Imperial College London

JTTRI

Japan Transport and Tourism Research Institute
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European High-Speed Rail: Strengths and weaknesses as we approach an uncertain future

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Timeline of high-speed rail in Europe

- High-speed rail in Europe took off after the 1974 petrol crisis.
- Europe's energy dependency threatened internal mobility, so several Member States (of the EU) decided to develop a safe, fast, comfortable and ecological mode of transport in the form of high-speed rail lines.
- Italy was the first European country to inaugurate a high-speed rail line: the line from Florence and Rome opened in 1977.
- Shortly afterwards, France inaugurated its own "Trains à Grande Vitesse" (TGV) lines. Germany's first high-speed lines, served by "Intercity Express" (ICE) trains, opened in the early 1990s, whereas Spain's "Alta Velocidad Española" (AVE) high-speed service commenced operations in 1992.

SPAIN RENFE

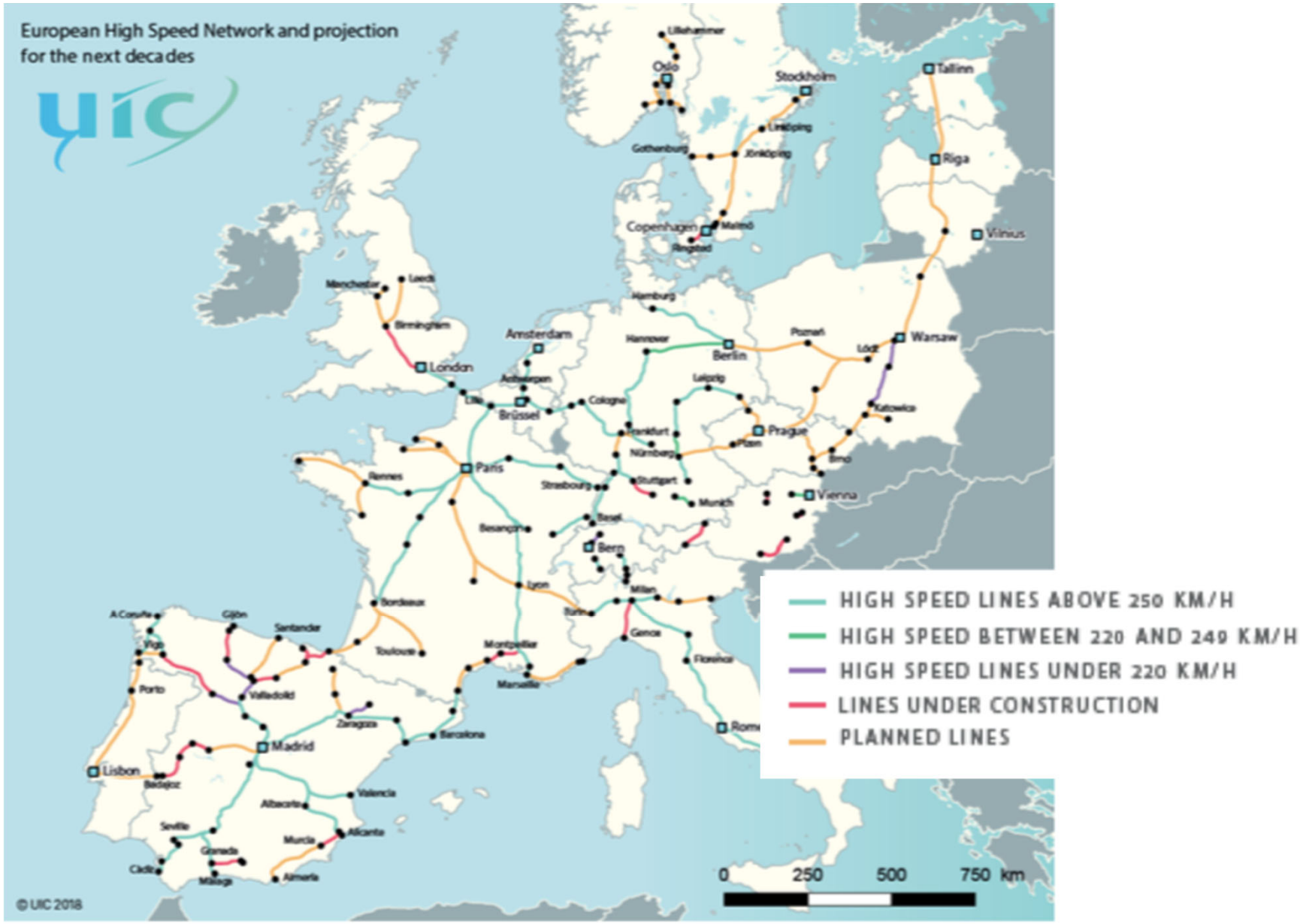
Many countries
Many types

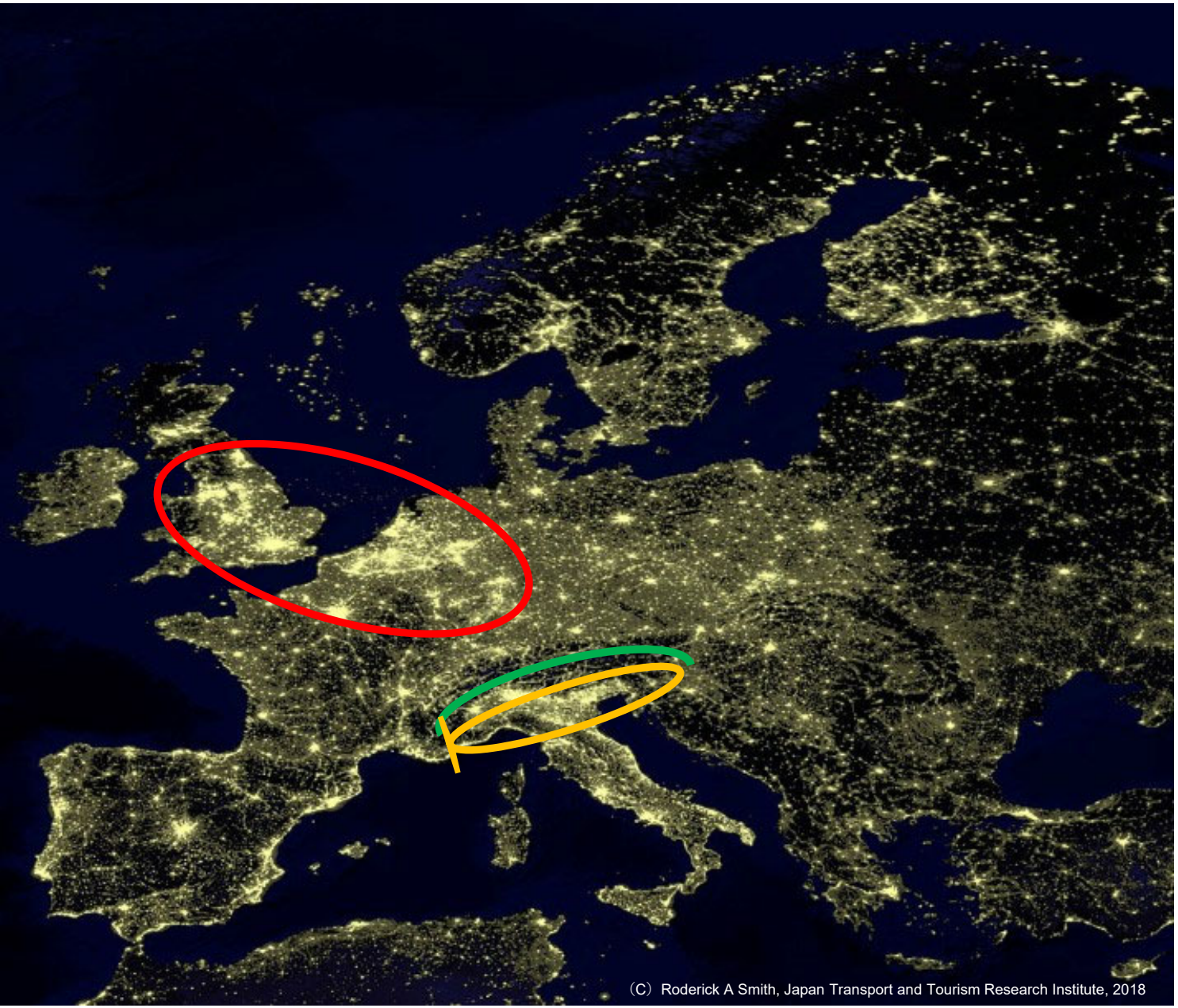
Now in process of changing to distributed traction from loco hauled

GERMAN ICE

EUROSTAR

FRANCE





Europe:
Using night lights as
a proxy for population

Importance of geography

High density
England
Low Countries

The Alps as a barrier
separating

North Italy

East and North?

France

Key route Paris Lyon

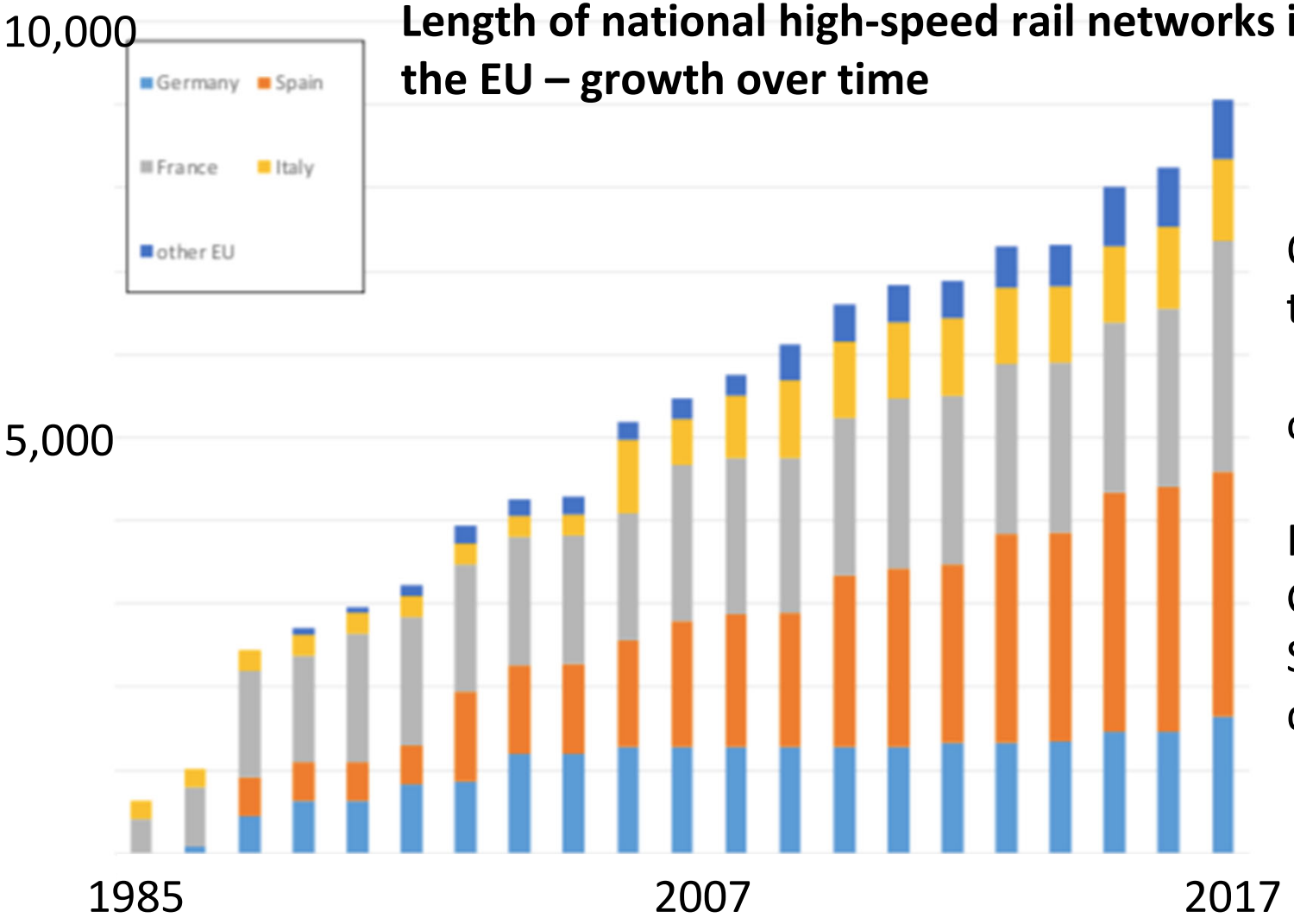
Distribution of small cities

Spain

Madrid Barcelona

Distribution of even smaller cities

Length of national high-speed rail networks in the EU – growth over time



Only includes trains travelling at speeds > 250kph on part of journey

France
Germany
Spain
dominate

Source: EU Statistical Pocketbook 2017; UIC.

Operational mix for High Speed Trains

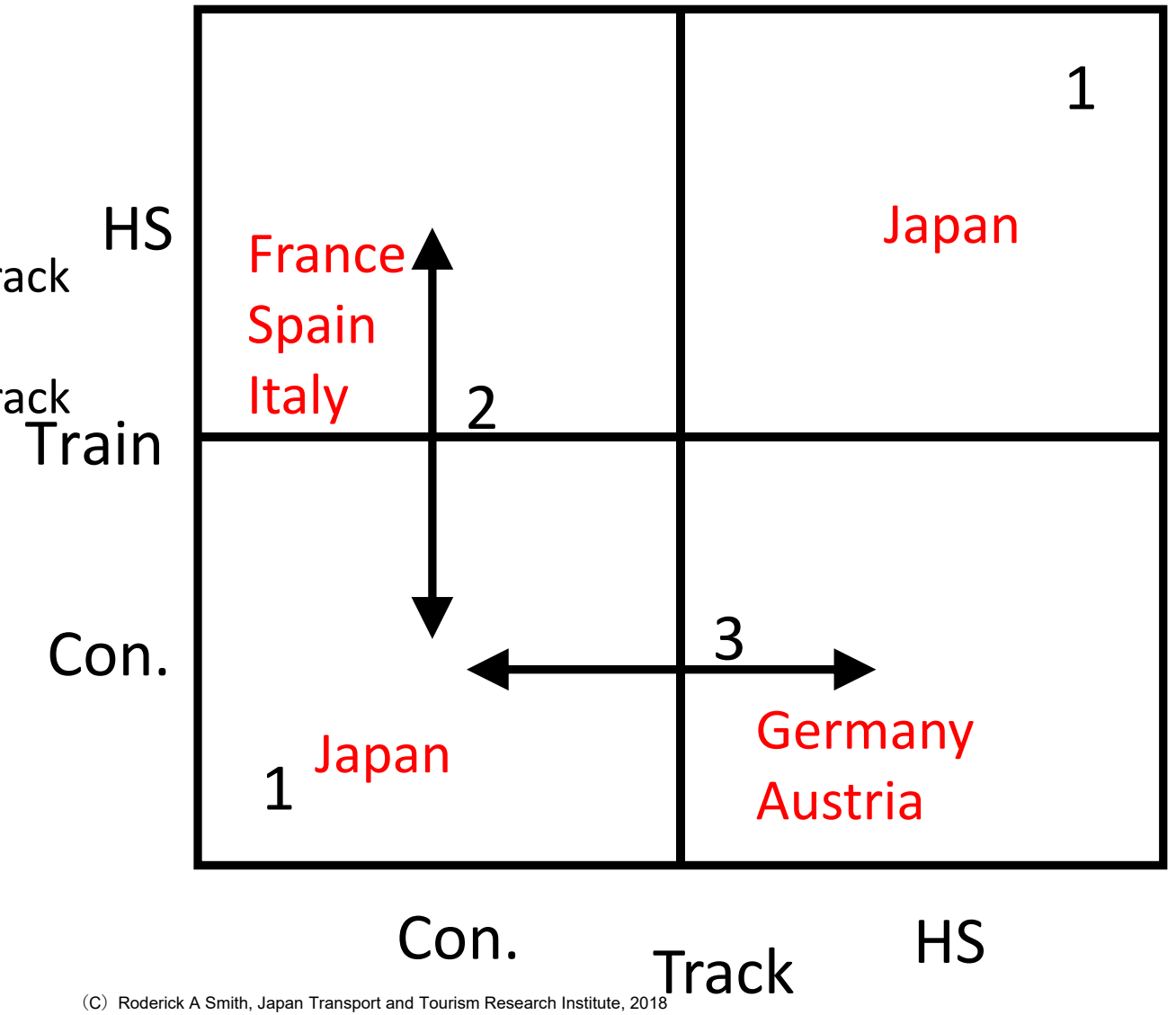
1. Segregated, separate
HS train on HS track,
Con. Train on Con. Track

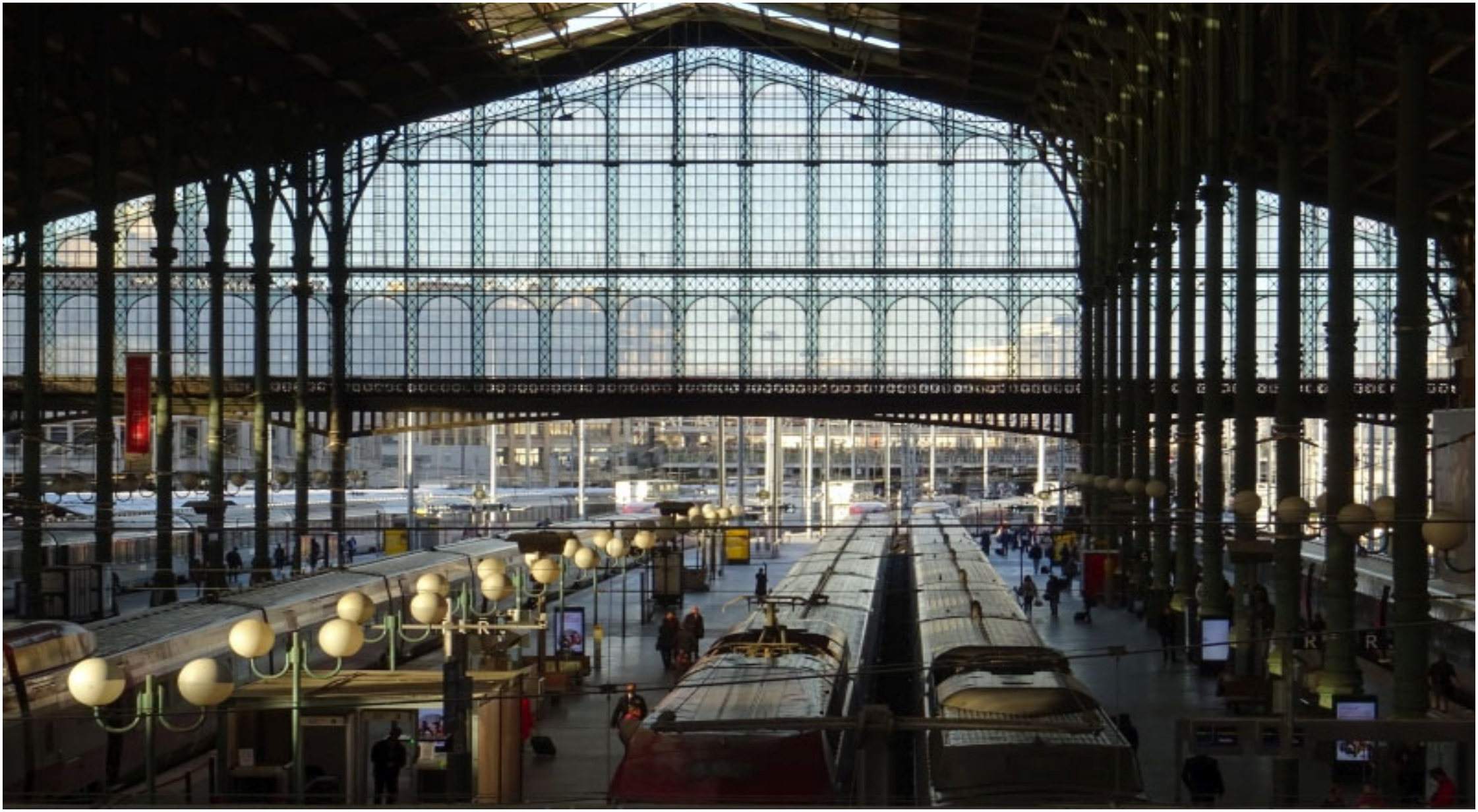
2. Mixed HS train onto Con. Track

3. Mixed Con. Train onto HS track

4 Promiscuous
Both types of train on
both types of track

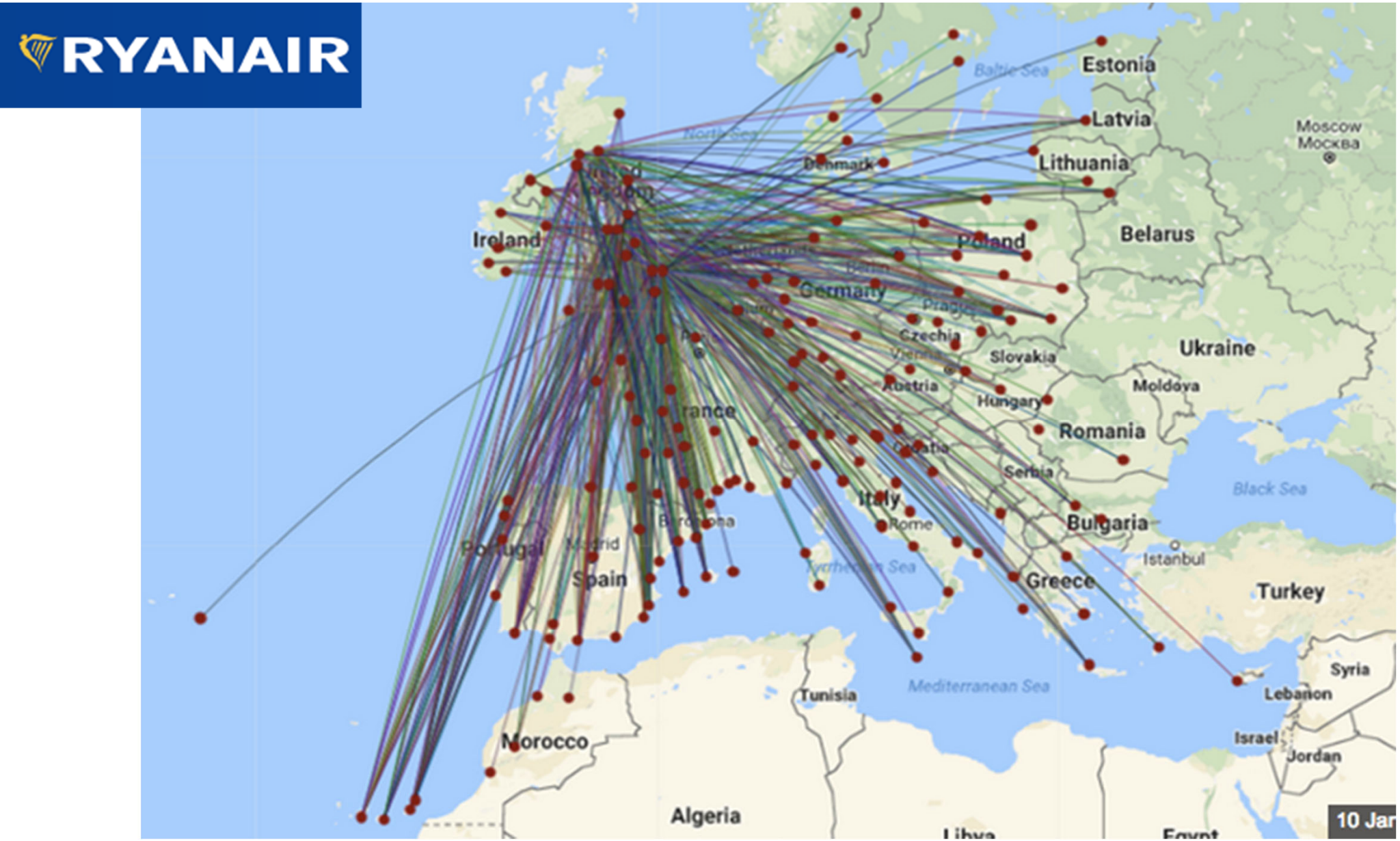
Examples





Liège-Guillemins TGV station

The rise and rise of the Low Cost Carriers (LCC)
A major displacement from long distance rail and growth in demand



Seikan tunnel	Comparison	Channel tunnel
Honshu Hokkaido	Connects	UK France
1939-40	Concept	1802
1971-88	Construction	1988-1991
53.8 km	Length	50.5 km
23.3 km	Length under sea	38 km
Complex, faulted Much leakage	Geology	Simple Chalk
34	Workers killed	10
50 freight trains /day + 30 shinkansen	Usage	400 trains/day 50,000 passengers 54,000 tons freight 6000 cars
140 kph	Max speed	160 kph
Single bore + service Duel standed +narrow gauge		Twin bore +service Standed gauge

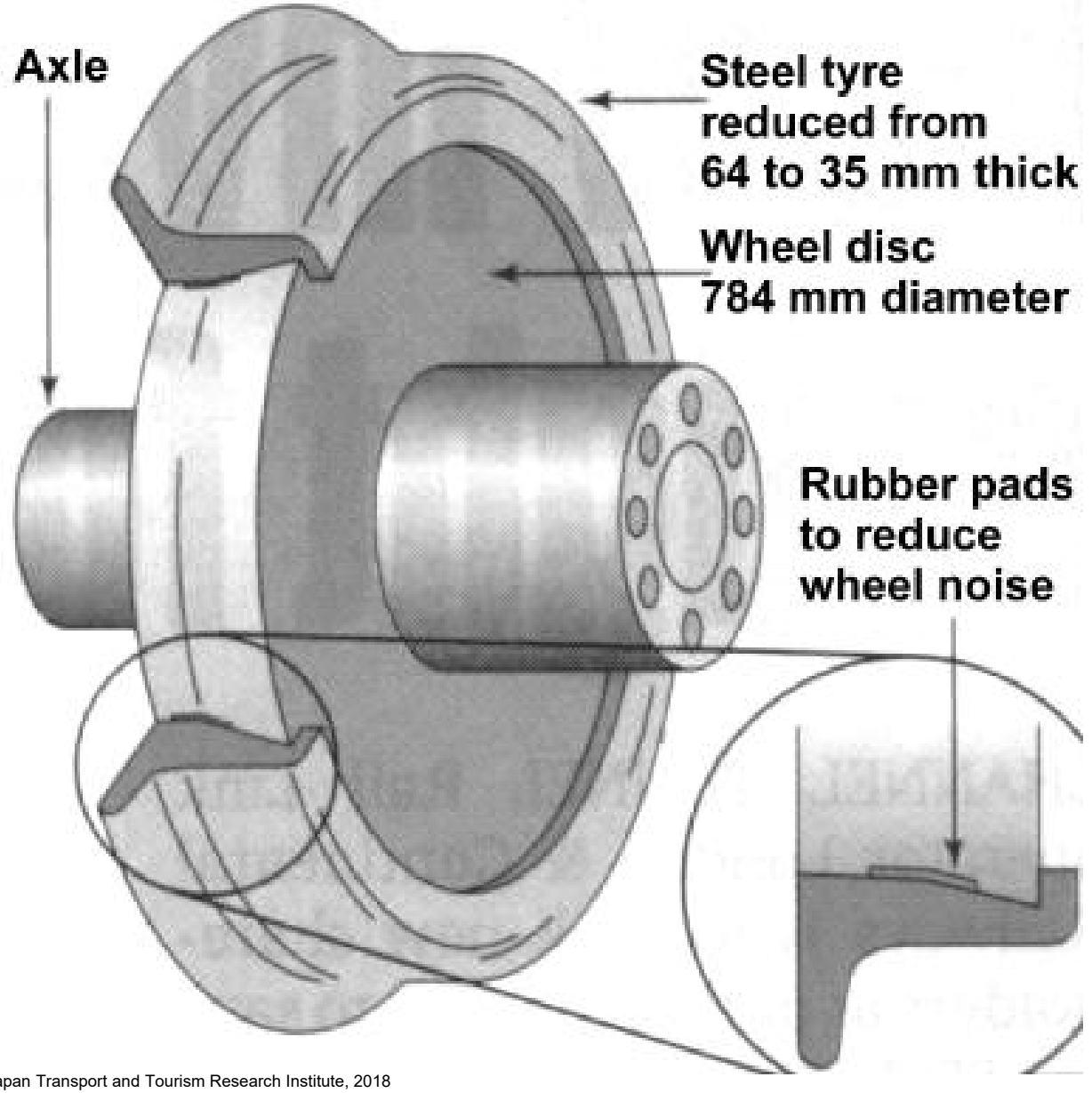
Safety on HSR: Japan-Europe Comparison

- Two philosophies:

1. Crash avoidance
    - Japan from 1964
        - Dedicated system with different rail gauge
2. Manage the risk
    - EU from 1981
    - Existing rail gauge enabled interoperability
    - Spanish system (2nd in the world by length) still has EU crashworthy standards
    - Interoperability and Safety Directives
        - Technical Specifications for Interoperability
        - Common Safety Methods

Eschede derailment 3 June 1998

Pile-up
under bridge:
101 fatalities



Cause:
Fatigue failure of separate rim of resilient wheel

Santiago de Compostela 2013

On 28 July 2013, the train's driver Francisco José Garzón Amo was charged with 79 counts of homicide by professional recklessness and an undetermined number of counts of causing injury by professional recklessness

Strasbourg 2015

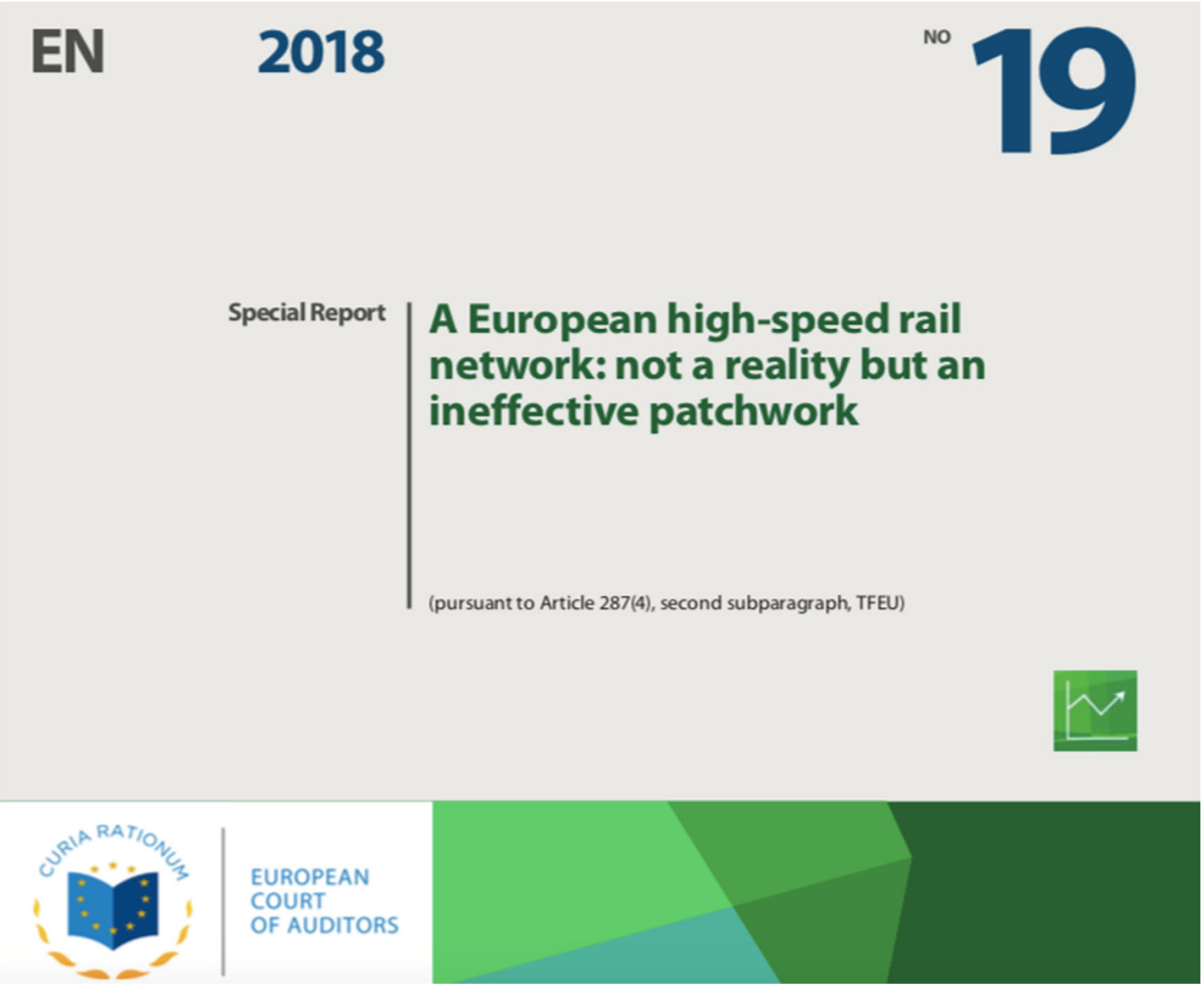
Test train

90kph overspeed on curve
derailment
11 deaths

Rescue workers search the wreckage of a test TGV train that derailed and crashed in a canal outside Eckwersheim near Strasbourg, eastern France, November 14, 2015. © Vincent Kessler / Reuters

Safety conclusions:

- Operation on dedicated HS lines is the lowest risk
- Operating HSR over conventional routes increases risk and imposes design constraints with significant cost
- Level Crossings and HSR do not mix well
- Transitions between different systems creates risks
- Integrating systems with different signalling and power creates risks – some of them unknown
- People are always going to make errors, and designing systems that do not deal with predictable human errors is the biggest source of risk to future HSR integration
- Simple / dedicated systems less susceptible to human error and technical incompatibility



Key report by European Court Of Auditors

Download from:
https://www.eca.europa.eu/en/Pages/DocItem.aspx?did=46398

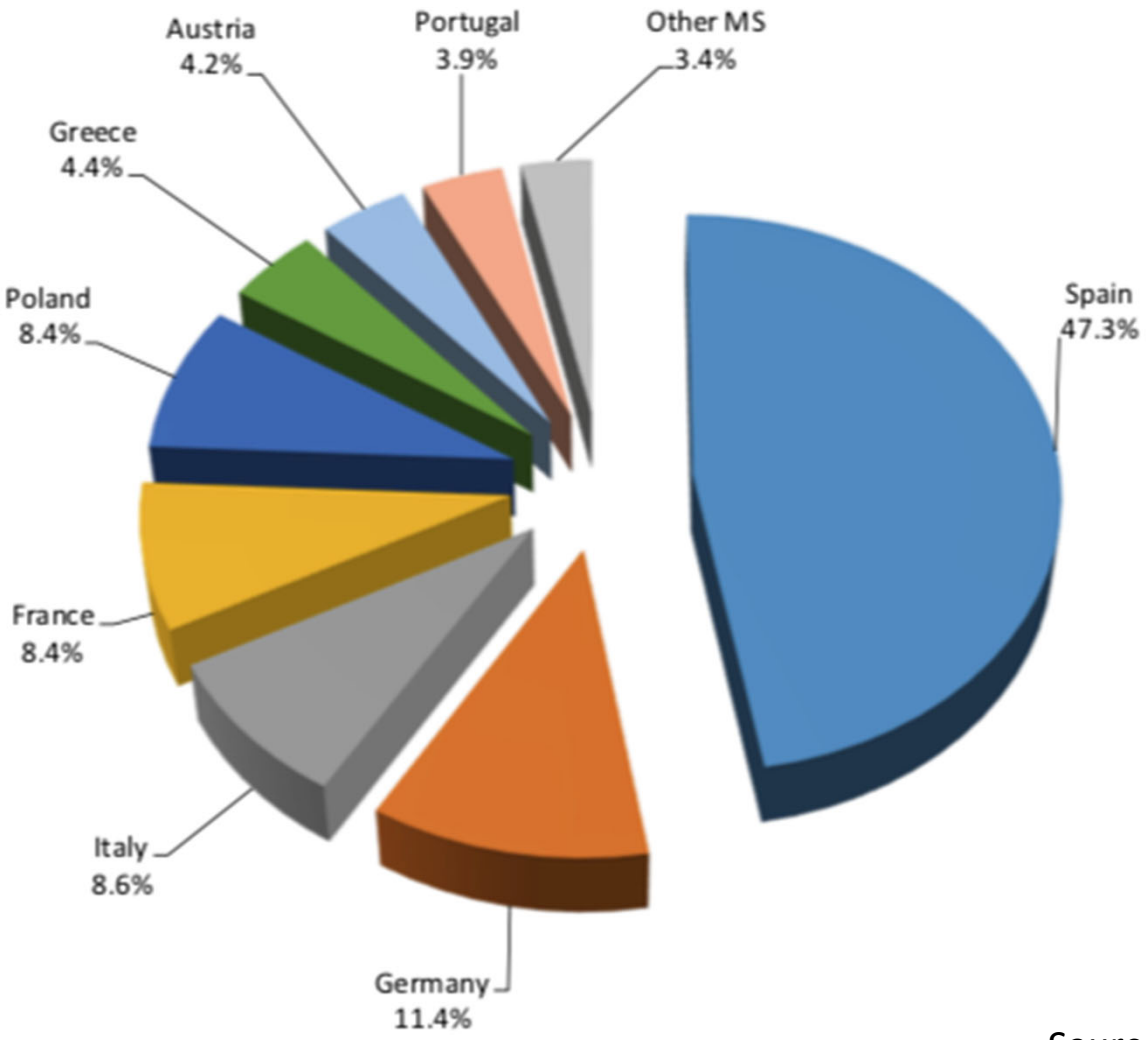
The report says:

- In reality there is no European high-speed rail network

- There is only a patchwork of national high-speed lines, planned and built by the Member States in isolation.

- This patchwork system has been constructed without proper coordination across borders: high-speed lines crossing national borders are not amongst the national priorities for construction, even though international agreements have been signed and provisions have been included in the TEN-T Regulation requiring core network corridors to be built by 2030.

- This means a low EU added value of the EU co-funding of high-speed rail infrastructure investments.



Overview of EU co-funding for high-speed rail by Member State (2000-2017)

Source: European Commission.

Assessment of time from planning to operation

Audited high-speed rail lines and Munich-Verona stretch	Planning started	Work started	In operation*	Years since planning	Duration of work in years
Berlin - Munich	1991	1996	2017**	26	21
Stuttgart - Munich	1995	2010	2025*	30	15
Rhin - Rhône	1992	2006	2011	19	5
LGV Est Européenne	1992	2002	2016	24	14
Madrid - Barcelona – French Border	1988	1997	2013	25	16
Eje Atlántico	1998	2001	2015	17	14
Madrid - León	1998	2001	2015	17	14
Madrid - Galicia	1998	2001	2019*	21	18
Milan - Venice	1995	2003	2028*	33	25
Turin - Salerno	1987	1994	2009	22	15
Munich - Verona	1986	2003	2040*	54	37

* Expected.

** 52 km not before 2018. *Source:* ECA.

Cost comparison of high-speed versus conventional rail: Venice – Trieste

Design configuration	Design speed *(km/h)*	Cost *(billion euro)*	Travel time *(min)*	Savings *(million euro/min)*
300 km/h new high-speed line	300	7.5	55	570
Upgraded conventional line	200	1.8	65	

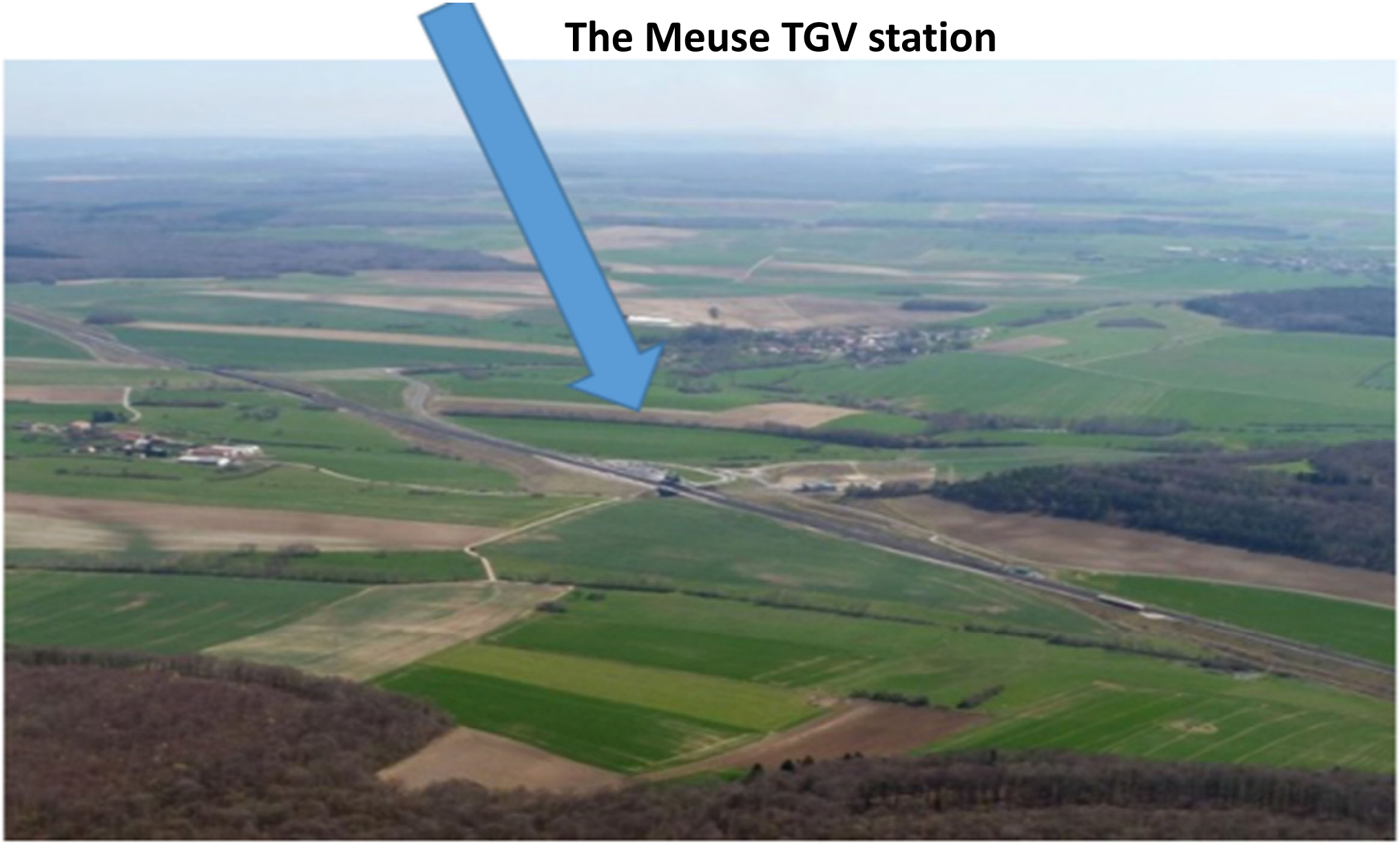
Source: ECA.

Door-to-door travel analysis on selected high-speed lines

	MADRID, Puerta del Sol - BARCELONA, Plaça de Catalunya		ROME, Piazza del Campidoglio - MILAN, Piazza del Duomo		BERLIN, Potsdamer Platz - MUNICH, Marienplatz		PARIS, Place de la Concorde - STRASBOURG, Place du Château	
Distance	607-698 km		572-661 km		587-654 km		466-548 km	
Mode of transport	Time	Price *(euro)*	Time	Price *(euro)*	Time	Price *(euro)*	Time	Price *(euro)*
Car	10:40-18:20	138-190	10:40-18:40	180	10:00-16:40	95-142	8:40-12:20	44-79
Air	6:30-8:00	227-253	6:30-7:00	140	6:30-8:00	146	N/A	N/A
Coach	16:20-18:00	36-49	15:00-21:00	40	17:00-23:00	45-79	13:00-22:40	33-55
Conventional rail	11:30-12:00	124-128	9:00-23:00	61-103	N/A	N/A	N/A	N/A
High-speed rail	6:00-8:20	159-181	6:50-9:00	23-205	8:30-10:30	66	5:10-5:30	158-165

Source: ECA.

The Meuse TGV station

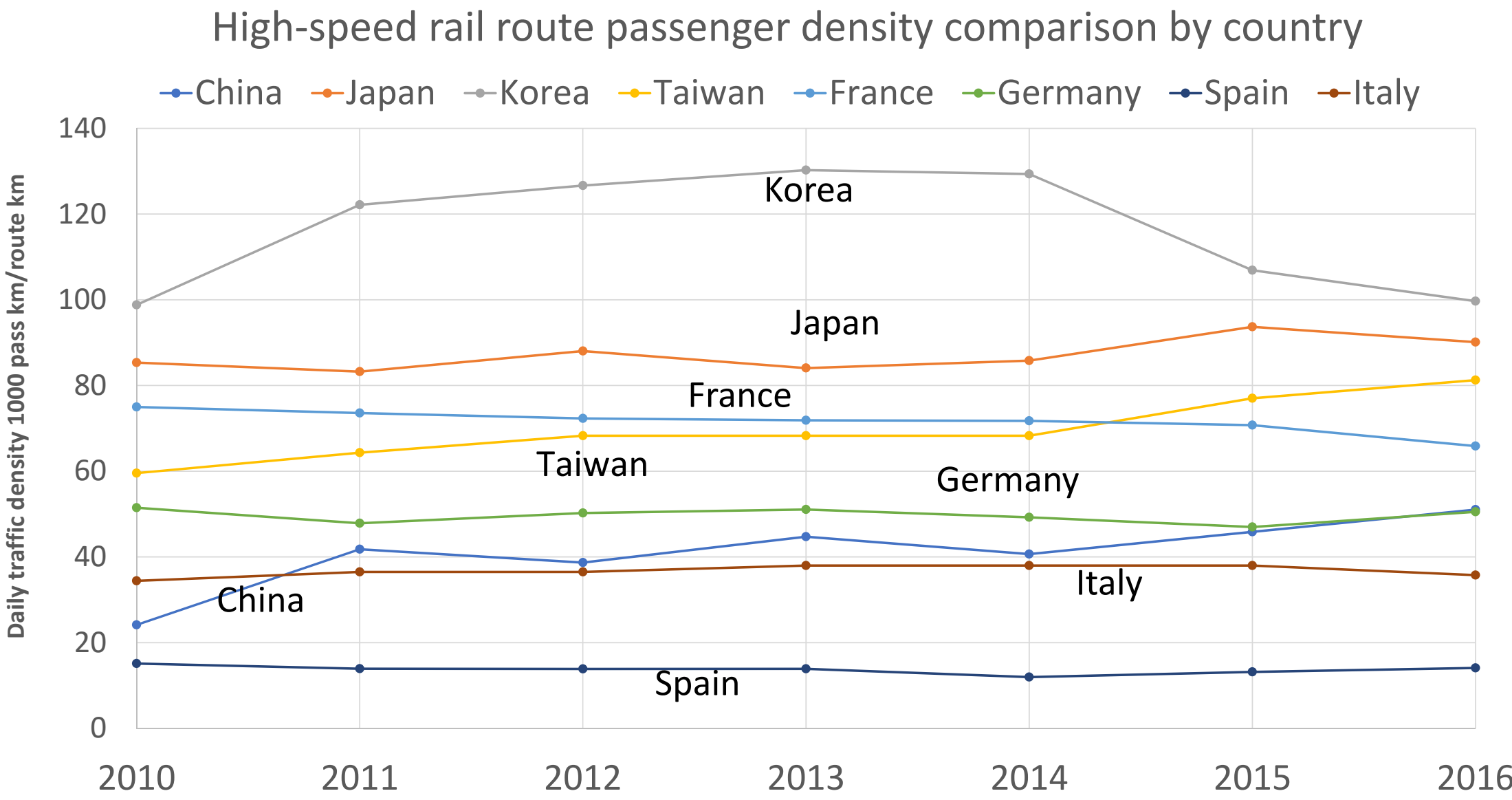


The report concludes:

High-speed rail operations have many advantages but there is no realistic long term EU plan, and there is no truly EU high-speed network

The Commission's target of tripling the length of the high-speed rail network (reaching more than 30 000 km in 2030) is not supported by credible analysis. We consider it unlikely that this target will be reached, because it takes around 16 years for high-speed rail infrastructure to be planned, built, and to begin operations.

There is no genuine European high-speed rail network: there is only a patchwork of national high-speed lines.



Key HSR Data per Member State

	HSR – completed *(km)*	HSR - completed and in construction *(km)*	Total Cost – completed *(million euro)*	Total Cost - completed and in construction *(million euro)*	EU co-funding - completed and in construction *(million euro)*	Pass-km *(billion)*	Population *(million)*
Spain	2 675	3 827	31 015	53 554	14 071	13.4	46.2
France	2 548	2 628	38 395	40 382	1 406	49.0	67.0
Italy	1 144	1 280	31 812	41 912	724	20.0	60.6
Germany	2 141	2 331	28 506	34 105	2 694	27.2	82.8

Calculated Key performance indicators

	Total Cost - completed / km	Total Cost - completed and in construction / km	Total Cost - completed / capita	Total Cost - completed and in construction / capita	Total Cost - completed / km / capita	Total Cost - completed and in construction / km / capita	EU co-funding / capita	Pass-km (mil) / km HSR	Pass-km / capita
Spain	12	14	671	1 159	0.25	0.30	305	5.0	290
France	15	15	573	603	0.22	0.23	21	19.2	731
Italy	28	33	525	692	0.46	0.54	12	17.5	330
Germany	13	15	344	412	0.16	0.18	33	12.7	329

Note: For France and Italy, the numbers exclude cross-border connections Brenner Base and Lyon - Turin tunnels; Pass-km for Italy is the latest publicly available estimate.

Source: ECA, national administration, infrastructure managers and railway operators.

Damage from HS2 'will be worse than thought'

The Times
13 Oct 2018

"The line to Birmingham, Leeds and Manchester will lead to the destruction of almost 900 homes, 1,000 business premises and at least 61 ancient woodlands".

Warning of power blackouts and end to Eurostar trains under no-deal Brexit

The Times 13 Oct 2018

Ministers are hoping to strike bilateral deals with France, the Netherlands and Belgium to keep services running but if these are not completed in time then they would have no legal basis to operate due to licence and border issues.

Concluding remarks:

HS rail started in Europe in 1974

Spain now has the largest route, France and Germany probably best established

“Captive” running on dedicated track is somewhat limited

Accidents have happened to HS trains on conventional track

Many lines terminate in old city centres

Cross border running is rather limit no European wide system exists

UK has many fast and frequent routes on conventional line, but now building HS

Eurostar from London to Paris and Brussels (and beyond) is the only example in the world of an undersea rail connection between countries

Threats exist from LCC airlines, Brexit, financial perturbations within the EU and terrorism

Therefore future growth is less than certain

Thank you for your kind attention