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# High Speed Railway Construction Programme for Poland – updated state of preparations

*Pendolino tested on CMK (8.12.2013); photo: G. Koclega*

Until the end of 2015 the necessary feasibility studies for the requirements of high speed railway construction programme will be performed. The last part of research is the analysis of the optimal connection of the future high speed line Warsaw – Lodz – Poznan/Wroclaw with Berlin and Prague. The contractor of the study is supposed to choose the best options for the construction of new lines from Poznan to Berlin and from Wroclaw to Prague. The complete feasibility study will be carried out on the basis of the presented proposals on the second stage of works. In this way, the liabilities resulting from the inclusion of the future line to the new trans-European transport network will be accomplished.

The construction programme for high speed railway in Poland that is currently under preparation, which had its beginnings in the nineties of the past century, is a key element of restructuring Polish railways towards their modernisation and implementation into the European railway system. The standards and quality of the latter make it possible to meet contemporary social and economic demands. At the same time there will be carried out the modernisation of Central Railway Line (CMK) to the parameters of high speed line and its extension from Warsaw to Krakow and Katowice and further to the Polish-Czech border. In 2014 it is planned to start on this line the exploitation of the trains Pendolino ED250 delivered by Alstom. On the first stage the trains will reach the maximum speed of 200 km/h.

## Development of the high speed railway concept in Poland

The *Directional Programme for High Speed Lines in Poland* drawn up in 1993 was the first concept for high speed rail lines construction in Poland. Although the programme in question was formed in the early nineties, the possibility of its execution was

set to 2030. Its main assumptions were to build a new east – west line through Warsaw, Lodz and Poznan in the trans-European axis from Berlin to Moscow and the extension of CMK line from the area of Grodzisk near Warsaw through Plock and farther to Gdansk. At the time works concerning demarcation of this new line as well as the necessary reservation of land were completed. The route at the section Warsaw – Lodz was marked out along the A2 motorway.

The project for the Warsaw – Poznan – Lodz line was published in the document called „National Transport Policy for 2001–2015” elaborated by the Ministry of Transport and Maritime Economy, 2001. In the first place it intended to construct the new Warsaw – Lodz line.

The 1993 study was the basis for the analysis on high speed railway connections development in Poland in *Passenger Traffic Study 2020 Poland and Czech Republic*, drawn up at the order of UIC in 2003. The summary of the Study in question contained the conclusions justifying the construction of high speed line at the section Warsaw – Lodz – Poznan – Berlin.

In 2002 a new concept of a radically improvement of Wroclaw – Warsaw connection was presented. However, even costly and significant modernisation of the existing line will not reduce the travel time between these cities to less than 2 hours. In consequence, there was proposed another economically justified conception of exploiting Warsaw – Poznan connection for trains operating on Warsaw – Wroclaw line with the turning to Wroclaw localised to the west of Lodz nearby Sieradz or Kalisz. The idea of constructing a junction in the vicinity of Kalisz has gained the greatest recognition and its advantage would be the minimalisation of the length of the new line with nearly equal times of travel

from Warsaw to Poznan and Wroclaw ranging from about 90 to 100 minutes. In this way, such dynamically developing metropolitan areas as Warsaw, Lodz, Poznan, Wroclaw and lesser Kalisz and Ostrow (approximately 5 million inhabitants in total) would be connected by a high speed railway. One more concept concerned linking this new line with the planned to modernise to high speed parameters Central Railway Line (CMK). This connection may be created through the modernisation of Lodz – Opoczno line (station localised at the CMK Line) or at the further stage by building a new line between these cities. As a result, there would exist high speed railway network of approximately more than 900 km, linking the largest metropolitan areas of Poland and numbering altogether around 10 million inhabitants. Furthermore, modernisation of the lines coming out of these urban areas and both extensions and adaptation of these lines for high speed trains create the possibility for most of provincial cities in Poland of being included in the high speed railway network. It is estimated that almost a half of Polish citizens would benefit directly or indirectly from these new high speed lines.

This concept gained extreme recognition and, as a result, in 2005 commissioned pre-feasibility study for its development.

### Planned 'Y' line and its inclusion into CMK line system

The route of a new Warsaw – Lodz – Poznan/Wroclaw line was determined in the study elaborated by the Polish Railway Institute (IK) in 2005 and, after its revision conducted during consultations, it became a basis for the analysis performed in a study carried out by IDOM (Spain). In 2013 the study was completed and the recommended optima variant of the route of the line was approved by the Inter-resort Team.

The route of the given line:

- ◆ from the stations Warszawa Centralna – Warszawa Zachodnia trains would operate on the current diameter line and from Warszawa Zachodnia there would be marked out a new route through grounds to the north of existing lines. At the border of Warsaw trains would reach the speed of 200 km/h and then change traction power supply system from 3 kV DC into 25 kV AC, and enter a new line;
- ◆ a route in the corridor of currently built A2 motorway between Warsaw and Strykow near Lodz, in the area of Grodzisk (about 30 km from Warsaw) would ramify to the south of the existed CMK line to Korytow station. Such solution would allow trains that run in the west and south directions to exploit the common high speed corridor;
- ◆ then from the crossing of A1 and A2 motorways the route would run under Strykow and then through A1 motorway corridor to the south and farther to Lodz Widzew station;
- ◆ from Lodz Widzew station through a tunnel and new underground station Lodz Fabryczna and farther by the tunnel under the city centre in westward direction (tunnel length will be about 4 km);
- ◆ next section of the line would run to the south of Jeziorsko Reservoir on the Warta River;

- ◆ then turning near Kalisz in the directions of Poznan and Wroclaw;
- ◆ the route to Wroclaw would run between Kalisz and Ostrow Wielkopolski. Near Ociadz and Antonin would be built junctions that will provide connection across the existing lines of Ostrow Wielkopolski junction would be built;
- ◆ the introduction of the line to the Wroclaw junction from the south east side with modernisation of the existing section Czernica Wroclawska – Siechnice – Wroclaw Brochów – Wroclaw Główny;
- ◆ the construction of a link at the east side of Wroclaw from a new line to E30 Wroclaw – Opole – Katowice line in order to connect Opole with Warsaw in travel time not longer than 2 hours;
- ◆ the introduction of a line to the Poznan junction from the side of Poznan Staroleka station
- ◆ at the west side of Ostrow Wielkopolski there is designed a connector about 10 km long which will enable direct linking of Poznan and Wroclaw with a high speed line.

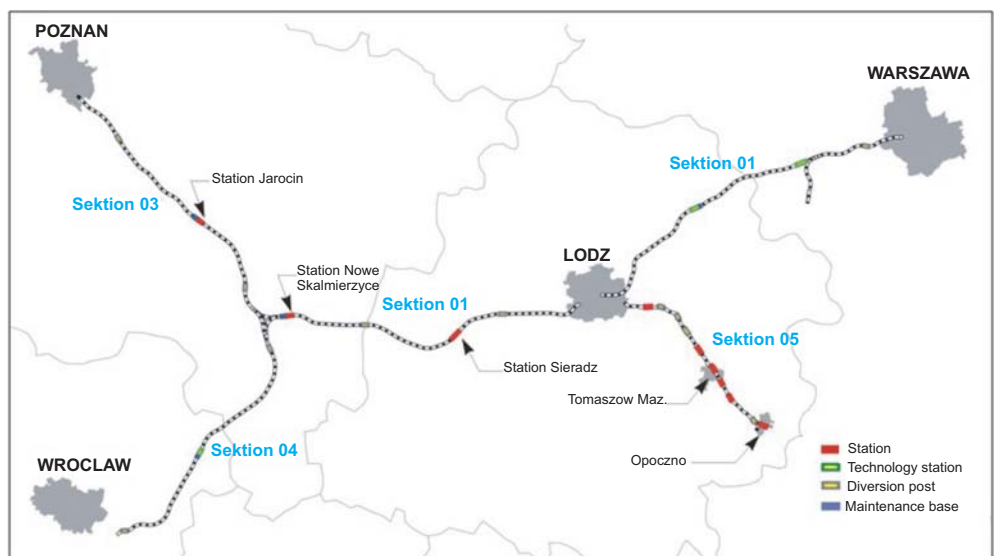
The total length of Warszawa Centralna – Wroclaw line will amount to 351,8 km and the route Warsaw – Poznan to 340,5 km.

At the same time the variant of connecting the new line with the CMK line between Lodz and Warsaw was chosen. It was decided that the modernisation of the existing railway lines to the speed of 160 km/h would be the best option. After its completion the distance of 90 km/h will be covered in about 40 min.

### Railway nodes

The governmental project for Constructing and Launching High Speed Transport in Poland requires the construction of central intermodal nodes that would link high speed, regional and urban systems with public transportation services in four cities at the Warsaw – Lodz – Poznan/Wroclaw line. Detailed feasibility studies have been conducted for adjusting these nodes to high speed railway operation with simultaneous integration with the existing conventional network.

This is particularly important in case of Lodz, as more than 50 percent of passengers of this new line will be travelling between Lodz and Warsaw. As a result, effective conducting of the line through Lodz will decide on the success of the entire project.



The route of the KDP Line Warsaw – Lodz – Poznan/Wroclaw

Source: Elaborated by IDOM.

Building in Lodz a multimodal station determines then the profitability of constructing this new line.

The Lodz node in its current state is dated from the 19<sup>th</sup> century and consists of two poorly connected systems with two stations of very low standard. Until now it has not been possible to join these systems by a diametric line. It is a major barrier for transport development in the region as well as for creating efficient interregional connections in Katowice/Krakow – Bydgoszcz and Warsaw – Kalisz – Wroclaw directions.

An investment package for transport permeability in this region of Poland has been prepared. The package consists of regional and central funds. To the most significant railway projects belong:

- construction of urban railway system from local governments and European funds (the beginning of its exploitation took place in June 2014);
- modernisation and revitalisation of railway lines in the region from regional and PKP PLK's funds, and development of regional network connections based on them;
- construction of a diametric tunnel under the city centre.

The construction project of a new central station as a regional multi-modal junction joins these projects together. The construction of this station was planned within the second stage of the modernisation of the current connection Lodz – Warsaw. This will enable the creation of important for high speed railway system effectiveness of trans-regional node in both east – west and north – south directions (regions of Gorny Slask – Kujawy and Pomorze). Map 2 describes a framework line system in the Lodz

junction. The completion of building works together with a tunnel in the west direction is planned for the end of 2015. Currently study works for the west part of the tunnel are carried out, which will enable the beginning of construction works in 2016. The length of the west tunnel is estimated for 3 km and it will have 4 rail routes, similarly to the east tunnel, where two of those rail routes will be designed for high speed lines.

## Technical parameters of the new line

The feasibility study, prepared by the Polish Railway Institute in 2006, determined elementary technical parameters for a new line Warsaw – Lodz – Poznan/Wroclaw on the basis of a foreign experience and current technical specifications of interoperability TSI.

The values of the most important parameters approved during the new line routing are presented in table 1.

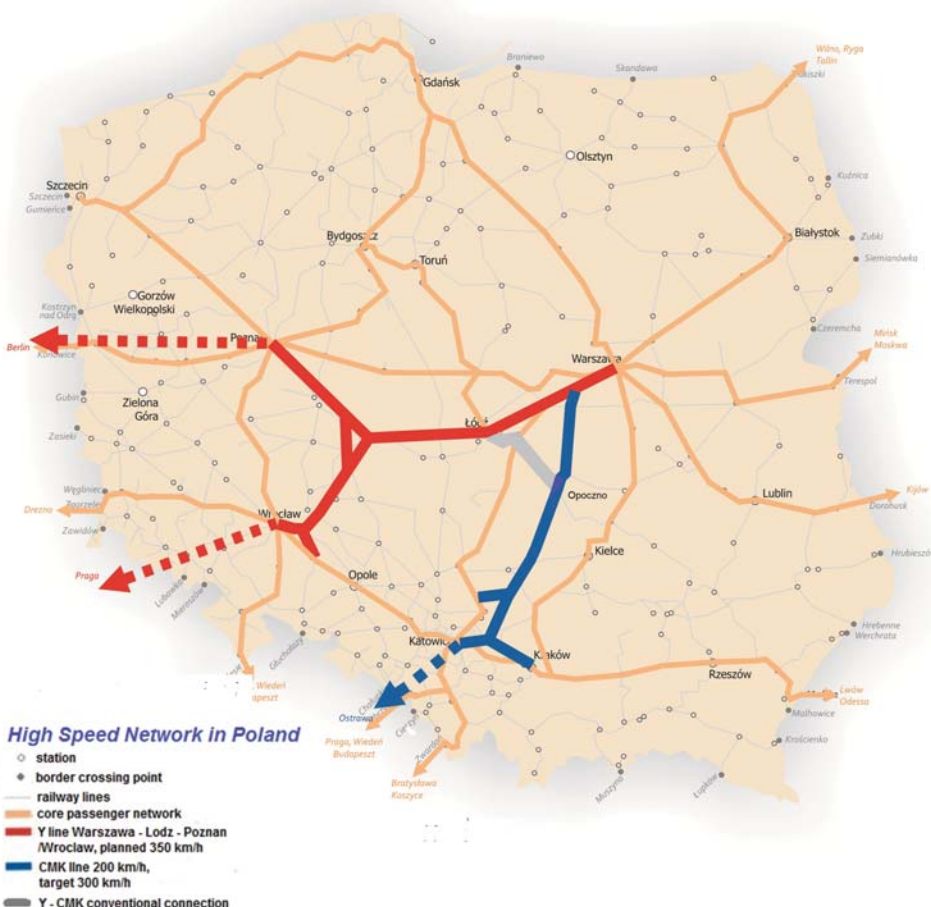
High Speed Railway was designed taking into account highly rigorous parameters concerning the comfort of travelling so as to increase the exploitation speed to 400 km/h in the future. Therefore, on the sections outside railway junctions and apart from the sections where specific conditions appeared (avoidance of environmentally important locations) the increase of the speed up to 400 km/h will be possible.

Reaching the maximum speed of 400 km/h will be possible thanks to increasing the tilt up to 180mm, i.e. to the maximum value allowed by TSI. Owing to this, even on the arcs with the radius  $R=7500$  m and clothoids  $L=500$  m it will be possible to increase the speed to this value.

Traction power system 2x25 kV 50 Hz with traction substations localised every 40–60 km and power supplied from isolated power line 220/400 kV AC were adopted for the new line sections where the speed reaches over 300 km/h, according to TSI [11] specification. Between these substations sectioning points equipped with autotransformers will be located. This system expects the construction of a contact line with diameter of 300–320 mm<sup>2</sup>. Traction system parameters together with power supply should enable trains to operate with a maximum speed of 350 km/h.

In the power system of 2x25 kV 50 Hz non-traction needs can be supplied from 27,5 kV catenary or railway tracks of traction substations and sectioning points via single-phase transformers. However, in 3 kV DC system non-traction needs require non-traction need line with SN/NN transformers. Public power supply can be a back-up power supply for both of the systems.

The basic requirement for control and command devices is providing high speed railway with Level 2 European Train Control System (ERTMS/ETCS) centralized devices which could constitute control and command system for trains based on data transmission between the track and the vehicle. ERTMS 2 system was also selected as a target system for Polish railway network.

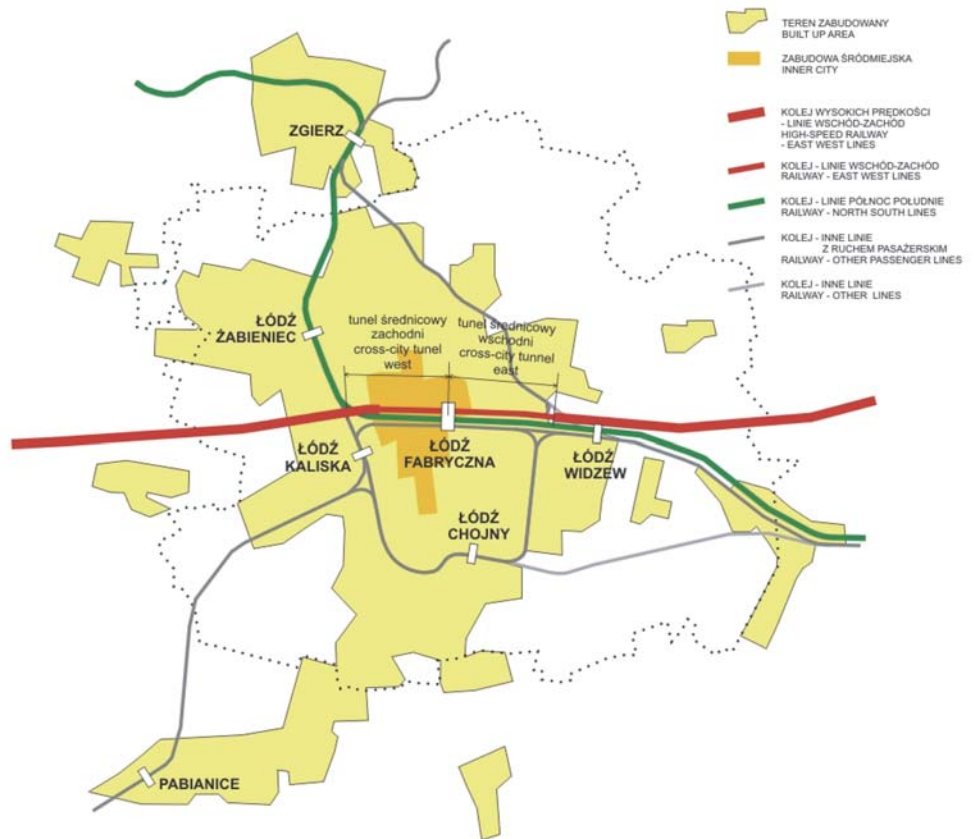


Map 1. The scheme of the route Warsaw – Lodz – Poznan/Wroclaw

**CMK line Warsaw – Katowice/Krakov**

The existing CMK line from Warszawa to Krakow and Katowice is going to be modernised and the speed can be raised even up to 300 km/h. It is possible due to its geometrical parameters (this line was built in the 70s of the 20<sup>th</sup> century). Moreover, the conducted study has analysed extensions of this line by new lines from Psary to Krakow and Katowice. The most convenient option is the extension of the CMK line in the south direction to Olkusz and the construction of new lines from there in the direction of Krakow and Katowice.

Entering the CMK line from Warsaw, which practically begins 30 km from Warsaw to the west in Grodzisk, would take place by means of a new line Warsaw – Lodz – Poznan/Wroclaw with the turning to the north from Grodzisk. Currently the CMK line at the section Grodzisk – Psary – Zawiercie is being modernised to reach the speed of 200 km/h. At the second stage of modernisation the speed can be increased to 300 km/h. The new sections of the lines would be built to reach the maximum speed of 300 km/h. In the future the line would be electrified with the power of 25 kV AC. Technical standards for the line would be the same as for the newly built line Warsaw – Lodz – Poznan/Wroclaw.



**Map 2.** The inclusion of Warsaw – Lodz – Poznan/Wroclaw high speed line into Lodz Railway Junction

**Table 1.** Rudimentary initial designing parameters of Warsaw – Lodz – Poznan/Wroclaw line

Parameter	Proposed values
Tilt	Proposed value - 160 mm Maximum value - 180 mm
Unstable acceleration	Proposed value $a_{dop} = 0,6 \text{ m/s}^2$
Minimal radius of horizontal arc	Basic value $R = 6000 \text{ m}$ Exceptional value $R = 4500 \text{ m}$
Longitudinal inclination	Proposed value - 15% Maximum value - 35%
Radiuses of vertical arcs	Basic value - 25 000 m Exceptional value - 20 000 m
Width of interrail	4,75 m

**Table 2.** Travel times in exemplary relations

Relations	Current times	High Speed times (including modernised conventional lines)
Warszawa – Lodz	1:30	0:35
Warsaw – Poznan	2:45	1:35
Warsaw – Wroclaw	5:00	1:40
Poznan – Wroclaw	2:00	0:50
Warsaw – Szczecin	5:30	3:15
Warsaw – Krakow	2:35	1:15
Warsaw – Katowice	2:25	1:15
Krakow – Poznan	7:00	3:00

**Outcomes and forecasts**

The construction of new lines will radically reduce travel time between largest agglomerations in Poland, 2-3 times on average. As a result, also competitiveness of railways should be remarkably improved in comparison to other means of transport. In many cases such short travel times will be unattainable for other conveyances. Consequently, there should be better synergy of cities and revival of economic and social relations. Exemplary travel times are described in table 2.

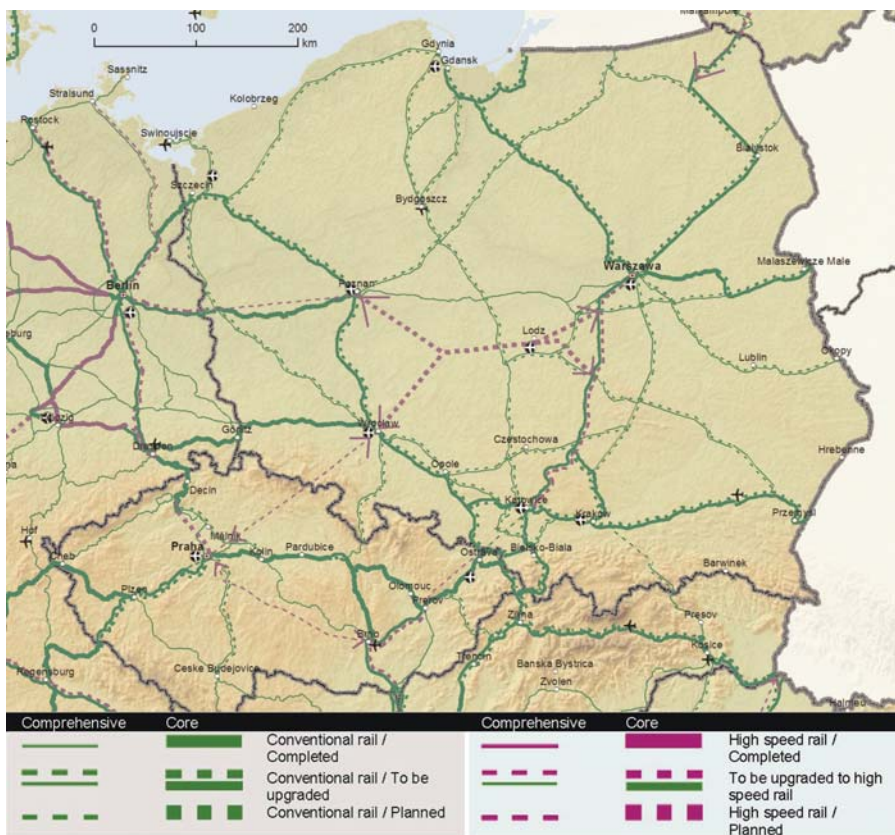
**International Connections**

The construction of a new Warsaw – Lodz – Poznan/Wroclaw line and the modernisation of the existing CMK Warsaw – Katowice/Krakov line should lead to the development of international railway connections.

The main relation which will significantly benefit from building a new Warsaw – Lodz – Wroclaw/Poznan line is Warsaw – Berlin. The travel time for this relation is estimated for approximately 3 hours and it will enable the creation of attractive for passenger night trains to different cities in west Germany, Belgium or the Netherlands. Moreover, it will be possible to launch high speed trains from Krakow through Lodz and Poznan to Berlin with the travel time not exceeding 4 hours and 20 minutes.

Radical improvement of Warsaw – Wroclaw connection and modernisation of E30 line from Wroclaw to the country border will create comforting conditions for the return on tracks of the eliminated few years ago trains from Poland to Drezden and Leipzig.

It will be also possible to create a good connection from Warsaw through Wroclaw to Prague. There is a proposal of building a new line in the direction of Walbrzych and through the tunnel



**Map 3.** Future High Speed TEN-T in Poland under new regulation of the European Parliament and the Council 1315/2013

under the Sudety and from Prague by a newly built high speed line to Nuremberg. The final spatial solution will be established through consultations with foreign partners.

Upon implementation of the Rail Baltica Line project, it is feasible to obtain convenient links from Wrocław and Poznań at least with Lithuania. Warsaw – Łódź – Wrocław line is a natural extension of E75 line (the first Pan-European corridor).

International connections are the subject of the agreement within the frameworks of Visegrad Group from 20 April 2010. They were the basis of establishing the route of Trans-European transport network in Poland and neighbouring countries. In the scope of international connections it was accepted that the designed high speed line Warsaw – Łódź – Poznań/Wrocław would be lengthened from Poznań to Berlin and from Wrocław to Prague. Moreover, the central main line from Warsaw to Katowice will be extended to Ostrawa and included into the Czech high speed network. In December 2013 a new regulation of the European Parliament and the Council 1315/2013 was published, specifying the directions of TEN-T network development for all kinds of transport. According to the White Book of European Commission from 2011, high speed railways play a significant role on the transport map of Europe. Both Polish high speed lines and their connections with high speed networks of the Czech Republic and Germany appeared on the maps in the regulation.

### 293 km/h – a new speed record on Polish tracks and preparations for launching the first high speed trains in Poland

Currently 20 trains from ED250 series based on the construction of Pendolino ETR610 produced by Alstom are being delivered. Thanks to this, at the turn of 2014/2015, it will be possible to reach the speed at the first stage up to 200 km/h on the currently

modernised CMK line. In the following years this speed can be increased even to 250 km/h.

The installation of the ERTM system level 1 on the line is being finalized. After the first tests, since August 2013, on a testing rail of the Railway Institute near Zmigrod exploitation tests of the trains on the CMK line between Psary and Góra Włodowska have been started and they have been conducted by specialists from the Railway Institute, Alstom, PKP Intercity, PKP Polskie Linie Kolejowe and PKP Energetyka. The operation of security systems European Train Control System-ETCS and RADIO-STOPU has also been tested.

On 24<sup>th</sup> November 2013 team train PKP Intercity ED250-01 during technical and movement tests on the Central Main Line at the section Psary – Góra Włodowska reached the speed of 293 km/h, setting a new speed record on the Polish railway network. The former record 250 km/h had belonged to Pendolino ETR460 since 1996.

This record is also the highest speed reached in the history of exploiting Pendolino trains in the world. The previous record of these trains equalled to 283 km/h and was established in 2007. The tests in Poland were carried out without any vehicle

modifications for their realisation. The Polish record is also the world record of a vehicle powered from a system of direct current under the voltage of 3 kV. The previous record belonged to a train from Russian railways – Sapsan, Siemens production (the family of high speed trains Velaro) and was established on the line Moscow – Petersburg in 2010.

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24 October 2013 – new speed record on Polish tracks; photo: A. Pomykała