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Master Plan on High-Speed Trains

Executive Summary of the Master Plan

Submitted by the consultant of the TER High-Speed Trains Master Plan Project

I. Background

1. The TER Steering Committee requested the preparation of a TER High-Speed Trains Master Plan. The project was completed in September 2017, this document provides a summary of the Master Plan for discussion.

II. Introduction and history

2. Quoting European Union's (EU) definitions of high-speed railways, an overview of the individual work steps and the results of the study, are followed by the highlights of general railway history and the increasing railway speed over time. Another historical review reflects on EU railway infrastructure policy, the Trans-European Transport Network (TEN-T) with its revisions, the Pan-European Corridors, the Transport Infrastructure Needs Assessment (TINA process), the recent TEN Policy Review and EU funding and financing instruments, in particular the Connecting Europe Facility (CEF), including its funding conditions. The section ends with some general technicalities of high-speed rail.

III. Benefits, political background, best practice and high-speed status

3. While the benefits of high-speed, i.e. considerable time savings are evident, there is also a strong impact on space. Actually, short travelling times virtually make space shrink,

which results in a higher attractiveness of affected regions as a location for economy. Apart from the economic benefits for users, this is a relevant reason to invest in high-speed in many cases. These effects are illustrated by an Austrian example, the Koralm railway Graz-Klagenfurt, a new high-speed railway link closing the gap between these two cities.

4. At the European level, one can distinguish between monocentric countries such as e.g. France or Hungary and polycentric countries like the Czechia, Germany, Italy or Poland. Whereas in polycentric countries speeds on radial high-speed lines may be as high as technically, operationally and economically feasible, I polycentric countries network effects have to be taken into account, mostly by integrated clock-face timetables, which means that speeds should be selected as high as needed to implement such integrated timetable.

5. Examples in France and other large countries show that time savings due to high-speed are high enough to cause a relevant shift from both road and air traffic to railways, sometimes even replacing air traffic completely. The reduction of emissions from fossil fuels is very beneficial effect on climate and environment. Depending on selected speed levels, high-speed trains are competitive against road for distances above 100-200 km and against air up to 800 and 1,000 km. A project in Russian Federation may extend this threshold to about 1,500 km.

6. The reduction of travel times may induce a new commuting behaviour, with distances of 200 km and more in everyday commuting.

7. Furthermore, the gain of safety is not negligible, as in general, railways are safer than road by a factor of 10, at least.

8. The only disadvantage of rail, including high-speed, is the emission of noise. This can be mitigated or avoided by noise protection measures such as walls or tunnels, which though expensive, are supported by the progress in technology for reducing noise in vehicles.

9. All the advantages of high-speed rail are reasons for political decisions to implement concrete projects, mainly along the most important corridors and mainly linking the large urban agglomerations. But in many cases, even lower traffic demand is accepted, with the goal to foster regional development.

10. Running at speeds of 200 km/h has a number of effects that have to be taken into account for the layout and equipment of high-speed rolling stock: air resistance and dynamic air pressure are relevant reasons for special technical solutions of high-speed rolling stock. The result is aerodynamic shapes. Furthermore, track-side signals would not be visible enough for safe operation. Therefore, in-cabin signalling is the state of the art for high-speed operation. The EU coordinates and supports the implementation of the interoperable European Train Control System, together with GSM-R forming European Rail Traffic Management System.

11. The study gives an overview of high-speed rolling stock, comparing the basic design types, i.e. loco-driven versus axle-powered trains, either with two separate bogies per car or with Jacobs bogies. The description also considers active and passive tilting trains.

12. The existing high-speed lines in Austria, France, Germany, Italy and Spain are described. This leads to projects in the TER countries, as Rail Baltica, the “Centralna Magistrala Kolejowa” and the postponed “double Y” in Poland, the Czech projects, mainly along the Orient-EastMed and the Baltic-Adriatic Corridor, and projects in Croatia, Hungary, Greece, Serbia, Slovakia and Slovenia. There are important projects, partly already implemented, in the Russian Federation, e.g. the existing Moscow-St.Petersburg high-speed line, with the project of a parallel new line, even faster, and the Moscow-Rostov na Donu-Adler and the Moscow-Nizhny Novgorod-Kazan-

Yekaterinburg project. Finally, high-speed lines also exist in Turkey, such as the new Ankara-Polatli-Eskişehir-Istanbul line.

13. For high-speed lines in TER countries, the most important EU legislation consists of the TEN-T Regulation 1315/2013 with its counterpart for implementation, the CEF Regulation 1316/2013, as well as the set of Technical Standards for Interoperability (TSI). Annex 1 of the TEN-T Regulation is a set of maps that define the TEN-T comprehensive and core networks. These maps also indicate links where high-speed exists or is planned. But also, the four “railway packages” contain some stipulations that are relevant for high-speed.

IV. Review of related work, initiatives, policies and studies

14. Studies have been collected with the goal to cover the whole field of high-speed rail, in particular the socioeconomic benefits and the political framework, the technical aspects of planning, construction, operation and maintenance, track geometry and practical experience, as well as costs of implementation and operation. These studies have been described in accordance with their relevance and their scope. Therefore, the part on the International Union of Railways (UIC) “High-Speed Railway System Implementation Handbook” is the most comprehensive one.

15. A long section is dedicated to the technical challenges, where the particularities of all components of high-speed infrastructure, from technical infrastructure parameters like radii, gradients, cant and cant deficiency, transition curves as clothoids, track superstructure parameters (ballast, sleepers and rails), electric power supply system including catenary and pantographs as well as signalling, are considered and explained. Some paragraphs are dedicated to the complex challenge of track maintenance, abrasive wear, tolerances and tamping intervals. Finally, there are also deliberations about operational aspects and capacity, taking into account that mixed high-speed and conventional traffic consumes track capacity.

16. Of particular importance for high-speed lines is the provision of the adequate technical parameters. For EU member States, the most relevant regulations are comprised in the “Technical Specifications for Interoperability” (TSI). These specifications have passed through a twenty years process of development and consolidation, during which the initially separated prescriptions for conventional and high-speed rail have been merged. TSI cover all parts of the railway system, namely infrastructure, rolling stock, power supply and signalling. For a few special examples, TSI have been compared with national laws, in particular with the Russian standards for high-speed rail. Although not mandatory, non-EU TER countries are recommended to apply TSI to ensure full interoperability also across EU external borders and to be prepared for possible future EU accession. Alongside TSI, the use of national standards may complement design of high-speed railways, e.g. if they demand a higher level of protection of the environment or against noise or for auxiliary components.

17. The section on prefeasibility, feasibility and alignment studies includes descriptions of studies on an ambitious high-speed project in Austria, which accompanied a step-by-step decision process, from which finally only the above-mentioned Koralm railway survived, for which the optimisation process of the alignment is shown. Other feasibility studies refer to the Rail Baltica project, which will be a UIC standard gauge high-speed project from Tallinn to northern Poland at least partially, as well as the feasibility study for upgrading the existing Orient-EastMed Corridor (former Pan-European Corridor IV) section between the Czech-Slovak (Kúty) border via Bratislava to the Slovak-Hungarian (Štúrovo) border.

Based in the results of this study, it was decided to upgrade the greater part of this section to 200 km/h.

18. Finally, construction and maintenance costs, implementation schedules, funding and financing of high-speed projects are compiled and discussed. This shows that construction costs vary extremely much, depending on the morphology and the actual land use and, of course of the economic level of the corresponding country. The variation of maintenance costs is less pronounced. It depends on the type of superstructure, in particular on radius and superelevation of the track.

19. Most of the TER countries that are also EU member States, are cohesion countries. From CEF budget, they are also entitled to receive up to 85 per cent co-funding for railway projects, including high-speed.

V. Methodology and Data

20. Whereas a large part of the study is on collecting information, on studies, legislation, data and planned or existing high-speed lines or projects, this core of the study is this part. It covers the calculation of traffic demand potentials are often the reason for implementing high-speed.

21. The principle of the corresponding methodology is gravitation, which dates back to Lill's travelling law of 1891: the traffic demand between two cities is directly proportional to the number of their inhabitants and reciprocally proportional to almost the square of their mutual distance. Actually, best results are obtained with the exponent 1.7, but for large countries with big cities at great distances, 1.5 or 1.6 may be more appropriate exponents, allowing for the longer average distances accepted for travelling. Without considering a more or less constant coefficient (corresponding to the gravitation constant in Newton's formula), but setting it to one, the resulting values are not real numbers of travellers but only proxies of the relative volumes of demand of the considered railway sections.

22. Consideration of the economy and any ongoing developments in the individual countries, which also have a direct impact on real traffic demand potentials, results in gravitationally "weighted" coefficients, which are obtained from the GDP per capita values for a certain country over a specific time (2015, 2030 and 2050) against the average GDP per capita of the EU. The forecast is based on current growth rates, which are extrapolated to 2030 and 2050, according to a higher growth scenario (unchanged growth rate until 2030, then reduced to 50 per cent growth rate until 2050) and a lower growth scenario (half growth rate until 2030 and no further growth after). This procedure is roughly in line with a long-term forecast curve for Czechia.

23. The advantage of this methodology is that only a few and easily available data can be used. Nevertheless, only numbers of inhabitants living within the political borders of the cities are generally available, not those living in entire agglomerations. Using these data would distort the results in the same way so that for comparing them, the error would not be crucial. Equally, for the distances between the nodes, direct distances have been used in all cases.

24. This methodology is applied in two examples: the existing high-speed line Vienna-Linz and the partially existing, at the long run continuous high-speed line Linz-Salzburg. The potential for Vienna-Linz being about twice as high as of Linz-Salzburg confirms the setting of priorities.

VI. Results, Assessment, Conclusions and Recommendations

25. In a first step, the above methodology is carried out for a set of “reference links”, i.e. existing high-speed lines, mainly in Western Europe and in the Russian Federation and Turkey. The results obtained can be used as the reference values, meaning that they may be understood as the minimum requirements necessary for high-speed investment.

26. Then, calculations are made for about 80 different sections that cover most of the TER area, but are focused on the international main corridors. The results are seen in five maps showing present potential traffic demands, and two forecasts for each of the two scenarios gives a good impression where priorities could be in the future. As an example of good practice, the high-speed strategy of Turkey is underlined.

27. This is followed by a section on project assessment. It starts with some deliberations in principle, as the distinction of strategic versus project level, delimitation, rules for monetising, and considerations of different assessment levels (operator, infrastructure and public society). Different assessment methods, such as effect analyses, multi-criteria analyses and cost-benefit analyses are compared. Representing the latter, two examples are described in detail: the extended cost-benefit analyses as had been developed by the Austrian Railways (ÖBB) and others, to include also socioeconomic effects resulting from improved regional accessibility, and the simpler Swiss NIBA. An excel tool from the NIBA method is presented in this section, and includes an assessment of the Slovak Orient-East Med Corridor section as investigated in the above-mentioned feasibility study. The excel tool is also attached to the study.