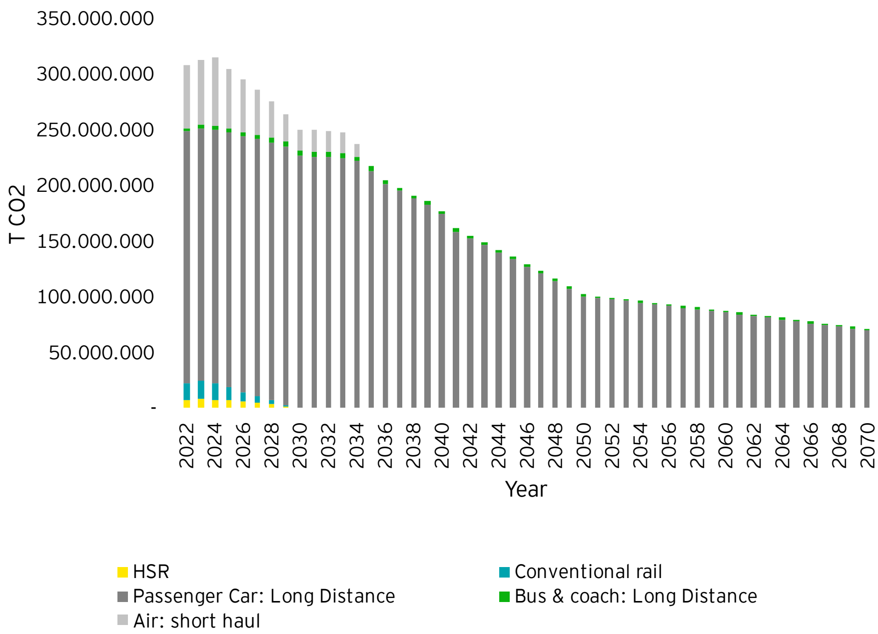

Figure 8: 2050 - CO2 emissions in t CO2 (operations only)

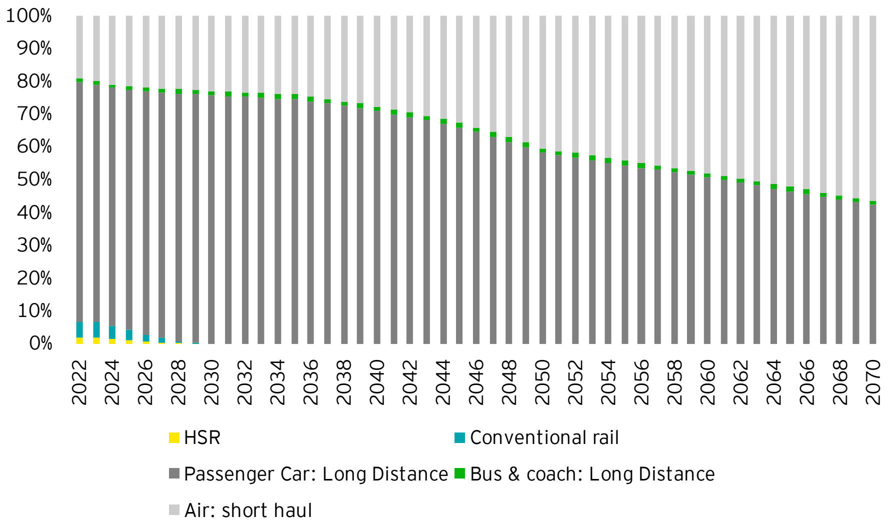

Figure 9: Baseline - CO2 emissions share per mode

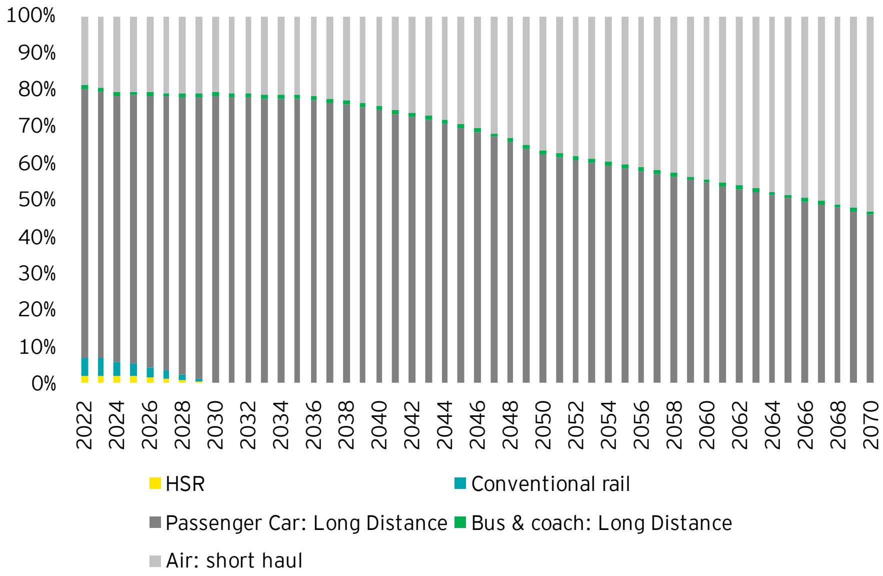

Figure 10: 2030 - CO2 emissions share per mode

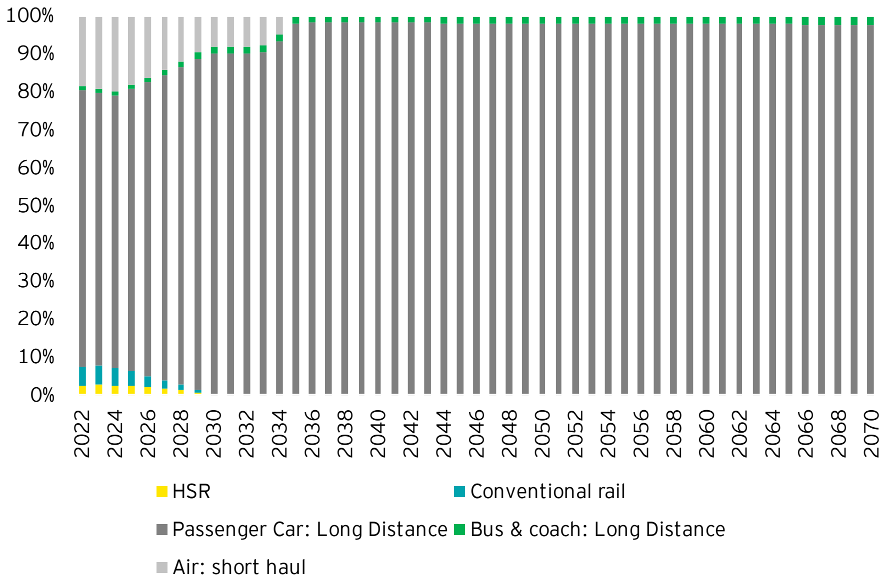

Figure 11: 2050 - CO2 emissions share per mode

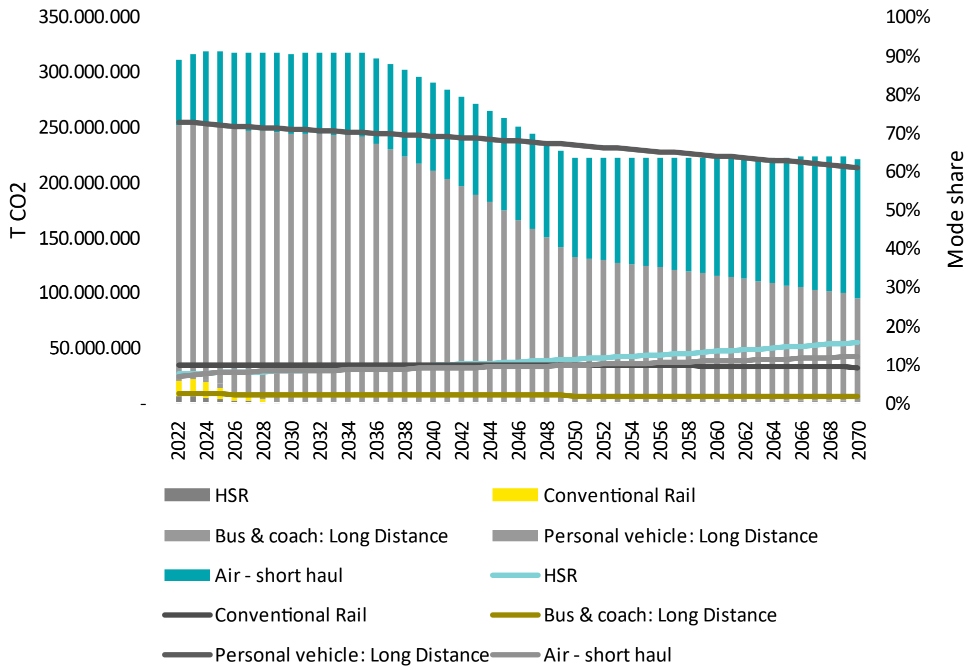

Figure 12: T CO2 emitted per mode and its modal share - Baseline

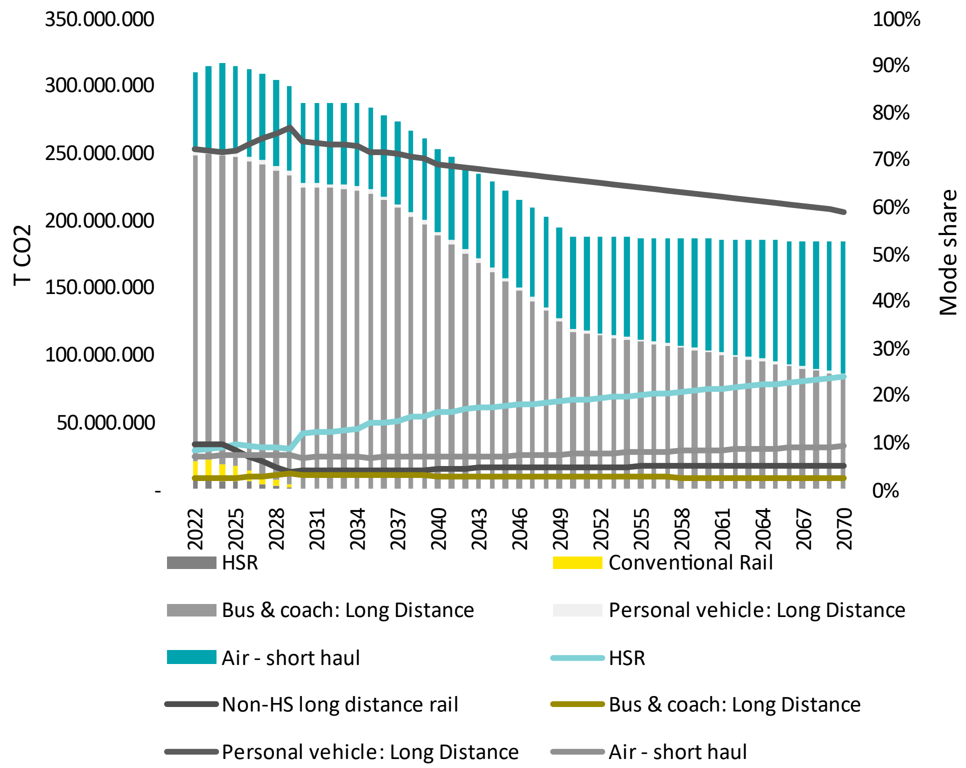

Figure 13: T CO2 emitted per mode and its modal share - 2030 scenario

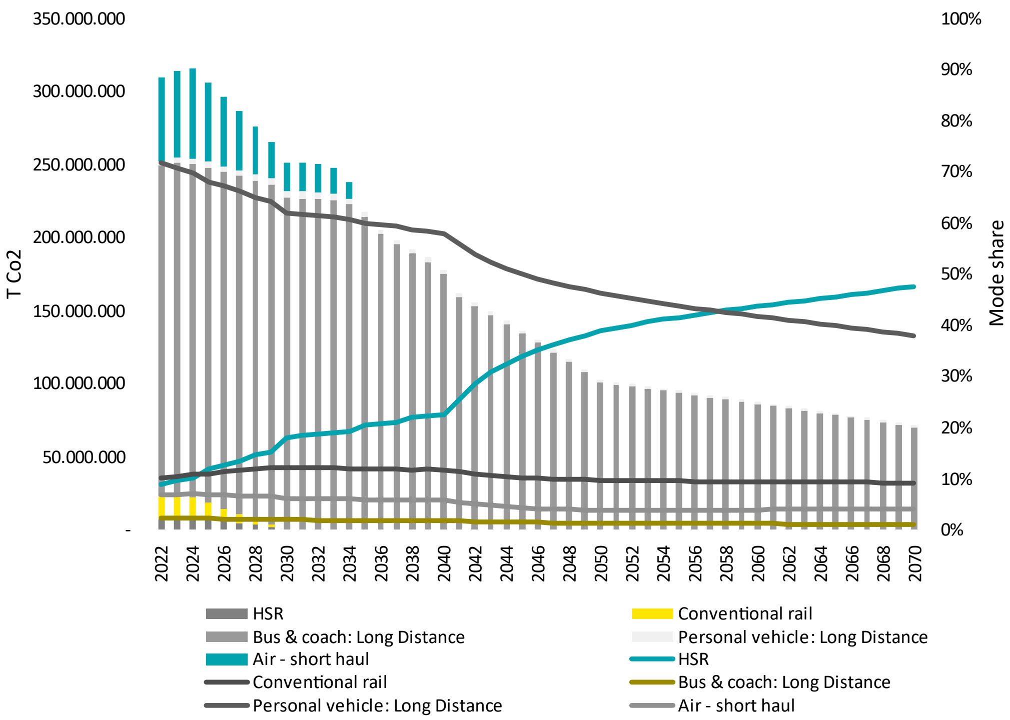

Figure 14: T CO2 emitted per mode and its modal share - 2050 scenario

Annex 6: Cost assumptions of the study

This section breaks down the assumptions on the costs of constructing the HSR lines.

Maintenance costs: The study assumes that operators run at equilibrium (between cost and revenue) and that track access charges are efficiently set to offset maintenance costs. Nevertheless, the CBA includes the infrastructure maintenance savings over the period of the study. Thus, infrastructure maintenance is included at macro level but not micro level.

Construction costs: The construction of HSR lines is cost-intensive due to requirements of the infrastructure in terms of earthworks and construction of tunnels or bridges. The construction cost assumption applied for this study is based on previous studies and assessments of the construction of HSR networks.

Greenfield costs denote the costs associated to the construction of entirely new HSR lines, where no rail tracks have been constructed prior. The greenfield construction includes everything from planning to earthworks and the construction of tunnels and viaducts. This study applies the costs identified in two previous studies: the European Court of Auditors report on a HSR network[86] and the UNECE

[86] European Court of Auditors (2018). *A European high-speed rail network: not a reality but an ineffective patchwork*. Retrieved from https://data.europa.eu/doi/10.2865/105814

study on Trans-European HSR network[87]. The ECA report has identified 10 HSR lines with an average cost of €10 M per KM, while the UNECE study assumes construction costs to be €12 M per KM. To account for any differences between initial and completion costs, this study assumes construction costs to be €16.5 M per KM.

Annex 7: CO2 emissions calculations and assumptions

The assumptions regarding the CO2 emissions from the different transport modes have been based on the CE Delft study on the external costs of transport[88].. The study both include the emissions from the production of energy (well-to-tank) and the operation of the modes (climate change, CO2 emissions), which was done to account for any emissions related to the energy mix and hereby the emissions of powering electric transport.

The energy mix (well-to-tank) has been assumed to gradually decarbonize over time as based on the forecast of the International Energy Agency in their World Energy Outlook 2021[89]. The energy mix needed to power electric vehicles is thereby assumed to be net zero by 2050. Based on the recent trend in partnerships between energy providers and infrastructure managers, it has been assumed that the energy mix for rail will be CO2 net-zero as of 2030[90] [91].. The delay in decarbonisation the energy mix of EVs is due to the larger supply of energy needed to power the future EV fleet in Europe.

The CO2 emissions related to the construction of the HSR network are based on a study of the UIC on the Carbon Footprint of HSR[92]. The study estimated the CO2 embedded emissions of HSR construction (entire construction phase including planning) over the 100 years lifetime of HSR infrastructure. The construction and maintenance of HSR lines has been estimated at emitting 58 t CO2 per km per year while an additional sensitivity analysis have been made for 200 t CO2 per km per year. The emissions depend greatly on the course of the lines. Additional bridges, tunnels and earthwork increase the CO2 emissions significantly. The two emission estimates (58 t and 200 t) hereby reflect a low and high estimate.

The study has, moreover, included estimations on the future CO2 emissions from constructing the other modes infrastructure (airports and highways). Future infrastructure construction was modelled after the forecasted demand

[87] United Nations Economic Commission for Europe (2021). *Trans-European Railway High-Speed Master Plan Study: Phase 2*. Retrieved from 2017852_E_web_light+c1.pdf (unece.org)
United Nations Economic Commission for Europe (2017). *Trans-European Railway High-Speed Master Plan Study: Phase 1*. Retrieved from TatlasER_High-Speed_Master_Plan_Study.pdf (unece.org)
[88] European Commission (2019). *EU Handbook on the external costs of transport*. Version 1.1. Retrieved from Handbook on the external costs of transport - Publications Office of the EU (europa.eu)
[89] International Energy Agency (2021). *World Energy Outlook 2021*. Retrieved from World Energy Outlook 2021 (windows.net)
[90] Network Rail (10 August 2022). *Network Rail signs solar power agreement with EDF Renewables UK in milestone step towards a cleaner and greener railway*. Retrieved from Network Rail signs solar power agreement with EDF Renewables UK in milestone step towards a cleaner and greener railway - Network Rail
[91] Moreover, studies indicate that even when decarbonizing the energy mix, the negative externalities of EVs are higher than for rail, see Boulouchos, K. & Ducrot, V. (2022). The Swiss experience to support modal shift Performance-based road-charging and efficient rail infrastructure. *The CER Essay Series.* Retrieved from CER Essay_SBB_FINAL.pdf
[92] International Union of Railways (2011). *Carbon Footprint of High Speed Rail*. Retrieved from HSR_Sustainability_carbon_footprint_FINAL _5_ (dot.gov)

developments in the baseline scenario. Meaning that the forecasted increase in demand for road and aviation will elicit an expansion in infrastructure capacity.

For road transport the following approach was applied: Based on a regression of Eurostat data on highway length in Europe and the increase in pkm in the same time period (2011-2019), it was estimated that a total of 14.375 lane-km of highway will be constructed until 2070. Lane-km was chosen as studies suggest that widening the existing highway network is more likely then extending the current length of the network[93]. The CO2 emissions from constructing one lane-km of highway has been set at 43 tons of CO2 per year[94].

For aviation: The expansion of the main European airports has been estimated in similar fashion. Based on airport extensions of the largest European airports in the last 20 years[95] and the historic data on passenger carried from Eurostat, it was estimated that there would be 22 runway expansions by 2070 to follow the increased demand. The CO2 emissions related to expanding an airport are based on data from the assessment of an extension of London Gatwick Airport, which estimates a total of 3.016.218 tonnes of CO2 emitted in the 60-year appraisal period[96].

Annex 8: Assumptions of the study

This section will briefly present and discuss the main assumptions applied in the study. These assumptions aim at simplifying the already complicated process of estimating long term market evolutions and calculating the subsequent economic and socioeconomic costs and benefits. The main idea is to present a case for high-speed rail as a holistic purpose, where the society (represented by different public institutions) decide to actively opt in favour of HSR (through infrastructure investment and policies and reaps the corresponding benefits).

- No capacity constraints on the network.

To simplify the models of the market and impact assessment, the study assumes that there are no capacity constraints on the HSR network. Given that the 2030 and 2050 scenarios will be entirely new construction on dedicated HSR lines there will be more capacity than in the baseline, where certain lines are shared with freight and conventional rail.

The next four assumptions are all based on the underlying consideration that, according to regulation[97], European railway undertakings will operate in an open market. This means that the theoretical rules that apply for open market competition can be applied here:

- Railway undertakings operate at equilibrium between revenue and costs.

[93] Ossokina, I.V., van Ommeren, J. & van Mourik, H. (2022). Do highway widenings reduce congestion? *Tinbergen Institute Discussion Paper*. Retrieved from Ossokina_et_al2022_Highways.pdf
[94] Williams-Derry, C. (2007). Increases in greenhouse-gas emissions from highway-widening projects. *Sightline Research Backgrounder*. Retrieved from Memorandum (ubc.ca)
[95] Dray, L. (2020). An empirical analysis of airport capacity expansion. *Journal of Air Transport Management*, 87. Retrieved from https://doi.org/10.1016/j.jairtraman.2020.101850
[96] Jacobs (2014). *8. Carbon: Baseline*. Retrieved from Carbon: Baseline (publishing.service.gov.uk)
[97] 4th Rail package, noticeably, Directive 2016/2370/EU

The railway undertakings are assumed to operate at equilibrium. Meaning that any surplus is redistributed back to the passengers through a lower price.

- The study does not take into consideration the procurement of vehicles, airplanes or rolling stock to match the growth in demand.

While the study forecasts traffic growth for all modes dependent on the scenario, the study does not take into account the procurement of rolling stock, purchase of passenger cars and airplanes. This assumption is strongly linked to the previous one, as, in the open market situation, railway undertakings (and other transporters) are supposed to cover their investment-related costs through their revenue.

- Track access charges completely cover infrastructure maintenance.

Infrastructure maintenance for all modes is assumed to be covered fully by track access charges. This is also included to align with European Regulation.

- The study makes no assumption on the evolution of the fares.

While an important part of increasing the demand for HSR, the study does not take into account the evolution of fares. The studies used for the competition shock took into account the evolution of prices due to competition. As seen on other lines, where open-access competition exists, prices decrease as a result of competition[98][99].

These assumptions, while strongly theoretical, do not jeopardize the study robustness as they are:

- Consistent with the regulatory and market evolutions already observed, and assumed to continue in the next decades
- Consistent with the objective of the study, which is a case for the railway as a whole, not a case for specific actors.

Annex 9: EU Accession candidate countries scenario

This section will present the results for the scenario including the EU accession candidate countries. It is presented separately as the results are uncertain due to limited data availability for the demand for transport per mode. Similarly, the results below have had no shocks applied to them[100]. Due to aforementioned, the traffic is uncertain and hence less benefits arise. Consequently, the results are negative. The local economic effects on the other hand depend on constructed km of network and hence show positive results, which offset the infrastructure investment costs with an infrastructure cost of 12 M per KM. With shocks applied it can be assumed that the B/C ratio would be above 1.

[98] Tomeš, Z., Kvizda, M., Jandová, M., & Rederer, V. (2016). Open access passenger rail competition in the Czech Republic. *Transport policy*, *47*, 203-211.

[99] Antoniazzi, F., Giuricin, A. & Tosatti, R. (2019). Introducing competition in Italian high-speed rail. *L'Espace géographique*, 48, 329-349. https://doi.org/10.3917/eg.484.0329

[100] See the attached sensitivity analysis for a comparison with the 2030 and 2050 scenarios without any shocks applied.

Avg. Construction costs	Scenario	Construction cost (bn €)	NPV (M€)	B/C Ratio
12 €M per KM[101]				
	2050 EU	41	-9614	0,69
16.5 €M per KM[102]				
	2050 EU	71	-20.992	0,51
25 €M per KM[103]				
	2050 EU	107	-42.483	0.35

Table 6: CBA results for the EU accession countries

Scenario	Incremental production from construction (€ M)[104]	Incremental GVA from construction (€ M)[105]	Incremental job-years from construction ('000)	Incremental GVA from operations (€ M)[106]
2050 EU Accession scenario	12402 (-30%) 15517 (100%) 23032 (130%)	5767 (-30%) 7039 (100%) 10711 (130%)	138	18591-29050

Table 7: Local economic effects - 2050 EU accession

Annex 10: Local economic effect per NUTS3 region

This section presents the local economic effects of the construction and operations of the HSR network per NUTS3 regions covered by the network. Some regions have been estimated to not have an impact of operation. This is due to estimations on operations only accounting for lines where a new connection is established with a neighbouring region. This has been done to avoid double counting. The calculations have been made for NUTS3 regions as there is more available data for NUTS3 than for FUAs. Some regions who are part of the 2050 scenario may appear in the EU accession 2050 scenario table since the lines cross over. The estimations are based on the article of Ahlfeldt & Feddersen (2015).

[101] Based on the construction costs in United Nations Economic Commission for Europe (2021). Trans-European Railway High-Speed Master Plan Study: Phase 2. Retrieved from 2017852_E_web_light+c1.pdf (unece.org)
[102] € 16.5 million per KM was also the completion cost per KM for the French LGV Est Européenne HSR line. See European Court of Auditors (2018). *A European high-speed rail network: not a reality but an ineffective patchwork*. Retrieved from https://data.europa.eu/doi/10.2865/105814
[103] Average final construction costs audited by the ECA in European Court of Auditors (2018). *A European high-speed rail network: not a reality but an ineffective patchwork.* Retrieved from https://data.europa.eu/doi/10.2865/105814
[104] 100% based on Fouqueray, E. (2016). Impact économique de la construction de la LGV SEA Tours-Bordeaux sur les régions traversées. *Revue d'Économie Régionale & Urbaine*, 2, pp. 385-416. Retrieved from https://doi.org/10.3917/reru.162.0385. The two other serve as a range of 70% or 130% of the impact.
[105] Same as above.
[106] High range based on Ahlfeldt, G.M. & Feddersen, A. (2015). From Periphery to Core: Measuring Agglomeration Effects Using High-Speed Rail. *SERC Discussion Paper,* 172, p. 1-20, Retrieved from From Periphery to Core: Measuring Agglomeration Effects Using High-Speed Rail (repec.org) and low range based on Cascetta, E., Cartenì, A., Henke, I., & Pagliara, F. (2020). Economic growth, transport accessibility and regional equity impacts of high-speed railways in Italy: ten years ex post evaluation and future perspectives. *Transportation Research. Part A, Policy and Practice, 139*, 412 - 428.

2030 scenario

NUTS3 region name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Niederösterreich-Süd	AT122	206	96	2	0
Klagenfurt-Villach	AT211	65	30	1	1078
Unterkärnten	AT213	292	136	2	432
West- und Südsteiermark	AT225	218	101	2	504
Linz-Wels	AT312	113	52	1	0
Traunviertel	AT315	235	109	2	854
Salzburg und Umgebung	AT323	189	88	2	1794
Innsbruck	AT332	152	71	1	0
Tiroler Unterland	AT335	77	36	1	0
Basel-Stadt	CH031	11	5	0	0
Hlavní město Praha	CZ010	95	44	1	5235
Středočeský kraj	CZ020	485	225	4	2274
Ústecký kraj	CZ042	102	47	1	1052
Jihomoravský kraj	CZ064	316	147	3	2021
Stuttgart, Stadtkreis	DE111	60	28	1	0
Esslingen	DE113	152	71	1	1972
Karlsruhe, Stadtkreis	DE122	29	14	0	0
Karlsruhe, Landkreis	DE123	27	13	0	1472
Rastatt	DE124	52	24	0	890
Breisgau-Hochschwarzwald	DE132	32	15	0	691
Emmendingen	DE133	27	13	0	473
Ortenaukreis	DE134	139	65	1	0
Lörrach	DE139	97	45	1	678
Reutlingen	DE141	25	12	0	1017

NUTS3 region name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Ulm, Stadtkreis	DE144	41	19	0	858
Alb-Donau-Kreis	DE145	134	62	1	566
Neu-Ulm	DE279	1	1	0	585
Vest- og Sydsjælland	DK022	276	129	2	0
Fyn	DK031	208	97	2	0
Sydjylland	DK032	8	4	0	0
Põhja-Eesti	EE001	228	106	2	1535
Lääne-Eesti	EE004	522	243	4	153
Kesk-Eesti	EE009	263	122	2	132
Xanthi	EL512	124	57	1	92
Thasos, Kavala	EL515	286	133	2	160
Thessaloniki	EL522	421	196	4	0
Serres	EL526	201	93	2	151
Achaia	EL632	270	126	2	339
Korinthia	EL652	106	49	1	0
Araba/Álava	ES211	409	190	3	1023
Gipuzkoa	ES212	495	230	4	2113
Bizkaia	ES213	191	89	2	3159
Navarra	ES220	844	393	7	1777
Zaragoza	ES243	258	120	2	2415
Madrid	ES300	16	7	0	0
Burgos	ES412	475	221	4	0
Toledo	ES425	602	280	5	1124
Badajoz	ES431	21	10	0	1058
Cáceres	ES432	82	38	1	0
Alicante/Alacant	ES521	218	102	2	0
Castellón/Castelló	ES522	158	73	1	0
Valencia/València	ES523	460	214	4	5227
Almería	ES611	414	192	4	0
Málaga	ES617	14	6	0	0
Murcia	ES620	349	163	3	0
Paris	FR101	4	2	0	21388
Yvelines	FR103	259	121	2	5211
Hauts-de-Seine	FR105	36	17	0	0

NUTS3 region name	NUTS ID	Incremental Production (EUR mn)	Incrementa l GVA from Contructio n (EUR mn)	Incrementa l Job-years ('000)	Increment al GVA from operation (EUR mn)
Seine-Saint-Denis	FR106	4	2	0	5763
Yonne	FRC14	55	26	0	727
Territoire de Belfort	FRC24	36	17	0	331
Eure	FRD21	103	48	1	1286
Haut-Rhin	FRF12	117	54	1	1951
Gironde	FRI12	487	226	4	0
Landes	FRI13	641	298	5	926
Lot-et-Garonne	FRI14	364	169	3	732
Pyrénées-Atlantiques	FRI15	162	75	1	1868
Aude	FRJ11	239	111	2	737
Gard	FRJ12	113	52	1	0
Hérault	FRJ13	490	228	4	3060
Pyrénées-Orientales	FRJ15	99	46	1	0
Haute-Garonne	FRJ23	143	67	1	5094
Tarn-et-Garonne	FRJ28	331	154	3	519
Isère	FRK24	254	118	2	3709
Savoie	FRK27	504	234	4	1368
Alpes-Maritimes	FRL03	133	62	1	3456
Var	FRL05	15	7	0	2393
Torino	ITC11	20	9	0	6381
Alessandria	ITC18	190	88	2	1045
Genova	ITC33	91	42	1	2587
Brescia	ITC47	174	81	1	0
Milano	ITC4C	41	19	0	0
Caserta	ITF31	73	34	1	1356
Benevento	ITF32	344	160	3	404
Avellino	ITF34	153	71	1	654
Salerno	ITF35	529	246	4	0
Foggia	ITF46	214	100	2	969
Potenza	ITF51	112	52	1	766
Cosenza	ITF61	18	8	0	943
Bolzano-Bozen	ITH10	128	59	1	0
Verona	ITH31	309	144	3	2729
Vicenza	ITH32	172	80	1	2572

NUTS3 region name	NUTS ID	Incremental Production (EUR mn)	Incrementa l GVA from Contructio n (EUR mn)	Incrementa l Job-years ('000)	Increment al GVA from operation (EUR mn)
Padova	ITH36	71	33	1	2770
Bologna	ITH55	0	0	0	0
Vilniaus apskritis	LT011	247	115	2	1764
Kauno apskritis	LT022	816	379	7	850
Marijampolės apskritis	LT024	283	132	2	121
Panevėžio apskritis	LT025	488	227	4	231
Rīga	LV006	87	40	1	1375
Pierīga	LV007	1066	496	9	438
Zemgale	LV009	244	114	2	201
Miasto Poznań	PL415	39	18	0	1281
Kaliski	PL416	628	292	5	701
Poznański	PL418	212	98	2	941
Miasto Wrocław	PL514	67	31	1	1324
Wrocławski	PL518	197	91	2	713
Ełcki	PL623	232	108	2	188
Miasto Łódź	PL711	97	45	1	1053
Łódzki	PL712	178	83	2	380
Sieradzki	PL714	231	108	2	359
Skierniewicki	PL715	147	68	1	302
Białostocki	PL841	100	47	1	0
Suwalski	PL843	506	235	4	198
Żyrardowski	PL926	51	24	0	258
Área Metropolitana do Porto	PT11A	163	76	1	2928
Oeste	PT16B	29	13	0	520
Região de Aveiro	PT16D	346	161	3	627
Região de Coimbra	PT16E	232	108	2	699
Região de Leiria	PT16F	127	59	1	497
Viseu Dão Lafões	PT16G	154	72	1	343
Médio Tejo	PT16I	209	97	2	328
Área Metropolitana de Lisboa	PT170	409	190	3	6582

NUTS3 region name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Lezíria do Tejo	PT185	280	130	2	357
Alto Alentejo	PT186	94	44	1	0
Alentejo Central	PT187	611	284	5	242
Constanţa	RO223	1098	511	9	713
Călăraşi	RO312	852	396	7	166
Bucureşti	RO321	217	101	2	4714
Stockholms län	SE110	54	25	0	12859
Södermanlands län	SE122	356	166	3	873
Östergötlands län	SE123	294	137	2	1584

2050 scenario

NUTS3 name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Nordburgenland	AT112	83	38	1	464
Wiener Umland/Südteil	AT127	287	134	2	0
Klagenfurt-Villach	AT211	493	229	4	0
Oberkärnten	AT212	239	111	2	315
Graz	AT221	219	102	2	1981
Östliche Obersteiermark	AT223	284	132	2	542
Innviertel	AT311	376	175	3	975
Linz-Wels	AT312	161	75	1	0
Mühlviertel	AT313	292	136	2	526
Lungau	AT321	156	73	1	65
Pinzgau-Pongau	AT322	292	136	2	666
Salzburg und Umgebung	AT323	250	116	2	0
Außerfern	AT331	156	73	1	139

NUTS3 name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Innsbruck	AT332	274	127	2	0
Tiroler Oberland	AT334	145	67	1	445
Tiroler Unterland	AT335	39	18	0	0
Arr. Tongeren	BE223	13	6	0	415
Arr. Aalst	BE231	43	20	0	666
Arr. Dendermonde	BE232	110	51	1	496
Arr. Eeklo	BE233	27	13	0	212
Arr. Gent	BE234	201	93	2	2357
Arr. Halle-Vilvoorde	BE241	158	73	1	2758
Arr. Brugge	BE251	161	75	1	1006
Arr. Oostende	BE255	133	62	1	445
Arr. Veurne	BE258	122	57	1	199
Arr. Liège	BE332	296	138	3	1731
Arr. Verviers – communes francophones	BE335	159	74	1	488
Arr. Bastogne	BE342	124	58	1	99
Vidin	BG311	510	237	4	32
Montana	BG312	339	158	3	53
Vratsa	BG313	435	202	4	94
Pleven	BG314	655	305	6	102
Lovech	BG315	113	53	1	56
Veliko Tarnovo	BG321	320	149	3	113
Ruse	BG323	575	267	5	121
Razgrad	BG324	294	137	2	51
Varna	BG331	827	384	7	336
Dobrich	BG332	480	223	4	76
Shumen	BG333	326	152	3	77
Targovishte	BG334	14	6	0	51
Burgas	BG341	639	297	5	241
Sliven	BG342	231	107	2	66
Yambol	BG343	323	150	3	52
Stara Zagora	BG344	463	215	4	224
Sofia (stolitsa)	BG411	374	174	3	2239
Sofia	BG412	678	315	6	169
Blagoevgrad	BG413	601	279	5	137
Pernik	BG414	178	83	2	49
Kyustendil	BG415	230	107	2	49
Plovdiv	BG421	706	328	6	422

NUTS3 name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Haskovo	BG422	622	289	5	90
Pazardzhik	BG423	345	160	3	111
Vaud	CH011	666	310	6	0
Valais	CH012	706	328	6	0
Genève	CH013	131	61	1	0
Bern	CH021	407	189	3	0
Freiburg	CH022	352	163	3	0
Solothurn	CH023	69	32	1	0
Basel-Stadt	CH031	33	15	0	0
Basel-Landschaft	CH032	185	86	2	0
Aargau	CH033	359	167	3	0
Zürich	CH040	294	137	2	0
Schaffhausen	CH052	50	23	0	0
Luzern	CH061	299	139	3	0
Uri	CH062	112	52	1	0
Schwyz	CH063	151	70	1	0
Zug	CH066	4	2	0	0
Ticino	CH070	270	125	2	0
Hlavní město Praha	CZ010	192	89	2	0
Středočeský kraj	CZ020	819	381	7	2274
Jihočeský kraj	CZ031	749	348	6	929
Plzeňský kraj	CZ032	928	432	8	927
Karlovarský kraj	CZ041	746	347	6	331
Ústecký kraj	CZ042	1046	487	9	0
Královéhradecký kraj	CZ052	566	263	5	877
Kraj Vysočina	CZ063	457	213	4	733
Jihomoravský kraj	CZ064	331	154	3	0

NUTS3 name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Olomoucký kraj	CZ071	473	220	4	0
Moravskoslezský kraj	CZ080	461	214	4	1688
Mannheim, Stadtkreis	DE126	68	31	1	0
Breisgau-Hochschwarzwald	DE132	21	10	0	0
Ortenaukreis	DE134	91	42	1	0
Konstanz	DE138	245	114	2	879
Waldshut	DE13A	6	3	0	452
Bodenseekreis	DE147	335	156	3	931
München, Kreisfreie Stadt	DE212	19	9	0	10422
Rosenheim, Kreisfreie Stadt	DE213	58	27	0	289
Berchtesgadener Land	DE215	102	48	1	318
Ebersberg	DE218	138	64	1	393
München, Landkreis	DE21H	55	26	0	3467
Rosenheim, Landkreis	DE21K	334	155	3	765
Traunstein	DE21M	194	90	2	631
Passau, Kreisfreie Stadt	DE222	62	29	1	306
Straubing, Kreisfreie Stadt	DE223	58	27	0	230
Deggendorf	DE224	207	96	2	423
Passau, Landkreis	DE228	139	65	1	511
Straubing-Bogen	DE22B	136	63	1	251
Regensburg, Kreisfreie Stadt	DE232	75	35	1	1121
Amberg-Sulzbach	DE234	232	108	2	250
Cham	DE235	146	68	1	425
Neumarkt i. d. OPf.	DE236	346	161	3	454
Regensburg, Landkreis	DE238	318	148	3	431
Schwandorf	DE239	246	114	2	464
Fürth, Kreisfreie Stadt	DE253	44	21	0	415
Nürnberg, Kreisfreie Stadt	DE254	103	48	1	2763

NUTS3 name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Fürth, Landkreis	DE258	34	16	0	0
Nürnberger Land	DE259	255	119	2	472
Augsburg, Kreisfreie Stadt	DE271	7	3	0	0
Kempten (Allgäu), Kreisfreie Stadt	DE273	22	10	0	314
Augsburg, Landkreis	DE276	198	92	2	679
Günzburg	DE278	246	115	2	512
Neu-Ulm	DE279	75	35	1	0
Lindau (Bodensee)	DE27A	203	94	2	273
Ostallgäu	DE27B	127	59	1	451
Oberallgäu	DE27E	326	152	3	445
Berlin	DE300	576	268	5	13340
Cottbus, Kreisfreie Stadt	DE402	68	31	1	307
Frankfurt (Oder), Kreisfreie Stadt	DE403	138	64	1	191
Barnim	DE405	353	164	3	0
Elbe-Elster	DE407	35	16	0	0
Oberhavel	DE40A	462	215	4	481
Oder-Spree	DE40C	598	278	5	411
Spree-Neiße	DE40G	324	151	3	353
Uckermark	DE40I	342	159	3	311
Bremen, Kreisfreie Stadt	DE501	76	35	1	2506
Hamburg	DE600	255	118	2	10550
Frankfurt am Main, Kreisfreie Stadt	DE712	107	50	1	0
Offenbach am Main, Kreisfreie Stadt	DE713	34	16	0	406
Bergstraße	DE715	137	64	1	684
Groß-Gerau	DE717	230	107	2	1091
Hochtaunuskreis	DE718	11	5	0	983
Main-Kinzig-Kreis	DE719	419	195	4	1351
Offenbach, Landkreis	DE71C	50	23	0	1240

NUTS3 name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Wetteraukreis	DE71E	170	79	1	796
Gießen, Landkreis	DE721	194	90	2	855
Vogelsbergkreis	DE725	252	117	2	252
Fulda	DE732	82	38	1	727
Hersfeld-Rotenburg	DE733	299	139	3	398
Kassel, Landkreis	DE734	291	135	2	632
Schwalm-Eder-Kreis	DE735	6	3	0	512
Rostock, Kreisfreie Stadt	DE803	23	11	0	681
Mecklenburgische Seenplatte	DE80J	510	237	4	638
Landkreis Rostock	DE80K	634	295	5	496
Nordwestmecklenburg	DE80M	441	205	4	343
Ludwigslust-Parchim	DE80O	19	9	0	464
Schaumburg	DE928	430	200	4	357
Region Hannover	DE929	274	127	2	4750
Rotenburg (Wümme)	DE937	265	123	2	460
Heidekreis	DE938	252	117	2	421
Verden	DE93B	231	108	2	382
Delmenhorst, Kreisfreie Stadt	DE941	15	7	0	164
Oldenburg (Oldenburg), Kreisfreie Stadt	DE943	56	26	0	697
Osnabrück, Kreisfreie Stadt	DE944	39	18	0	0
Ammerland	DE946	187	87	2	343
Leer	DE94C	279	130	2	385
Oldenburg, Landkreis	DE94D	153	71	1	286
Osnabrück, Landkreis	DE94E	20	9	0	958
Duisburg, Kreisfreie Stadt	DEA12	75	35	1	0
Essen, Kreisfreie Stadt	DEA13	90	42	1	2245

NUTS3 name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Mülheim an der Ruhr, Kreisfreie Stadt	DEA16	61	29	1	522
Kleve	DEA1B	193	90	2	849
Wesel	DEA1F	210	97	2	1181
Bielefeld, Kreisfreie Stadt	DEA41	47	22	0	1210
Herford	DEA43	47	22	0	749
Höxter	DEA44	169	79	1	348
Lippe	DEA45	146	68	1	944
Minden-Lübbecke	DEA46	7	3	0	1137
Paderborn	DEA47	331	154	3	974
Bochum, Kreisfreie Stadt	DEA51	108	50	1	1086
Dortmund, Kreisfreie Stadt	DEA52	56	26	0	0
Hamm, Kreisfreie Stadt	DEA54	72	33	1	466
Soest	DEA5B	328	153	3	957
Regionalverband Saarbrücken	DEC01	30	14	0	0
Dresden, Kreisfreie Stadt	DED21	90	42	1	1987
Görlitz	DED2D	649	302	6	621
Meißen	DED2E	382	178	3	0
Sächsische Schweiz-Osterzgebirge	DED2F	182	84	2	506
Vogtlandkreis	DED44	335	156	3	511
Leipzig, Kreisfreie Stadt	DED51	60	28	1	1951
Leipzig	DED52	95	44	1	597
Burgenlandkreis	DEE08	187	87	2	402
Flensburg, Kreisfreie Stadt	DEF01	24	11	0	330
Lübeck, Kreisfreie Stadt	DEF03	91	42	1	0
Neumünster, Kreisfreie Stadt	DEF04	19	9	0	307
Rendsburg-Eckernförde	DEF0B	338	157	3	718
Schleswig-Flensburg	DEF0C	294	137	2	472
Segeberg	DEF0D	266	124	2	772

NUTS3 name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Stormarn	DEF0F	254	118	2	731
Gera, Kreisfreie Stadt	DEG02	99	46	1	236
Saale-Holzland-Kreis	DEG0J	25	12	0	170
Greiz	DEG0L	184	86	2	206
Eisenach, Kreisfreie Stadt	DEG0 N	52	24	0	143
Byen København	DK011	75	35	1	0
Vest- og Sydsjælland	DK022	256	119	2	0
Fyn	DK031	182	85	2	0
Sydjylland	DK032	942	438	8	3220
Vestjylland	DK041	17	8	0	1889
Østjylland	DK042	974	453	8	3610
Nordjylland	DK050	419	195	4	2228
Anatoliki Attiki	EL305	9	4	0	870
Dytiki Attiki	EL306	168	78	1	359
Evros	EL511	359	167	3	155
Xanthi	EL512	58	27	0	0
Rodopi	EL513	378	176	3	99
Drama	EL514	212	99	2	87
Thasos, Kavala	EL515	46	21	0	160
Serres	EL526	614	285	5	151
A Coruña	ES111	202	94	2	0
Lugo	ES112	755	351	6	0
Ourense	ES113	263	122	2	611
Pontevedra	ES114	375	174	3	1852
Cantabria	ES130	893	415	8	1204
Araba/Álava	ES211	200	93	2	1023
Bizkaia	ES213	87	40	1	0
Navarra	ES220	93	43	1	1777
La Rioja	ES230	519	241	4	752
Huesca	ES241	545	253	5	531
Teruel	ES242	400	186	3	0
León	ES413	815	379	7	867
Palencia	ES414	668	311	6	382
Salamanca	ES415	779	362	7	0
Albacete	ES421	526	245	4	723
Ciudad Real	ES422	594	276	5	905
Ciudad Real	ES422	245	114	2	0

NUTS3 name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Toledo	ES425	316	147	3	0
Badajoz	ES431	1	0	0	0
Barcelona	ES511	147	68	1	0
Castellón/Castelló	ES522	396	184	3	0
Valencia/València	ES523	118	55	1	0
Almería	ES611	474	221	4	0
Cádiz	ES612	345	160	3	0
Granada	ES614	715	332	6	0
Huelva	ES615	684	318	6	909
Jaén	ES616	629	293	5	964
Málaga	ES617	956	445	8	2738
Sevilla	ES618	931	433	8	3468
Murcia	ES620	497	231	4	2744
Pirkanmaa	FI197	293	136	2	1760
Helsinki-Uusimaa	FI1B1	1176	547	10	8113
Varsinais-Suomi	FI1C1	228	106	2	1652
Kanta-Häme	FI1C2	424	197	4	508
Päijät-Häme	FI1C3	13	6	0	570
Kymenlaakso	FI1C4	150	70	1	601
Essonne	FR104	459	214	4	4770
Seine-Saint-Denis	FR106	75	35	1	5763
Val-de-Marne	FR107	106	49	1	0
Val-d'Oise	FR108	125	58	1	3313
Cher	FRB01	623	290	5	693
Eure-et-Loir	FRB02	88	41	1	982
Loir-et-Cher	FRB05	200	93	2	743
Loiret	FRB06	392	182	3	1903
Côte-d'Or	FRC11	744	346	6	0
Côte-d'Or	FRC11	11	5	0	1618
Saône-et-Loire	FRC13	199	93	2	1262
Jura	FRC22	377	175	3	587
Calvados	FRD11	347	161	3	1763
Eure	FRD21	647	301	5	0
Seine-Maritime	FRD22	520	242	4	3418
Nord	FRE11	223	104	2	7230
Pas-de-Calais	FRE12	532	247	5	3130
Oise	FRE22	404	188	3	1928

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Somme	FRE23	702	327	6	1363
Bas-Rhin	FRF11	43	20	0	3438
Haut-Rhin	FRF12	578	269	5	0
Meurthe-et-Moselle	FRF31	490	228	4	1690
Moselle	FRF33	777	361	7	2285
Vosges	FRF34	523	243	4	785
Loire-Atlantique	FRG01	677	315	6	4517
Maine-et-Loire	FRG02	79	37	1	1995
Vendée	FRG05	102	48	1	1728
Côtes-d'Armor	FRH01	802	373	7	1376
Finistère	FRH02	1066	496	9	2229
Ille-et-Vilaine	FRH03	270	126	2	0
Morbihan	FRH04	778	362	7	1757
Gironde	FRI12	3	1	0	0
Landes	FRI13	292	136	2	926
Pyrénées-Atlantiques	FRI15	631	293	5	1868
Corrèze	FRI21	1066	496	9	541
Haute-Vienne	FRI23	581	270	5	863
Deux-Sèvres	FRI33	490	228	4	973
Vienne	FRI34	530	247	5	1098
Aude	FRJ11	701	326	6	737
Gard	FRJ12	68	32	1	0
Hérault	FRJ13	368	171	3	3060
Lozère	FRJ14	438	204	4	163
Aveyron	FRJ22	381	177	3	630
Haute-Garonne	FRJ23	256	119	2	0
Lot	FRJ25	578	269	5	387
Tarn-et-Garonne	FRJ28	197	92	2	519
Allier	FRK11	323	150	3	703
Cantal	FRK12	279	130	2	301
Haute-Loire	FRK13	88	41	1	462
Puy-de-Dôme	FRK14	1351	628	11	1862
Ain	FRK21	529	246	4	1489
Loire	FRK25	359	167	3	1880
Rhône	FRK26	346	161	3	7939
Savoie	FRK27	199	93	2	1368
Haute-Savoie	FRK28	395	184	3	2206

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Alpes-Maritimes	FRL03	201	94	2	0
Bouches-du-Rhône	FRL04	176	82	1	0
Var	FRL05	727	338	6	0
Brodsko-posavska županija	HR02 4	1071	498	7,0	62
Osječko-baranjska županija	HR02 5	80	37	0,5	154
Vukovarsko-srijemska županija	HR02 6	475	221	3,1	71
Karlovačka županija	HR02 7	783	364	7	93
Sisačko-moslavačka županija	HR02 8	874	407	5,7	78
Primorsko-goranska županija	HR03 1	517	240	4	366
Ličko-senjska županija	HR03 2	632	294	5	41
Zadarska županija	HR03 3	221	103	2	165
Šibensko-kninska županija	HR03 4	429	199	4	96
Splitsko-dalmatinska županija	HR03 5	816	380	7	409
Dubrovačko-neretvanska županija	HR03 7	100	46	1	152
Dubrovačko-neretvanska županija	HR03 7	98	46	0,6	0
Grad Zagreb	HR05 0	320	149	3	1629
Grad Zagreb	HR05 0	112	52	0,7	1054

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Koprivničko-križevačka županija	HR063	362	168	3	91
Zagrebačka županija	HR065	467	217	4	283
Zagrebačka županija	HR065	126	59	0,8	183
Budapest	HU110	204	95	2	4619
Pest	HU120	1081	503	9	1302
Fejér	HU211	885	411	8	527
Komárom-Esztergom	HU212	105	49	1	386
Győr-Moson-Sopron	HU221	561	261	5	680
Somogy	HU232	523	243	4	241
Tolna	HU233	404	188	3	209
Borsod-Abaúj-Zemplén	HU311	666	310	6	562
Heves	HU312	474	220	4	282
Hajdú-Bihar	HU321	707	329	6	480
Jász-Nagykun-Szolnok	HU322	401	187	3	298
Szabolcs-Szatmár-Bereg	HU323	569	265	5	407
Bács-Kiskun	HU331	209	97	2	519
Békés	HU332	203	94	2	244
Csongrád	HU333	741	345	6	376
West	IE042	632	294	5	1342
Mid-West	IE051	1050	488	9	2928
South-East	IE052	820	381	7	2126
South-West	IE053	288	134	2	7543
Dublin	IE061	233	108	2	12248
Mid-East	IE062	665	309	6	2729
Midland	IE063	403	187	3	547
Verbano-Cusio-Ossola	ITC14	430	200	4	338
Novara	ITC15	288	134	2	971

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Imperia	ITC31	146	68	1	443
Savona	ITC32	366	170	3	650
Genova	ITC33	149	69	1	0
Como	ITC42	161	75	1	1485
Milano	ITC4C	54	25	0	15403
Monza e della Brianza	ITC4D	86	40	1	2343
Brindisi	ITF44	500	232	4	613
Lecce	ITF45	156	73	1	1167
Bari	ITF47	307	143	3	0
Cosenza	ITF61	796	370	7	0
Catanzaro	ITF63	373	174	3	606
Vibo Valentia	ITF64	248	115	2	218
Reggio di Calabria	ITF65	371	173	3	822
Palermo	ITG12	749	348	6	2022
Messina	ITG13	1164	541	10	980
Caltanissetta	ITG15	77	36	1	347
Enna	ITG16	409	190	3	220
Catania	ITG17	488	227	4	1773
Verona	ITH31	10	4	0	0
Gorizia	ITH43	9	4	0	0
Trieste	ITH44	4	2	0	0
Luxembourg	LU000	518	241	4	5330
Oost-Groningen	NL111	181	84	2	294
Overig Groningen	NL113	158	74	1	1675
Noord-Drenthe	NL131	251	117	2	504
Zuidwest-Drenthe	NL133	206	96	2	401
Noord-Overijssel	NL211	189	88	2	1350
Zuidwest-Overijssel	NL212	159	74	1	502
Veluwe	NL221	132	61	1	2475
Achterhoek	NL225	144	67	1	1155
Arnhem/Nijmegen	NL226	460	214	4	2518
Utrecht	NL310	194	90	2	6545
Het Gooi en Vechtstreek	NL327	113	53	1	969
Groot-Amsterdam	NL329	87	40	1	10865
Noord-Limburg	NL421	401	187	3	1041

NUTS3 name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Midden-Limburg	NL422	184	85	2	743
Zuid-Limburg	NL423	182	85	2	2138
Innlandet	NO020	1846	859	16	1467
Trøndelag	NO060	970	451	8	2156
Oslo	NO081	184	86	2	5836
Viken	NO082	2050	954	17	5109
Vestfold og Telemark	NO091	1224	569	10	1639
Rogaland	NO0A1	512	238	4	2570
Vestland	NO0A2	1412	657	12	3056
Miasto Kraków	PL213	120	56	1	1555
Krakowski	PL214	384	179	3	662
Tarnowski	PL217	512	238	4	344
Nowosądecki	PL218	300	139	3	407
Oświęcimski	PL21A	302	140	3	479
Bielski	PL225	249	116	2	805
Bytomski	PL228	42	19	0	376
Gliwicki	PL229	204	95	2	664
Katowicki	PL22A	142	66	1	0
Sosnowiecki	PL22B	159	74	1	734
Tyski	PL22C	22	10	0	550
Pilski	PL411	374	174	3	356
Koniński	PL414	270	126	2	614
Miasto Poznań	PL415	107	50	1	0
Leszczyński	PL417	268	125	2	585
Poznański	PL418	285	133	2	941
Miasto Szczecin	PL424	78	36	1	560
Koszaliński	PL426	577	268	5	340
Szczecinecko-pyrzycki	PL427	878	408	7	291
Szczeciński	PL428	627	292	5	471
Gorzowski	PL431	600	279	5	365
Zielonogórski	PL432	540	251	5	607
Miasto Wrocław	PL514	194	90	2	0
Jeleniogórski	PL515	207	96	2	503
Legnicko-głogowski	PL516	326	151	3	663

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Wałbrzyski	PL517	302	140	3	548
Wrocławski	PL518	552	257	5	713
Nyski	PL523	184	86	2	261
Opolski	PL524	380	177	3	659
Bydgosko-toruński	PL613	935	435	8	923
Grudziądzki	PL616	473	220	4	309
Inowrocławski	PL617	599	278	5	275
Świecki	PL618	155	72	1	172
Włocławski	PL619	222	103	2	273
Elbląski	PL621	898	417	8	406
Olsztyński	PL622	838	390	7	558
Ełcki	PL623	311	145	3	0
Trójmiejski	PL633	244	113	2	1335
Gdański	PL634	520	242	4	508
Słupski	PL636	465	216	4	292
Starogardzki	PL638	579	269	5	386
Miasto Łódź	PL711	81	38	1	0
Łódzki	PL712	92	43	1	380
Piotrkowski	PL713	314	146	3	640
Bialski	PL811	427	198	4	210
Chełmsko-zamojski	PL812	756	352	6	380
Lubelski	PL814	736	342	6	770
Puławski	PL815	363	169	3	344
Przemyski	PL822	381	177	3	238
Rzeszowski	PL823	423	197	4	675
Tarnobrzeski	PL824	868	404	7	536
Miasto Warszawa	PL911	159	74	1	6256
Warszawski wschodni	PL912	319	148	3	631
Warszawski zachodni	PL913	214	100	2	1086
Ciechanowski	PL922	183	85	2	306
Płocki	PL923	341	159	3	614
Siedlecki	PL925	279	130	2	374
Alto Minho	PT111	285	132	2	316
Cávado	PT112	137	64	1	619
Ave	PT119	89	41	1	600
Área Metropolitana do Porto	PT11A	154	72	1	0

NUTS3 name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Algarve	PT150	618	287	5	870
Viseu Dão Lafões	PT16G	239	111	2	0
Beiras e Serra da Estrela	PT16J	430	200	4	261
Baixo Alentejo	PT184	647	301	5	195
Alentejo Central	PT187	220	102	2	242
Bihor	RO111	447	208	4	441
Bistriţa-Năsăud	RO112	531	247	5	195
Cluj	RO113	769	358	7	952
Sălaj	RO116	559	260	5	164
Alba	RO121	454	211	4	309
Braşov	RO122	663	308	6	630
Sibiu	RO126	744	346	6	423
Bacău	RO211	503	234	4	365
Botoşani	RO212	349	163	3	192
Iaşi	RO213	310	144	3	613
Neamţ	RO214	197	92	2	261
Suceava	RO215	795	370	7	363
Buzău	RO222	472	220	4	269
Galaţi	RO224	388	181	3	334
Tulcea	RO225	831	387	7	142
Vrancea	RO226	699	325	6	196
Giurgiu	RO314	314	146	3	123
Prahova	RO316	883	411	7	658
Ilfov	RO322	276	128	2	532
Mehedinţi	RO413	291	135	2	138

NUTS3 name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Arad	RO421	447	208	4	413
Caraş-Severin	RO422	585	272	5	197
Hunedoara	RO423	430	200	4	300
Timiş	RO424	1176	547	10	887
Borska oblast	RS221	327	152	3	68
Stockholms län	SE110	427	199	4	0
Södermanlands län	SE122	460	214	4	873
Östergötlands län	SE123	463	215	4	0
Örebro län	SE124	288	134	2	1033
Västmanlands län	SE125	238	111	2	878
Jönköpings län	SE211	1065	495	9	1243
Kronobergs län	SE212	387	180	3	747
Skåne län	SE224	1667	775	14	4659
Hallands län	SE231	1033	481	9	1019
Västra Götalands län	SE232	1966	914	17	6815
Savinjska	SI034	38	18	0	459
Zasavska	SI035	165	77	1	59
Posavska	SI036	303	141	3	126
Primorsko-notranjska	SI038	404	188	3	72
Osrednjeslovenska	SI041	433	201	4	1531
Gorenjska	SI042	223	104	2	363
Obalno-kraška	SI044	139	65	1	225
Bratislavský kraj	SK010	19	9	0	2248
Prešovský kraj	SK041	533	248	5	740
Košický kraj	SK042	245	114	2	936
Manchester	UKD33	44	21	0	0
Greater Manchester South West	UKD34	52	24	0	0
Cheshire East	UKD62	257	120	2	0
Barnsley, Doncaster and Rotherham	UKE31	191	89	2	0

NUTS3 name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Leeds	UKE42	91	42	1	0
Wakefield	UKE45	147	68	1	0
East Derbyshire	UKF12	176	82	1	0
South and West Derbyshire	UKF13	45	21	0	0
Nottingham	UKF14	5	2	0	0
North Nottinghamshire	UKF15	74	34	1	0
South Nottinghamshire	UKF16	66	31	1	0
Leicestershire CC and Rutland	UKF22	216	101	2	0
Warwickshire	UKG13	391	182	3	0
Staffordshire CC	UKG24	329	153	3	0
Birmingham	UKG31	152	71	1	0
Solihull	UKG32	67	31	1	0
Sandwell	UKG37	29	14	0	0
Walsall	UKG38	51	24	0	0
Wolverhampton	UKG39	10	5	0	0
Camden and City of London	UKI31	19	9	0	0
Westminster	UKI32	24	11	0	0
Kensington & Chelsea and Hammersmith & Fulham	UKI33	19	9	0	0
Ealing	UKI73	59	28	1	0
Harrow and Hillingdon	UKI74	56	26	0	0
Buckinghamshire CC	UKJ13	207	96	2	0
Oxfordshire	UKJ14	426	198	4	0

2050 EU Accession scenario:

NUTS3 name	NUTS ID	Incremental Production (EUR mn)	Incremental GVA from Contruction (EUR mn)	Incremental Job-years ('000)	Incremental GVA from operation (EUR mn)
Durrës	AL012	306	142	2,0	77
Lezhë	AL014	371	173	2,4	24
Shkodër	AL015	497	231	3,2	38
Tiranë	AL022	279	130	1,8	323
Sofia (stolitsa)	BG411	106	49	0,7	1449
Sofia	BG412	368	171	2,4	110
Haskovo	BG422	48	22	0,3	58
Evros	EL511	12	6	0,1	100
Kilkis	EL523	19	9	0,1	51
Csongrád	HU333	110	51	0,7	243
Crna Gora	ME000	1080	502	7,0	272
Vardarski	MK001	783	364	5,1	49
Jugoistočen	MK004	293	136	1,9	57
Severoistočen	MK007	256	119	1,7	29
Skopski	MK008	719	334	4,7	267
Chełmsko-zamojski	PL812	343	160	2,2	246
Lubelski	PL814	385	179	2,5	498
Iaşi	RO213	414	193	2,7	0
Timiş	RO424	506	235	3,3	574
City of Belgrade	RS110	842	392	5,5	0
City of Belgrade	RS110	353	164	3,0	0

Južnobanatska oblast	RS122	720	335	4,7	0
Južnobačka oblast	RS123	395	184	2,6	0
Južnobačka oblast	RS123	88	41	0,8	0
Severnobanatska oblast	RS124	10	5	0,1	0
Severnobačka oblast	RS125	580	270	3,8	0
Sremska oblast	RS127	818	380	5,3	0
Sremska oblast	RS127	172	80	1,5	0
Zlatiborska oblast	RS211	1491	693	9,7	72
Kolubarska oblast	RS212	463	215	3,0	44
Moravička oblast	RS214	325	151	2,1	60
Pomoravska oblast	RS215	256	119	2,2	70
Rasinska oblast	RS216	443	206	2,9	50
Rasinska oblast	RS216	141	66	1,2	78
Raška oblast	RS217	982	457	6,4	55
Šumadijska oblast	RS218	46	21	0,4	123
Jablanička oblast	RS224	430	200	2,8	36
Nišavska oblast	RS225	454	211	3,0	100
Nišavska oblast	RS225	216	100	1,8	155
Pirotska oblast	RS226	663	308	4,3	25
Podunavska oblast	RS227	295	137	2,5	47
Pčinjska oblast	RS228	662	308	4,3	33

İstanbul	TR100	1200	558	7,8	11474
Tekirdağ	TR211	1541	717	10,1	639
Edirne	TR212	779	362	5,1	157
Kırklareli	TR213	504	234	3,3	179