# UIC-Study **Night Trains 2.0**

## New opportunities by HSR?

Executive summary


# Night Trains 2.0 – New opportunities by HSR?

UIC-Study

DB International GmbH

on behalf of the

INTERNATIONAL UNION OF RAILWAYS (UIC)

Berlin, 30 April 2013

# Agenda

- First general results and recommendations
- Background and purpose of the study
- Analysis of the current situation
- Survey of infrastructure and operation conditions
- Identification of opportunities for Night Trains in 2025
- Backup

# Agenda

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**First general results and recommendations**

Background and purpose of the study

Analysis of the current situation

Survey of infrastructure and operation conditions

Identification of opportunities for Night Trains in 2025

Backup

# Very Long Distance Night Trains (VLDNT) can compete traditional air routes in the near future if rail infrastructure costs fall significantly

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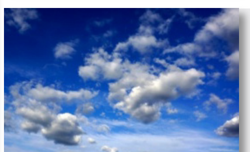
Recommendations

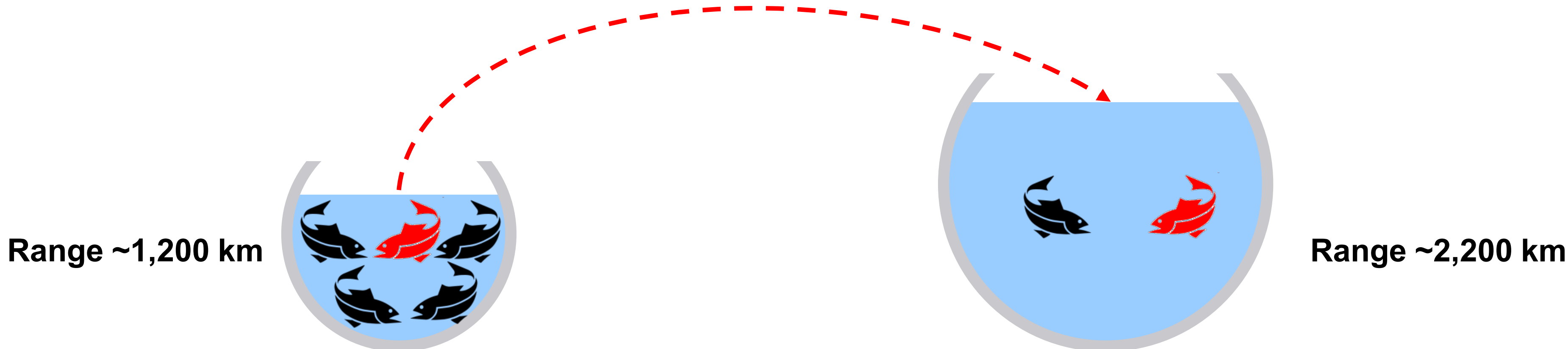
## Assets & challenges

| | | KEY FINDINGS | RECOMMENDATIONS |
|---|---|---|---|
| **ASSETS** |  | **New HS infrastructure and rolling stock** significantly extends overnight travel ranges and makes numerous long distance city connections possible | **Continuing construction** |
| **ASSETS** |  | **PAX traffic volume** on reviewed connections offers a substantial base for planning new Very Long Distance Night Train services | **Detail studies** |
| **ASSETS** |  | **High energy efficiency and environmental advantages** will improve VLDNT competitiveness vs. air transport in view of rising oil prices and stronger regulations | **Intensified communication** |
| **DAILY BUSINESS** |  | **Infrastructure and operation limitations** require different maintenance procedures and modified freight operations in some network areas | **Detail studies** |
| **CHALLENGE** |  1) | **Infrastructure costs** are by far the biggest cost driver and prohibit competitive VLDNT offers at the moment | **Political lobbying** |

# Using HS infrastructure and rolling stock, Night Train service enters a different competitive arena: Very Long Distance segment

Assets

## Competition area



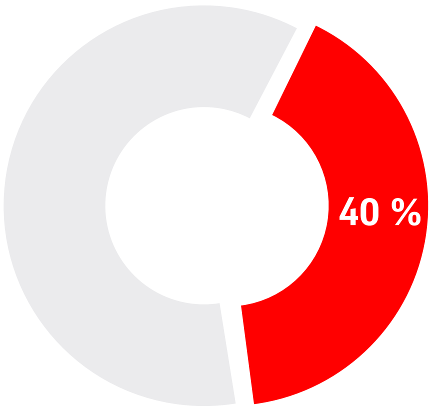

| | | | | | |
|---|---|---|---|---|---|
|  | HS day train | Comfortable, fast | ✓ | Whole day trip, today < 5 % market share | ✗ |
|  | Car | Cheap, one day trip | ✓ | > 24 h, overnight stay spending | ✗ |
|  | Coach | Cheap, one day trip | ✓ | > 24 h, uncomfortable | ✗ |
|  2) | Plane | Fast, affordable | ✓ | Fast, affordable | ✓ |
|  | Night Train | Overnight, affordable | ✓ | Overnight, affordable | ✓ |

# In order to achieve successful load factors VLDNT just have to acquire a fraction of modal shifts – e.g. HS market entry

Assets

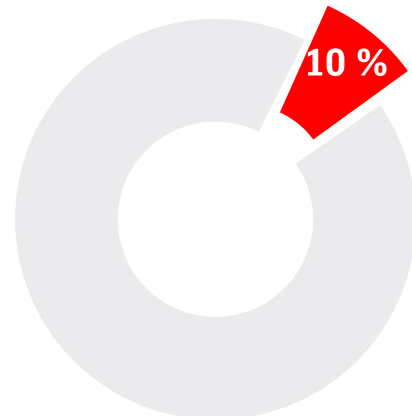
## Market

### Achieved shift from air to HS...




| | 2000/02 | 2008/12 |
|---|---|---|
| Barcelona - Madrid | 10 % | 50 % |
| Paris - London | 60 % | 80 % |
| Paris - Marseille | 45 % | 80 % |

### Required shift from air to VLDNT....




| | 2012 | 2025 |
|---|---|---|
| China South East | 0 % | 2 % |
| Europe West | 0 % | 4 % |
| Japan Link | 0 % | 7 % |

Sources: http://ebookbrowse.com/sdg-2009-potential-for-modal-shift-from-air-to-rail-for-uk-aviation-pdf-d214312717
http://ec.europa.eu/transport/rail/studies/doc/2006_08_study_air_rail_competition_en.pdf
http://www.invensysrail.com/whitepapers/hsh-research-report.pdf
http://www.publicsectortravel.org.uk/chart-of-the-week-railair-market-share/

# VLDNT benefits from electric mobility on the long run because of rising oil prices and state-run climate protection regulations

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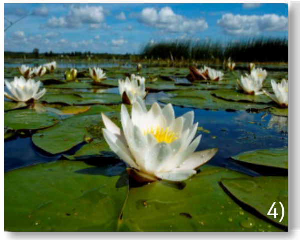
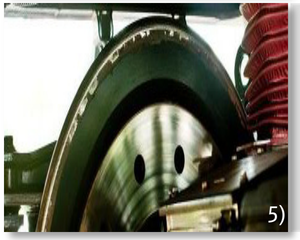
**Assets**

**Environment**

| | | **Very Long Distance Night Train** | **Medium haul flight** |
|---|---|---|---|
|  3) | **OIL INDEPENDENCY** | – Electric powered train<br>– 100 % renewable energy supply feasible | – No serious alternatives to fossil fuels so far<br>– Forecast: long-term dependency from Oil |
|  4) | **ENVIRONMENTAL SUSTAINABILITY** | – High energy efficiency<br>– Use of renewable energies | – High climate effects based on RFI |
|  5) | **ROOM FOR TECHNICAL IMPROVEMENT** | – Potential of energy savings until 2025: **50 %** | – Potential of energy savings until 2025: **40 %** |
| | **FUTURE VIABILITY** | | |

# At the moment there are some infrastructure and operation limitations for NT using HS infrastructure – but no insuperable obstacles

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## Infrastructure and operation limitations

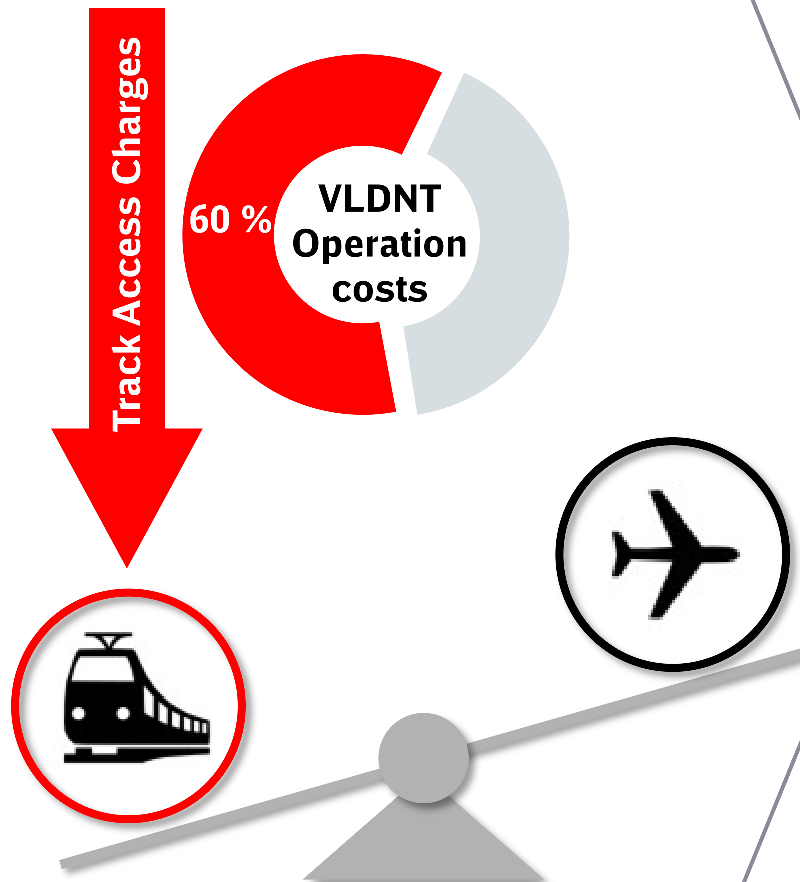
| | | | Daily business |
|---|---|---|---|
| OPERATIONS |  | **Intersection capacity** – traffic bottlenecks due to capacity deficits in rush hour times) | ⚠ ⚠ ⚠ |
| |  | **Rolling stock requirements** – maximum gradient of HSL requires special rolling stock parameters | ⚠ ⚠ |
| NIGHT OPERATIONS |  | **Maintenance** – Overnight maintenance could lead to HSL closures | ⚠ ⚠ |
| |  | **Freight train operations** – conflict of VLDNT with slower freight trains on infrastructure shared by passenger and freight trains | ⚠ ⚠ |
| SECURITY |   6) | **Border control** – operational stops due to process passenger controls | ⚠ |
| |  7) | **Check-In facilities** – absence of security check-in facilities at stations served by trains using exposed HSL | ⚠ |
| INTER-OPERABILITY |  8) | **Interoperability** – obstacles for nonstop operations due to technical incompatibilities | ⚠ ⚠ |

# Track access charges are by far the biggest cost driver and prohibit competitive VLDNT offers



Challenge

**Infrastructure costs**




- Round about **60 % of operation costs** cannot be influenced by the train operator
- Present high **track access charges overcompensate advantages** of VLDNT in comparison to air travel
- Particularly utilization of **Channel Tunnel** is **extremely expensive**

**Without adjusted charges for Night Train track slots VLDNT services are not competitive**

# Agenda

First general results and recommendations

**Background and purpose of the study**

Analysis of the current situation

Survey of infrastructure and operation conditions

Identification of opportunities for Night Trains in 2025

Backup

# Purpose of the study - The study reveals opportunities and challenges of a future night train

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**Background and purpose**

- What about the **opportunities of operating the Night Trains in an economic way** in future?
- How can the **extending / planned HSR support** a potential development?
- **The current challenges of the Night Trains could be characterised as follows:**
  - HSR has negative impact on the Night Trains (demand market)
  - New High Speed Lines and the network is growing
  - Extension of HSR day service
  - Competition of Night Trains with air traffic / low cost airlines is growing
  - Competition of the railways in respective to capacity on the network / HSL
  - Extremely expensive track access charges accrued due to the long distances



# Basic approach: High Speed Rail (HSR) as an opportunity to create new night train offers and service attributes

Background and purpose

## Chances

- **Extension of the network**
  - Development of new non-stop offers, extended travel range by using HSR infrastructure/rolling stock
  - Identification of route options / variants
- **Enhancement of the robustness in operation**
  - Later departure on existing lines
  - Reduction of the travelling times
- **New aspects for a positioning strategy**
  - Increasing importance of environmental aspects
- **Possibility of multiple utilization of night train rolling stock**
  - Night Trains are suitable for high quality HSR day traffic
  - Reduction of travel times at night frees up time to modify night into day trains

## Night Trains 2.0



## Challenges

- **Relation revenue vs. costs**
  - Main cost factors (e.g. track access charges) increase proportionally to the travel distance
  - At the same time the willingness to pay of the customer does not rise linearly to the increasing distance of the route
- **Infrastructure capacity**
  - Conflict potential in regard to the increasing day services and freight traffic volumes
- **Competition of Night Trains with air traffic and HSR**
  - Cut-throat price competition on many medium-haul flight routes caused by low-cost carriers

# In general, the three categories of Night Trains are conceivable but the study only focuses on the "Classic Night Trains"

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Background and purpose

## Night train categorisation model

| | Standard Day Train | Classic Night Train | | | Touristic Journey Train | |
|---|---|---|---|---|---|---|
| | Overnight Day Train | Simple Night Train | Traditional Night Train | Hotel Night Train | Multi-Day Night Train | Luxury (Night)Train |
| **Definition** | ▪ **Standard day** train rolling stock **running overnight** (core night time 24-05 h) on long distance connections | ▪ **Long distance** train including the **opportunity of couchette** coaches | ▪ **Long distance** train including the opportunity of **couchette** coaches and **sleeping** cars | ▪ **Long distance** train including the opportunity of **sleeping** cars, in this class only **whole compartments** can be booked, not single beds | ▪ **Long distance** train including the opportunity of **sleeping** cars<br>▪ Train journey including **two or more night times** | ▪ **Long distance** train running **partly overnight**, special **luxury** trains or at least luxury cars included |
| **Examples** | ▪ IC 2020 Frankfurt - Hamburg | ▪ Intercités de nuit | ▪ CNL<br>▪ EuroNight | ▪ Elipsos | ▪ Trans-Siberian Railwav<br>▪ Southwest Chief (coast-to-coast USA) | ▪ Eastern&Oriental Express<br>▪ Rocky Mountaineer<br>▪ Royal Scotsman<br>▪ Venice Simplon Orient Express |

Focus of the study to:

- **Market size** – also attractive for business travellers
- **Market segment** – competing medium-haul flights by overnight train trip (max. 12 h)
- **Product differentiation** – train bed vs. plane seat

# The use of HS Trains and HS Infrastructure offers a new market for overnight travel: Very Long Distance Night trains (VLDNT)

Background and purpose

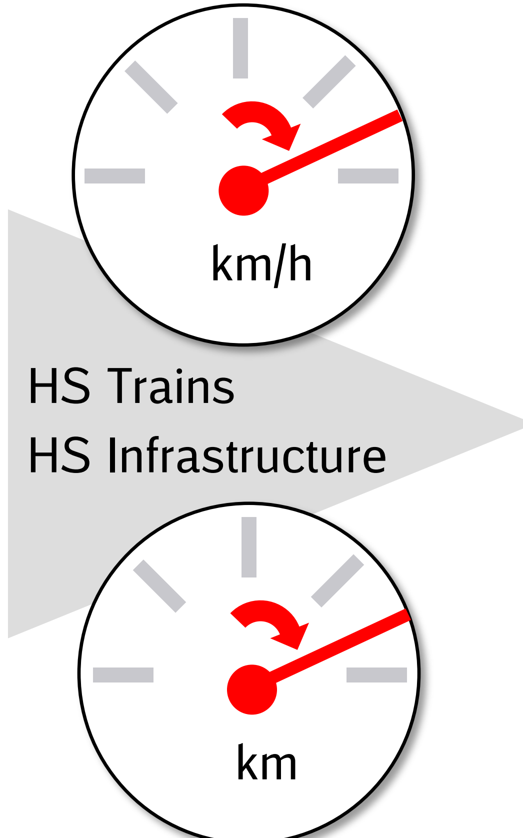
## Potential new Night Train market

### Traditional market


**NIGHT TRAIN**

**Maximum speed**
~ 200 km/h

**Travel range per 12 h**
~ 1,200 km




### New market

9)

**VERY LONG DISTANCE NIGHT TRAIN**

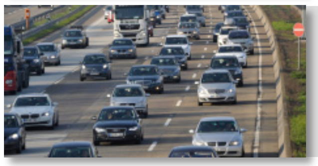
**Maximum speed**
~ 300 km/h

**Travel range per 12 h**
~ 2,000 km

# Conservative approach focuses on air travel market cause of highest market shares and adequate data availability

Background and purpose

## Considered competitors in potential analysis

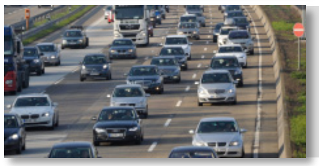
| | Market relevance | Data availability | Explicit treatment in potential analysis |
|---|---|---|---|
|  | ↘ | ↘ | ✗ |
|  | ↘ | ↘ | ✗ |
|  | ↘ | → | ✗ |
|  2) | ↑ | ↑ | ✓ |

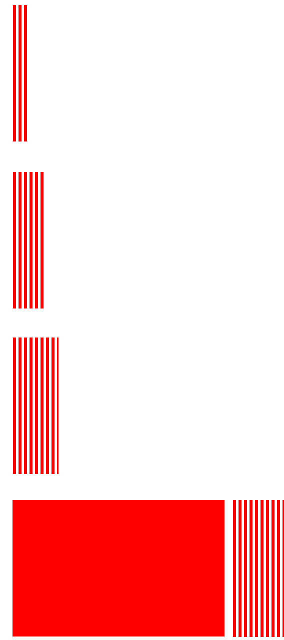
- **Very conservative approach** that is focused on **shifting modal shares from air to VLDNT**
- Attractive VLDNT offers will probably also win **PAX from current coach and day train connections** – but there is no confirmed data allowing proper estimations.
- Some experts predict a **change of competitive environment** caused by VLDNT market entry – e.g. new coach services. These assumptions are not part of the study.

# Very Long Distance Night Trains will attack an airline dominated market and "Win airline passengers or fail!"

Background and purpose

## Prioritisation of the competitor – 2,000 km trip

| | Maximum speed | Travel duration | Price sensitivity | Market share |
|---|---|---|---|---|
|  | 330 km/h | ~10 h | → | 0 - 5 % |
|  | 130 km/h | ~30 h | ↑ | 0 - 10 % |
|  | 100 km/h | ~25 h | ↑ | 0 - 15 % |
|  2) | 900 km/h | ~3 h | ↘ | 70 - 90 % |
|  | 300 km/h | ~12 h overnight | → NEW! | |



# Only for the airline market exists resilient and accessible data to conduct the potential analysis

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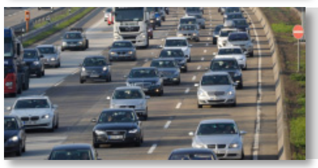
Background and purpose

## Accessible information about …

| | Time table / capacity | Load factor | Point-to-Point PAX volume | Transfer PAX | Database for potential analysis |
|---|---|---|---|---|---|
|  | Green | Yellow | Red | Red | Red |
|  | Red | Red | Red | Red | Red |
|  | Yellow | Yellow | Red | Red | Red |
|  2) | Green | Green | Green | Red | Green |

# The final selection process for the business cases includes all recent results but will be done by using selection criteria

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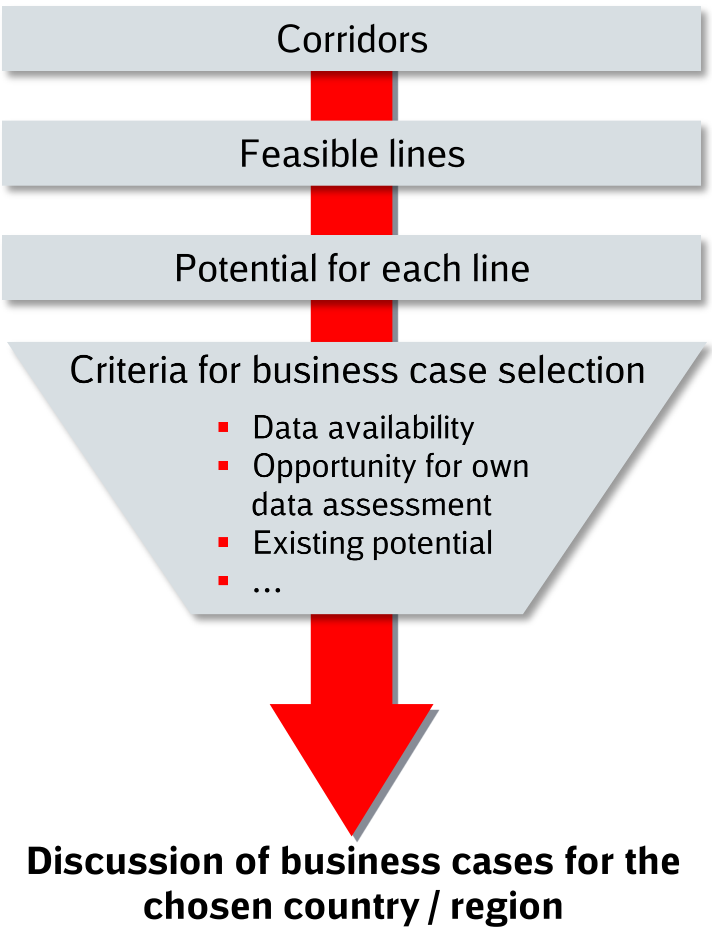
## Working approach – corridor to business case




- Definition of **potential corridors** for each region / country serves as **basis** for the **overall work** – depends on the **framework conditions** in the considered area
- Further analyses on the basis of the corridors lead to **feasible lines** (consideration of infrastructure, speed, HS projects, …) – depends on the **framework conditions** in the considered area
- **Potential analysis** will be done for **all selected lines** (conservative approach considers only air market)
- **Selection** of the **business cases** bases on the defined **decision criteria** (not all lines will be analysed in detail)
- Discussing the business cases mainly bases on **cost comparisons**

# Agenda

First general results and recommendations

Background and purpose of the study

**Analysis of the current situation**

Survey of infrastructure and operation conditions

Identification of opportunities for Night Trains in 2025

Backup

# The study includes 3 main working steps that will be prepared in sequence

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## Overall working approach

### 1 Analysis of the current situation

- Consideration of **Night Train routes** and analysis of the **current situation** as well as the **development in the past** (preparation of maps)
- **Comparison** of the **rail** and **air** network and traffic volumes
- **Preparation** of **an overview of revenue and cost structures** of Night Trains
- Preparation of an **environmental viewpoint** considering Night Trains

### 2 Survey of infrastructure and operation conditions

- Infrastructure **availability** (network)
- **Capacity** and potential **path conflicts**

### 3 Identification of opportunities for Night Trains in 2025

## Final Output

- **Report** and **presentation** of the results
  (Serves as a component for image campaigns or similar activities)

## Background

- **Countries**
  - France
  - Germany
  - Spain
  - China
  - USA
  - Russia
  - India
  - Japan

# Agenda

**Analysis of the current situation and future opportunities**

- Consideration of **Night Train routes** and analysis of the **current situation** as well as the **development in the past** (preparation of maps)
  - Illustration of the current situation respectively Night Train Lines in Maps
  - Development in the past
- **Comparison** of the **rail** and **air** network and traffic volumes
  - Determination of the potential corridors for HS Night Trains
  - Determination of the potential for the defined corridors
- **Preparation** of **an overview of revenue and cost structures** of Night Trains
  - Analysis of the cost structure of HS Night Trains - Costs
  - Analysis of sales potentials – Prices
- Preparation of an **environmental viewpoint** considering Night Trains


# Basic Idea: Three step analysis to estimation of potential

## General overall approach for getting substitution potential

**1 Gravitation model**

- **Population as factor** whether or not a city is comprised to the analysis
- **No database available for any other indicators** that affect the traffic amount

**2 Night Train specific corridor scetches**

- Based on the limitations from step 1 and the **operational characteristics** of Night Trains, **reasonable corridors** are determined
- Therefore, the assumptions of average speed and maximum travel time need to be validated in expert meetings

**3 Air traffic substitution potential**

- Number of **potential passengers** on each route **covered by a new Night Train** is measured on the **basis of airline** passengers (PAX) travelling on these routes
- Required **air traffic substitution rate** (%)

**Route Assessment / Selection for Business Case**

# Example “West Axis” (Europe): Definition of the corridor, calculation of PAX shifting potential by detailed corridor analysis

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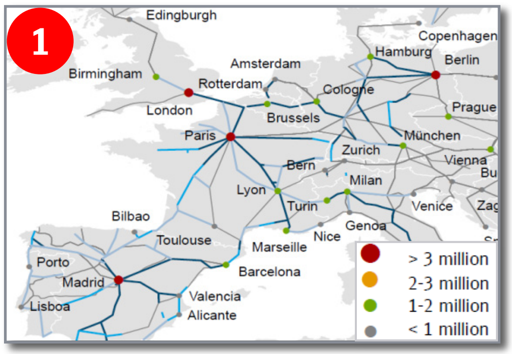
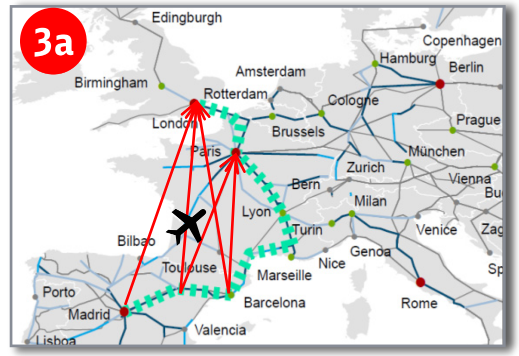
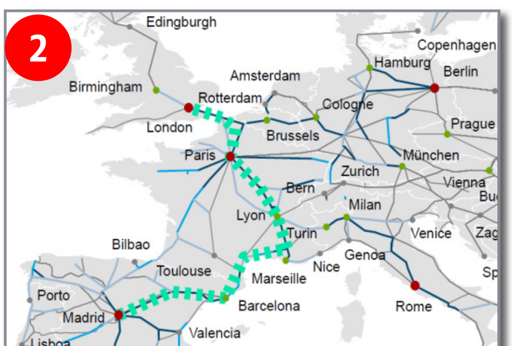
## Three step potential analysis for London - Madrid



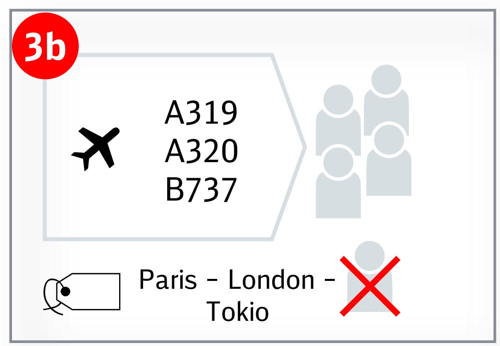

- Identification of the of the European **cities with the highest population density**
- Four-colour system for **city categorization** according to size




- Identification of all **nonstop air connections covered by “West axis”**: flights starting in London or Paris and landing in Madrid, Barcelona or Zaragoza




- Sketch of **corridors connecting a maximum of big cities** within range of max. 2,200 km
- In fact, **12 h travelling time** and an **average speed of 180 km/h** is assumed
- **One option:** London – Paris – Barcelona – Zaragoza – Madrid (“West Axis”)




- **Calculation of flight PAX** per day based on number of flights, seat capacities of used aircraft types and average load factors
- **Correction of shifting potential** by discounting PAX with connecting flights at start or destination airport
- **Risk analysis** for testing the **robustness** of the results

# Due to the geo-political situation in Europe, border crossing night lines are very common

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Maps

## Main Night Train Routes 2012 - Europe

# In India, night trains are operating basically on all main electrified and non-electrified railway routes

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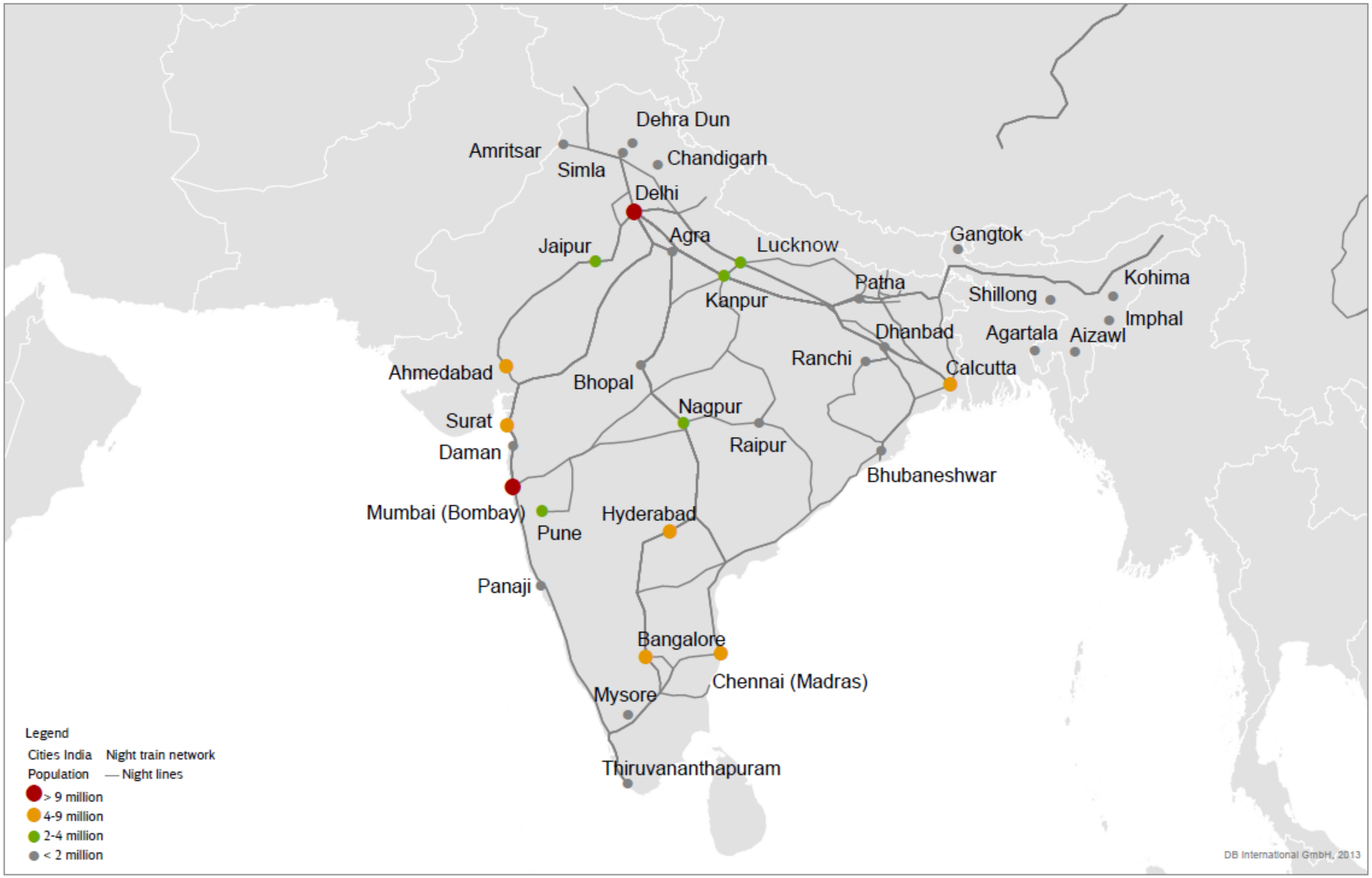
Maps

## Main Night Train Routes 2012 - India



# The night train network in the USA mostly connects the major cities of the Eastern and Western part of the country

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Maps

## Main Night Train Routes 2012 - USA

# The Chinese night train network is clearly concentrated on the agglomeration areas in Eastern China

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## Main Night Train Routes 2012 - China

# Compared to high-speed traffic, only few night trains operate in Japan

Maps

## Main Night Train Routes 2012 - Japan

# The characteristics of night train networks and operations vary regionally

## Key characteristics of the night train networks

**Europe**

- Operation of an **own** brand Night Trains / fixed element of the portfolio in the majority of the western European railway companies
- **Travel distances** usually varies between **800** and **1,500 km** (distances in Russia are usually more extended)
- Night train network is most dense in the center of Europe
- Based on the geo-political situation, **border crossing night lines are very common**

**India**

- **Night trains are running** on the **majority of the main railway routes** in India (electrified and non-electrified)
- Based on the socio-economic structure and on the considerable price advantages towards the transport by an own car or by an air plane, **night travelling is very common** in India

**USA**

- **Night lines network** basically **connects the cities of the Eastern and Western part** of the USA
- **Night train operator** (respectively passenger train operator) has **"dispatching priority"** against freight trains

**China**

- Chinese night lines are **clearly concentrated** in the **Eastern part** (positions of the mega cities)
- Likewise the Indian network, **almost on every major train route, night trains are operated**

**Japan**

- **Network of night lines** connects the cities of the **Northern and Southern part** ofJapan
- Due to Japan´s geographical situation, **no border crossing night lines** exist

# In Europe service suspensions due to new HSR routes and low budget flights, while the night train network in India expands continuously

Maps

## Night train developments in Europe and India


- Service suspension due to **new HSR** and **flight routes as competing relations** associated with an simultaneously decline in demand:
  - between Switzerland and Barcelona (Elipsos)[1]
  - between Wien/Milan and Amsterdam (CNL) and between Berlin and Warszawa (Kaliningrad)[2]
- Other reasons for service suspensions constitute a general declining of demand and or required, high investment and maintenance costs[1,2,3].
- Nevertheless, additional night lines like the Thello-relation between Paris and Rome (Palatino) were introduced[4].

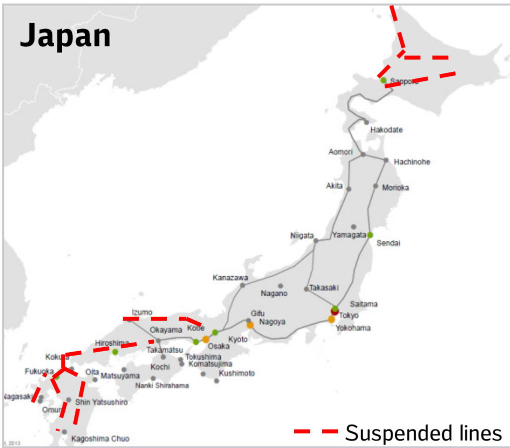

- Generally, the **Indian Night Train network expands in correspondence to the increasing long distance train network.**
- This development generally goes along with the general **growing rail budget** required by a high transport demand[5].

[1] http://www.nzz.ch/aktuell/schweiz/das-ende-der-nachtzuege-in-den-sueden-1.17872000
[2] http://www.fairkehr-magazin.de/861.html
[3] Trenitalia, 31.10.2012
[4] Le Monde, 06.12.2012
[5] Expert Interview, 2012

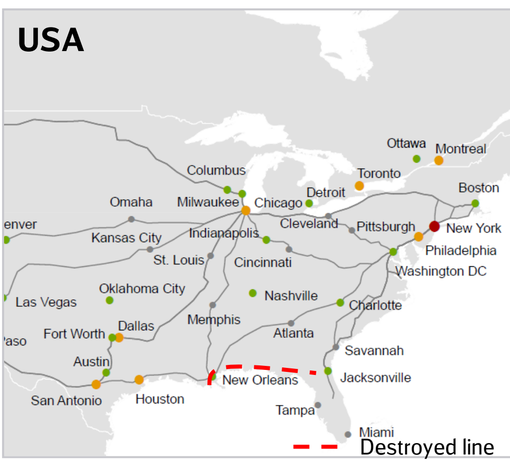
# Japanese night train network shrunk noticeably, while the Chinese network is extending and the US-network remains on the same level

**Maps**

## Night train developments in Japan, USA and China




- Basically, the **number of Night Trains in Japan has decreased significantly** in recent years.
- One reason is the **extension** of several **Shinkansen day lines** providing shorter journey times and lower ticket fares than the night trains.
- A further reason is the **progressed infrastructure development** of other transport modes (road and air), which leads to convenient journey times, ticket fares etc. in bus and air transportation.




- The **only change** of the Night Train network in the USA is the destruction of the route between **New Orleans and Jacksonville** caused by a hurricane[1].

→this route was not reconstructed.


- Corresponding to the overall extension of the railway network, the **night train network** is **expanding** simultaneously.

(Expert Interviews)

# Agenda

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**1 Analysis of the current situation and future opportunities**

- Consideration of **Night Train routes** and analysis of the **current situation** as well as the **development in the past** (preparation of maps)
  - Illustration of the current situation respectively Night Train Lines in Maps
  - Development in the past

- **Comparison** of the **rail** and **air** network and traffic volumes
  - Determination of the potential corridors for HS Night Trains
  - Determination of the potential for the defined corridors


- **Preparation** of **an overview of revenue and cost structures** of Night Trains
  - Analysis of the cost structure of HS Night Trains - Costs
  - Analysis of sales potentials – Prices


- Preparation of an **environmental viewpoint** considering Night Trains

# A specific operational picture for Night Trains has been specified

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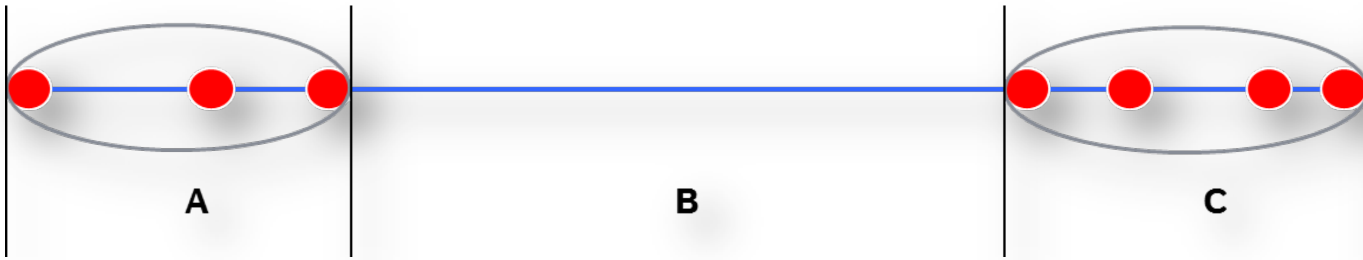
Networks
Logistics

Corridors

## Specific operation picture for Night Trains

The following operation scheme is applied:




**Boarding area**
Night Train stops at several origins
- Boarding time of high quality Night Trains usually ends at midnight
- Boarding after midnight is not attractive
- Travel time 0 – 3 hours
- Travel distance 0 – 400 km

**„Night Time“**
Nonstop run to cover distance
- Defined boarding and de-boarding leads to a quiet night time for the passengers
- Travel time 6 – 12 hours
- Travel distance 1,100 – 2,200 km

**De-boarding area**
Train stops at several destinations
- De-boarding starts not before 6 a.m. due to attractive time level
- Travel time 0 – 3 hours
- Travel distance 0 – 400 km

**Example: London - Madrid**

- London
- Lille
- Paris

- Night time between Paris and Barcelona

- Barcelona
- Zaragoza
- Madrid

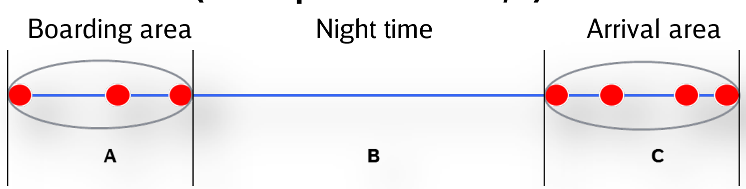
# The assumed average speed for the corridor analysis varies from country to country on the basis of research and expert discussions



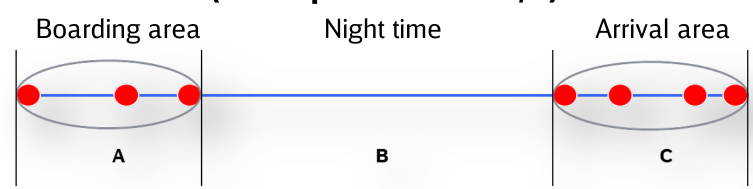
## Key assumptions – identification of the corridors

- The corridors do not consider interchanges **(nonstop connections)**
- The only decision criteria for the cities is the **number of inhabitants** (gravitation model)
- The **average speed** is defined on the basis of the **future available infrastructure, current running times** and **expert discussions** (potentials based on travel times at daily HSR service http://www.railteam.co.uk/for-your-journey/network-map)
- **HSR infrastructure** has to be **favoured** during route development in order to keep the assumptions
- The **current journey times** and **future improvements** serve as basis for the analysis
- Tools to **estimate distances** are applied (straight line distance): http://www.luftlinie.org – distance multiplied by diversion factor

**Conventional Night Trains (CNT) (max speed ~200 km/h)**




**HS Night Trains (max speed ~300 km/h)**




**Average Speed**

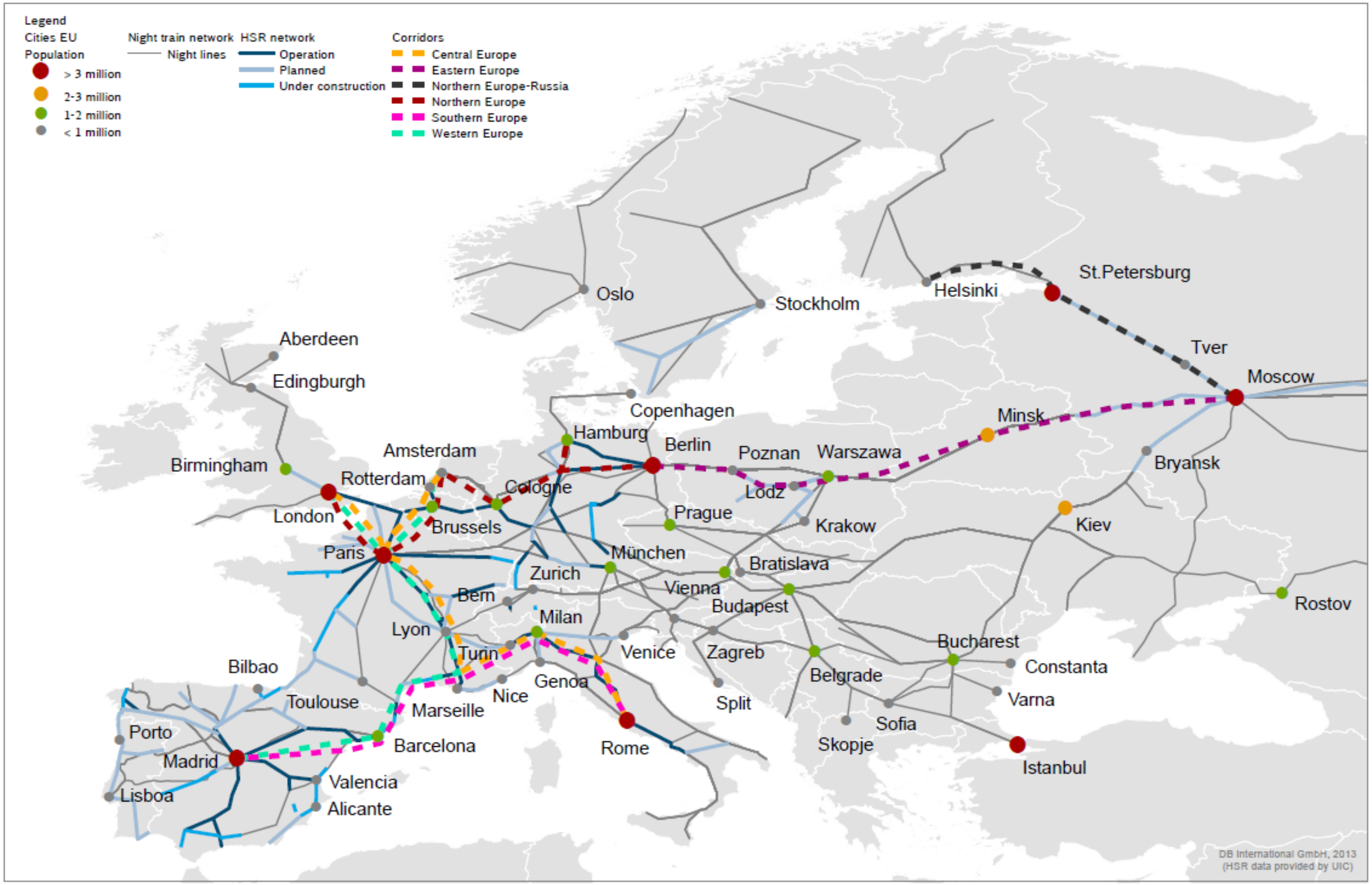
| | CNT A | CNT B | CNT C |
|---|---|---|---|
| Europe | 120 km/h | 180 km/h | 120 km/h |
| China | 120 km/h | 180 km/h | 120 km/h |
| Japan | 120 km/h | 180 km/h | 120 km/h |
| India | 90 km/h | 90 km/h | 90 km/h |
| USA | 60 km/h | 100 km/h | 60 km/h |

HS Night Trains: The assumptions base on the current and future possible journey times on HS tracks

# Preparation of potential corridors – Europe; Six corridors have been identified

Corridors

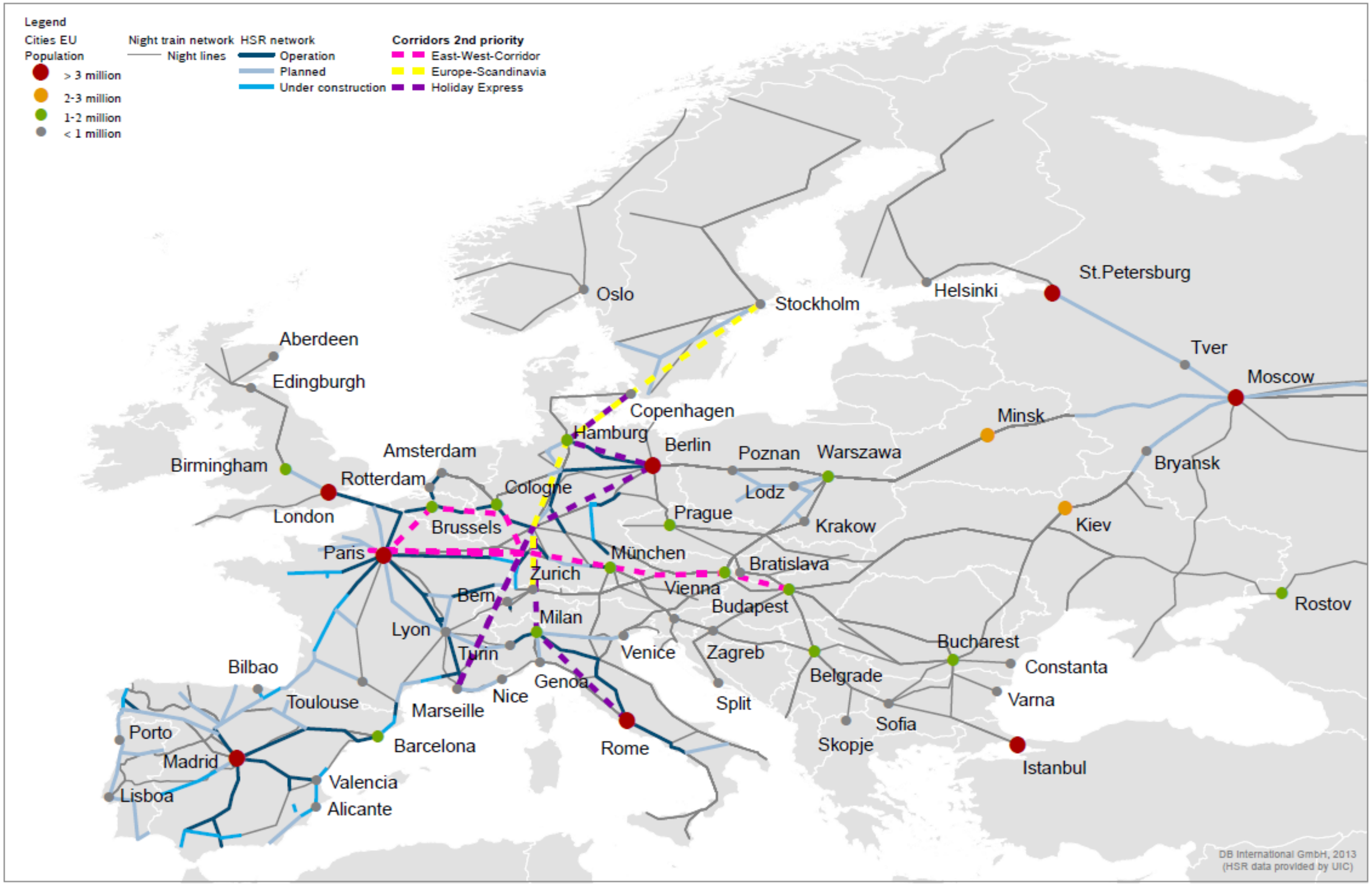
## Results potential corridors - Europe



# In addition, three corridors with a second priority have been prepared for Europe

Corridors

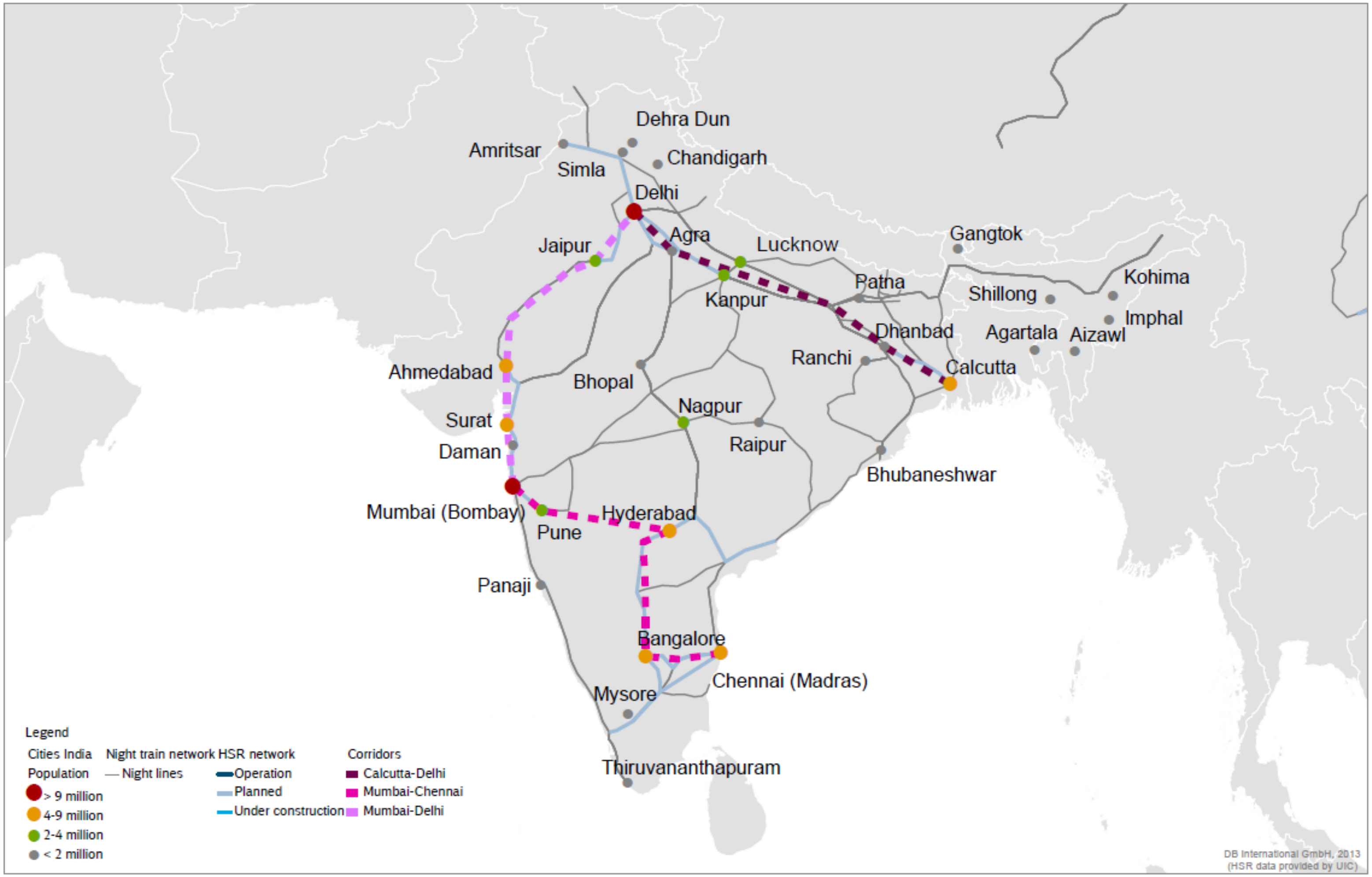
## Results potential corridors - Europe



# Preparation of potential corridors – India; Three corridors have been identified

Corridors

## Results potential corridors - India



# Preparation of potential corridors – USA; One corridor has been identified

Corridors

## Results potential corridors - USA

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# Preparation of potential corridors – China; Six central corridors have been identified

**Corridors**

## Results potential corridors - China

# Preparation of potential corridors – Japan; Three central corridors have been identified

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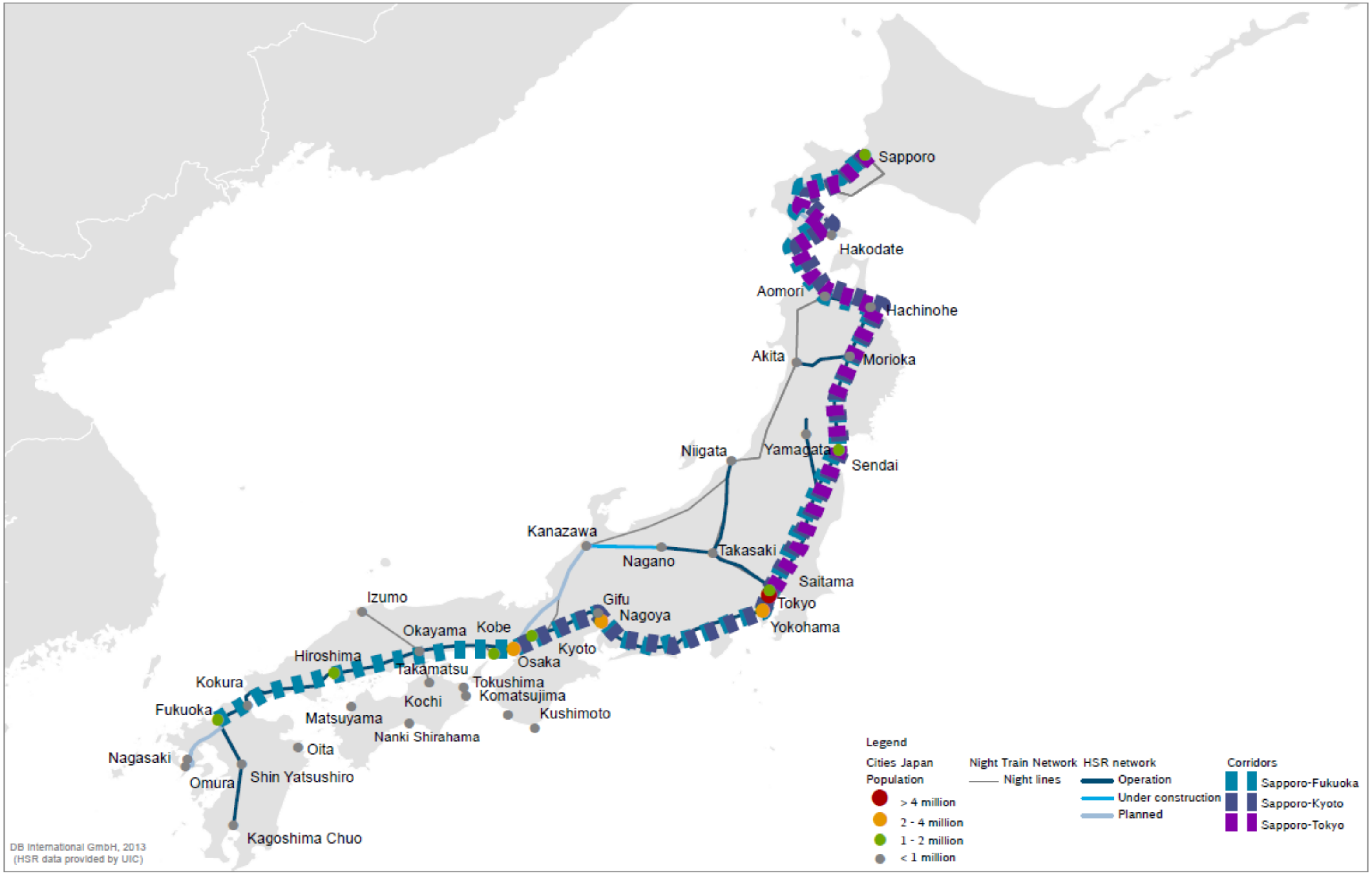
Corridors

## Results potential corridors - Japan



# Calculation of the substitution rates that VLDNT has to achieve in order to operate profitable

Corridors

## Calculation of required substitution rate

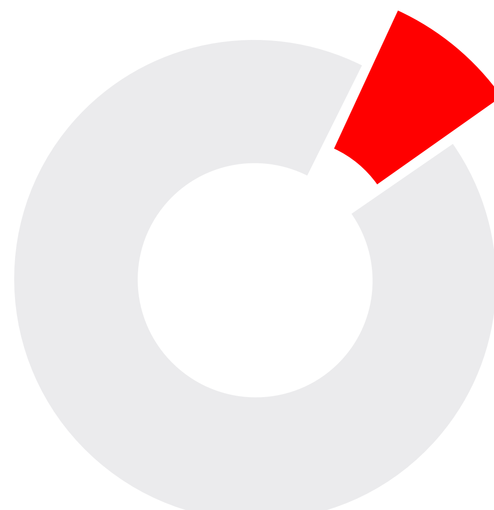
### Total shifting potential

- **Calculation of flight PAX** per day
- based on number of flights, seat capacities of used aircraft types and average load factors
- Correction of shifting potential by **discounting PAX with connecting flights at start or destination airport**

**PAX**
on flights covered by VLDNT

### Effectively required substitution rate

- **Substitution rate** resulting from total shifting potential and the necessary utilization of capacity (seats + beds) of VLDNT
- Assumption: **75 % load factor** is needed to operate VLDNT profitable

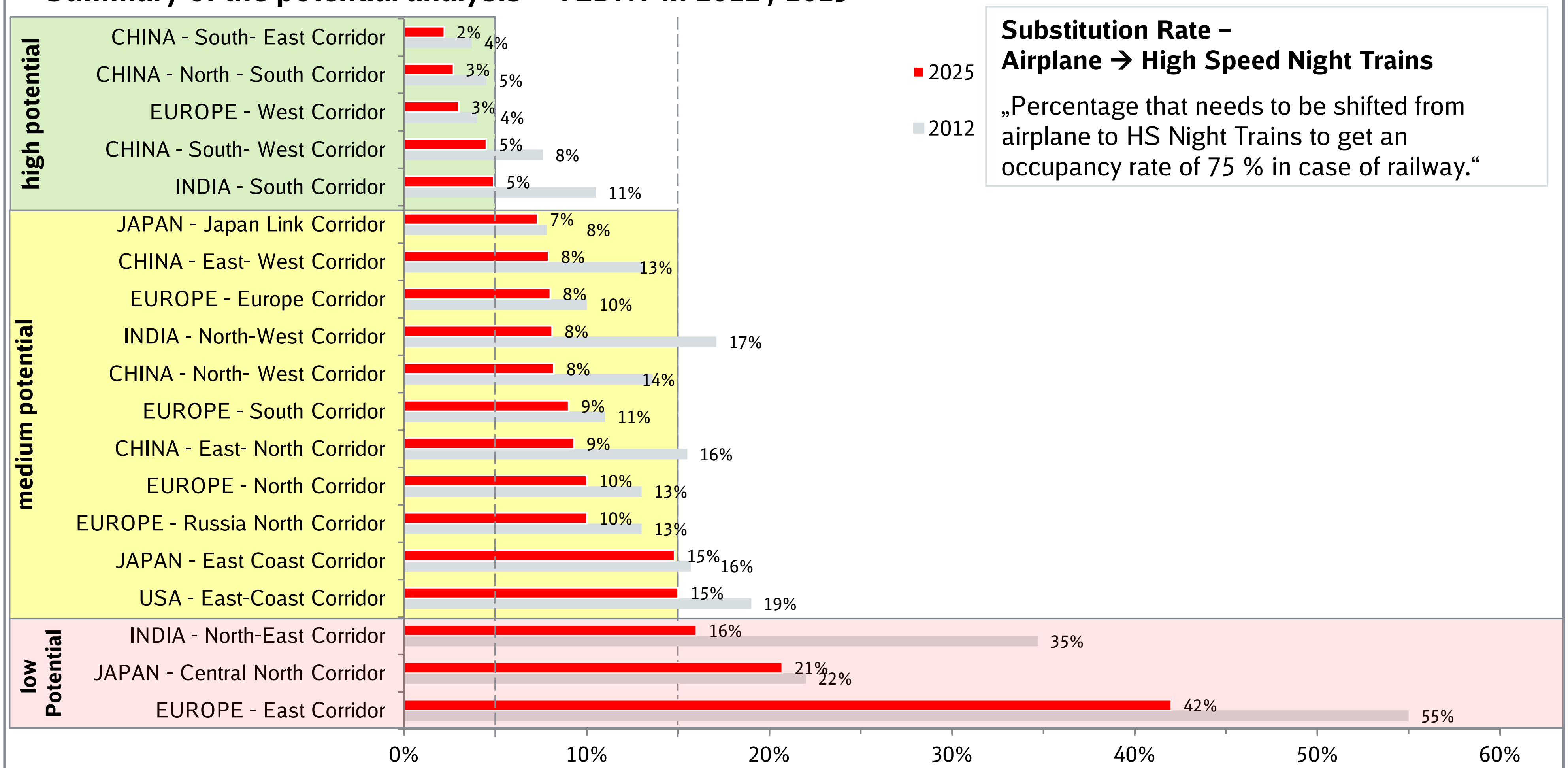


**PAX**
to be shifted to VLDNT for **75 %** load factor

# Small shifted traffic amounts from the plane could ensure a high occupancy rate in the Night Trains

Potential

## Summary of the potential analysis – VLDNT in 2012 / 2025



# High potentials for Conventional Night Trains (CNT) are especially identified in China and Europe having in mind the defined connections

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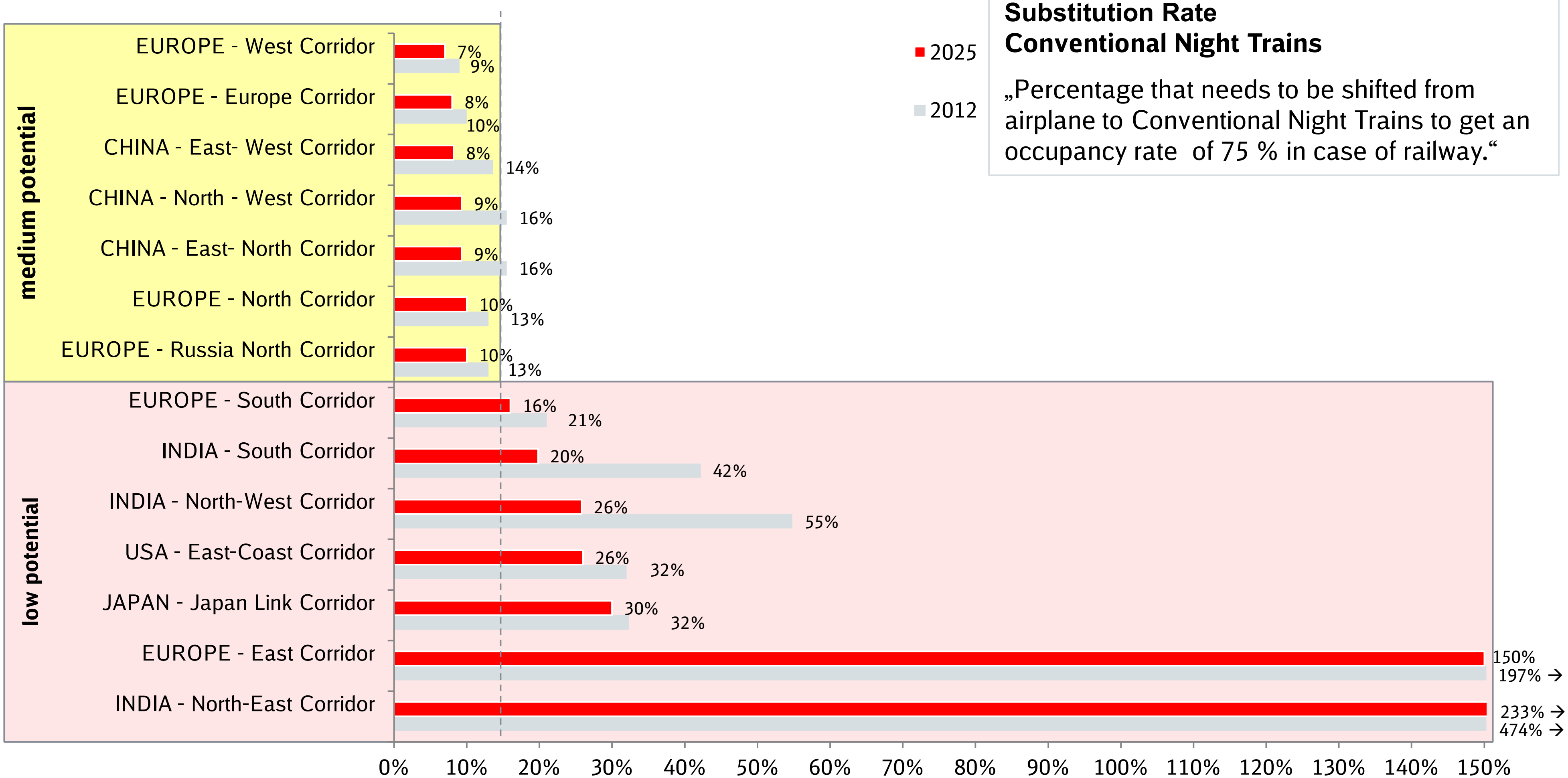
**Potential**

## Summary of the potential analysis – Conventional Night Train

**Substitution Rate**
**Conventional Night Trains**

„Percentage that needs to be shifted from airplane to Conventional Night Trains to get an occupancy rate of 75 % in case of railway.“



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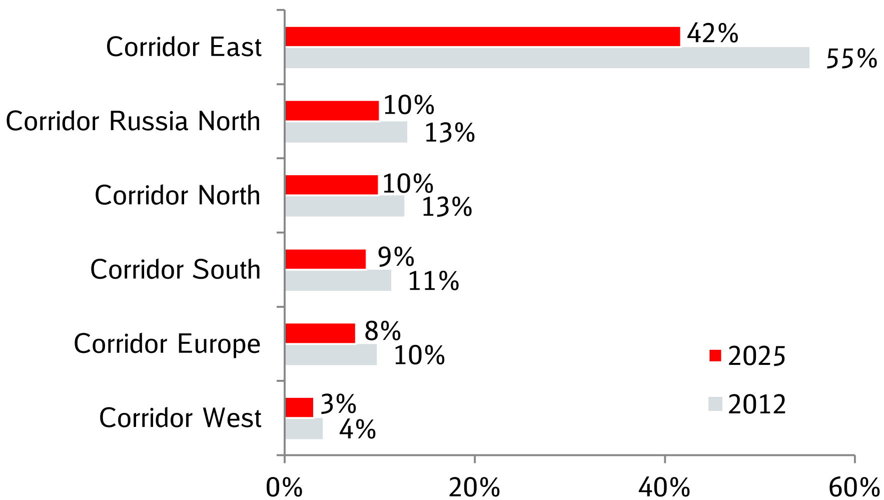
# Analysis shows that for EUROPE the West Corridor indicates the highest opportunity for night train operation

Potential Example

## Summary substitution rates High Speed Night Train - EUROPE

### Assessed substitution rate

- The “West Axis ” indicates the **best opportunities (London – Madrid | Amsterdam - Madrid)**
- A market entrance on the line **Berlin – Moscow** seems to  be **difficult** (Corridor East)




### Risk assessment

- Assessment also shows **good substitution rates in worst cases** (robust results)
- Risk assessment by applying **Monte Carlo Simulation**
- **Varying of variables** (load factor | flights per week | share transfer | growth rate 2025)

| **Corridor HS Night Trains** | **2025 [90 % significance]** | |
|---|---|---|
| | Min | Max |
| East | 30 % | 58 % |
| Russia North | 7 % | 14 % |
| North | 7 % | 14 % |
| South | 6 % | 12 % |
| Europe | 5 % | 10 % |
| West | 2 % | 4% |

# EUROPE West Corridor: 5 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

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**Potential Example – HSR**

| | |
|---|---|
| Direct flights (per day and direction): | 105 |
| Capacity (seats per day): | 16,750 |
| PAX (per day): | 13,250 |
| (1) **PAX without connecting flight (per day):** | **9,450** |

**Madrid Barcelona Saragossa** — **Paris London Brussels Antwerp Amsterdam Rotterdam**

| | |
|---|---|
| Potential HT Madrid-Amsterdam (per day): | 4,750 |
| Potential HT Madrid-London (per day): | 4,700 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 250 |
| (2) **Occupancy rate of 75 %:** | **375** |

**Madrid Barcelona Saragossa** — **Paris** — **London** / **Brussels** / **Antwerp** / **Amsterdam** / **Rotterdam**

**Required air traffic substitution rate:** (2) from (1) = **4 %**

* Calculation base: Bombardier ZEFIRO 250

# EUROPE West Corridor 2025: The required substitution rate could decline from 5 % in 2012 to 4 % in 2025 (conservative perspective)

Potential Example – HSR

**Madrid**
**Barcelona**
**Saragossa**

**Paris**
**London**
**Brussels**
**Antwerp**
**Amsterdam**
**Rotterdam**

| | 2012 | 2025 Airbus Forecast 2012-31: +3.4 % p.a. | 2025 DBI feat. Airbus 2012-25: +2 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 105 | not specified | not specified |
| Capacity (Seats per day) | 16,750 | not specified | not specified |
| PAX (per day) | 13,250 | 20,450 | 17,150 |
| PAX without connecting flights (per day) | 9,450 | 14,600 | 12,200 |
| **Required air traffic substitution rate** | **4 %** | **3 %** | **3 %** |

- Airbus forecasts a growth of 3.6 % up to 2021 and 3.1 % after 2021 considering  on inner-European routes
- No information regarding  the separation to existing and new routes

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# Analysis potential Barcelona²: 9 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

² Potential Example – HSR and CNT

| | |
|---|---|
| Direct flights (per day and direction): | 46 |
| Capacity (seats per day): | 7,600 |
| PAX (per day): | 6,000 |
| (1) **PAX without connecting flight (per day):** | **4,100** |

Barcelona – Paris, London, Brussels, Antwerp, Amsterdam, Rotterdam

| | |
|---|---|
| Potential HT Madrid-Amsterdam (per day): | 2,100 |
| Potential HT Madrid-London (per day): | 2,000 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 250 |
| (2) **Occupancy rate of 75 %:** | **375** |

Barcelona – Paris – London, Brussels, Antwerp, Amsterdam, Rotterdam

**Required air traffic substitution rate:** (2) from (1) = **9 %**

* Calculation base: Bombardier ZEFIRO 250

# Agenda

**Analysis of the current situation and future opportunities**

- Consideration of **Night Train routes** and analysis of the **current situation** as well as the **development in the past** (preparation of maps)
  - Illustration of the current situation respectively Night Train Lines in Maps
  - Development in the past

- **Comparison** of the **rail** and **air** network and traffic volumes
  - Determination of the potential corridors for HS Night Trains
  - Determination of the potential for the defined corridors


- **Preparation** of an **overview of revenue and cost structures** of Night Trains
  - Analysis of the cost structure of HS Night Trains - Costs
  - Analysis of sales potentials – Prices


- Preparation of an **environmental viewpoint** considering Night Trains

# Costs comparison documents current and future competitiveness, while price check documents current sales potentials

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Costs and Prices

## Prices vs. Costs

| | Costs | Prices |
|---|---|---|
| **Data availability** | Airline: **good available data** basis using business reports<br>Railway: **good assessment** on the basis of some connections using the UIC study[1] | Airline: connections related **survey** with a **small sample possible**<br>Railway: relevant connections would be new Night Train offers; therefore **prices are not yet available** |
| **Composition** | **Classical cost elements**: infrastructure, staff, energy, depreciation, working fund etc. | **Theory**: costs plus sales commission, profit margin |
| **Genese** | **Strong external influence**; assumed by using the external factors as for example energy, maintenance or personnel | **Internal determination**; in the case of cross-subsidation |
| **Validility** | **Current and future comptitiveness** | **Current sales potentials** |

[1] „Relationship between rail service operating direct costs and speed“ (12/2010)

# Basis for cost check is a benchmark respectively the airlines as the main considered competitor in the market

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Costs

## Costs benchmark - airlines

| Country / Region | chosen Airline | Costs per available seat-km (ASK)[5] |
|---|---|---|
| Europe / Russia | easyJet | 5.14 EUR-cent per available seat-km[1] |
| China | Juneyao Airlines | n/a |
| Japan | AirAsia | 2.63 EUR-cent per available seat-km[3] |
| USA | SouthWest | 4.92 EUR-cent per available seat-km[4] |
| India | JetAirways | n/a |

1) Business report http://2011annualreport.easyjet.com/performance-risk/financial-review.aspx | without Marketing & Sales
2) Business report http://www.ryanair.com/doc/investor/2011/Annual_Report_2011_Final.pdf | without Marketing & Sales
3) Business report http://www.airasia.com/iwov-resources/my/common/pdf/AirAsia/IR/annual-report-2010.pdfess | without Marketing & Sales
4) Business report http://www.southwestonereport.com/2011/#!/financial/performance-by-the-numbers | without Marketing & Sales
5) All costs are illustrated without marketing and sales costs.

# The main costs of the calculation are infrastructure charges – availability of data leads to the selection of business cases (only EUROPE)

Costs

## Selection of analysed Business case – data availability

- **Main cost blocks** of the OPEX consideration are train ownership, maintenance and cleaning, energy, operational personnel and infrastructure costs
- **Infrastructure** costs **dominate** the **OPEX**
- **Charges** for **infrastructure** use are only **available in Europe** → **concentration on the EUROPE** corridors in the business case
- Data for all parts could be adjusted with the European basis and/or with the help of local experts but the **estimation of track access charges** as most relevant fact **could not be done in an acceptable way** (uncertainty is too big and the influence in the total calculation too high)
- **Track access charges** are also **influenced by other factors than** the actual **cost basis**

| | |
|---|---|
| Train ownership | ✓ |
| Maintenance and Cleaning | ✓ |
| Energy | ✓ |
| Operation personnel | ✓ |
| Infrastructure | ✓ \| ✗ |

**Data availability | opportunity for useful assessments**

# Costs will be determined for each considered corridor using average values as well as corridor specific values

Costs

## Costs elements and assumptions in the assessment (EUROPE)[4]

| | | |
|---|---|---|
| **Train ownership** | ▪ Train repayment<br>▪ Costs of own and external capital<br>▪ Insurance costs | ▪ UIC weighting factor – 9 % of the acquisition costs[1]<br>▪ Acquisition costs base on the train Zefiro 250 (15 million EUR per train) |
| **Maintenance and cleaning[1]** | ▪ Fixed costs maintenance<br>▪ Variable costs maintenance<br>▪ Fixed costs maintenance workshop<br>▪ Exterior and interior cleaning costs | ▪ Maintenance costs 1,175 EUR per train meter and year[1]<br>▪ Maintenance costs 0.98 EUR per train meter and km[1]<br>▪ Cleaning costs 1.13 EUR per train meter and year[1] (factor Night Trains) – factors for several kinds of train[2] |
| **Energy** | ▪ Traction energy<br>▪ Energy returned to network<br>▪ Sales specific value | ▪ Energy price 0.12 EUR per kWh[2]<br>▪ Energy coefficient Pi 1.11 (traction and returned)[1]<br>▪ Sales specific value 1.5 % of the traction costs[1] |
| **Operation personnel** | ▪ Personnel costs train driver<br>▪ Personnel costs conductor | ▪ Costs train driver 40,000 EUR per year[2]<br>▪ Conductor 30,000 EUR per year[2]<br>▪ Shift train driver 4 hours \| conductor 4.5 hours[2]<br>▪ Number of conductors 2 - 4[2]<br>▪ Working days per year 210[2] |
| **Infrastructure costs** | ▪ Track access charges<br>▪ Station charges | ▪ 9 EUR - 22 EUR per train-km[3] in depending on the lines and passed countries (average per corridor)<br>▪ Station fee 0.84 EUR per PAX and station[1] |

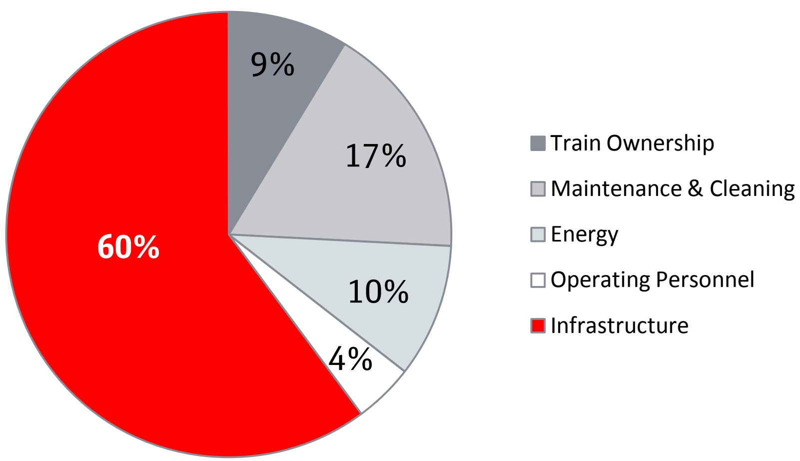
[1] UIC Study „Relationship between rail service operating direct costs and speed" (12/2010) http://www.uic.org/IMG/pdf/report_costshs.pdf | Costs for workshops are not applied due to the small amount as illustrated in the study.
[2] Assumptions by the Consultant on the basis of „Relationship between rail service operating direct costs and speed" (UIC 2010)
[3] Assumptions by the Consultant using the Network Statements of the infrastructure companies as well as UIC study on railway infrastructure charges in Europe (11/2012)
[4] Train configuration: Several train calculation applied (main costs calculated for a HS Train – 200 m 500 seats ; costs for Night Trains are assessed by using factors)

# Main cost driver of the HS Night Train is the infrastructure charge – positive correlation between route length and costs

Costs

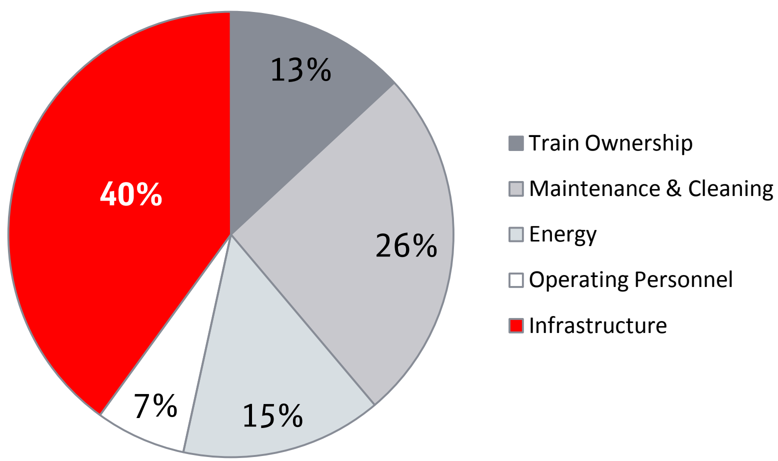
## Cost elements and share – HS Traditional Night Train

### Example: Madrid - London




- Distance of approx. **2,200 km**
- Average track access charge of **21 EUR / train-km** and station fee of **0.84 EUR per PAX and station**

### Example: Madrid - Rome




- Distance of approx. **2,200 km**
- Average track access charge of **9 EUR / train-km** and station fee of **0.84 EUR per PAX and station**

# Track access charges have been determined as average value per line having in mind the current prices as well as planned HSR sections

Costs

## Determination of the track access charges

- **Track access charges** have been determined for **each defined line** as a **weighted average value** (distance)
- **Data base 2012**, mostly not separated for night conditions or significant differences between **night and day** available
- **Charges for off-peak** time are considered **when provided**
- As **basis** serves the **Network Statements 2012** of the passed countries, **UIC study**[1] and **Consultant** assumptions
- **Track access charges** widely **vary** comparing the passed through **countries** as well as **sections of a line** within on country
- **Highest charges accrue** for the Channel Tunnel and in France on selected lines – generally higher charges for HSR infrastructure
- In case of 2012, **HSR routes** that have **not** yet been **commissioned** have been **priced with comparable current lines in operation** per country (average value of surrounding HSR lines)

| Corrdior | Line | Travel Distance km | Applied TAC EUR / train-km |
|---|---|---|---|
| North Corridor | London - Hamburg | ~1,500 | 22 |
| | London - Berlin | ~1,500 | 21 |
| **West Corridor** | **Madrid - London** | **~2,200** | **21** |
| | Madrid - Amsterdam | ~2,200 | 14 |
| Europe Corridor | Amsterdam - Rome | ~1,800 | 12 |
| | London - Rome | ~1,800 | 22 |
| South Corridor | Madrid - Rome | ~2,200 | 9 |

[1] UIC study on railway infrastructure charges in Europe (11/2012)

# The amount of track access charges widely differs for the routes the Night Train passes through

Costs

## Track access charges per section of selected lines

### Example: London – Madrid | Ø 21 EUR / train-km

| Section | EUR / train-km |
|---|---|
| **London** – Channel Tunnel Start | 43 |
| Channel Tunnel Start – Channel Tunnel End | 300 |
| Channel Tunnel End – Paris | 19 |
| Paris – Lyon | 20 |
| Lyon – Perpignan | 9 |
| Perpignan – Figueres | 50 |
| Figueres – Barcelona | 9 |
| Barcelona – **Madrid** | 9 |

### Example: Rome – Madrid | Ø 9 EUR / train-km

| Section | EUR / train-km |
|---|---|
| **Rome** – Florenz | 5 |
| Florenz – Milan | 5 |
| Milan – Turin | 5 |
| Turin – Lyon | 8 |
| Lyon – Perpignan | 9 |
| Perpignan – Figurees | 50 |
| Figurees – Barcelona | 9 |
| Barcelona – **Madrid** | 9 |

Schematic representation

# In order to have a competitive and cost- effective pricing, the NT has to reach a higher occupancy rate than the daily long distance HSR traffic

Costs - Summary

## Intermodal cost comparison Europe 2025 - Summary

| **HS Traditional Night Train** (conservative view) | | **Travel Distance ~ km** | **Total Cost per ASK EUR Ct/seat-km** | **Seat Cost per Travel EUR** | **Load Factor %** | **Total Cost per PAX EUR** | **Load factor to match TC easyJet %** |
|---|---|---|---|---|---|---|---|
| North Corridor | London - Hamburg | 1,500 | 9.14 | **137** | 50 | 274 | **203** |
| | London - Berlin | 1,500 | 8.90 | **134** | 50 | 267 | **158** |
| | easyJet London -Hamburg | 800 | 7.35 | **59** | 87 | 68 | |
| | easyJet London - Berlin | 1,000 | 7.35 | **73** | 87 | 84 | |
| **West Corridor** | **Madrid - London** | **2,200** | **8.21** | **181** | **50** | **361** | **153** |
| | Madrid - Amsterdam | 2,200 | 6.58 | **145** | 50 | 289 | **107** |
| | easyJet Madrid - London | 1,400 | 7.35 | **103** | 87 | 118 | |
| | easyJet Madrid - Amsterdam | 1,600 | 7.35 | **118** | 87 | 135 | |
| Europe Corridor | Amsterdam - Rome | 1,800 | 6.44 | **116** | 50 | 232 | **98** |
| | London - Rome | 1,800 | 8.77 | **158** | 50 | 316 | **125** |
| | easyJet Amsterdam - Rome | 1,400 | 7.35 | **103** | 87 | 118 | |
| | easyJet London - Rome | 1,500 | 7.35 | **110** | 87 | 127 | |
| South Corridor | Madrid - Rome | 2,200 | 5.41 | **119** | 50 | 238 | **94** |
| | easyJet Madrid - Rome | 1,500 | 7.35 | **96** | 87 | 110 | |

# The cost assessment is separated into three steps; definition of the key cost values – cost assessment for 2012 – cost projection 2025

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**Costs**

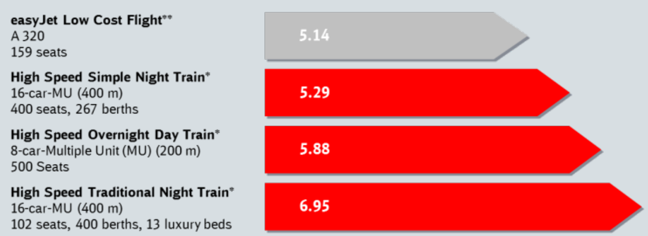
## General approach of the cost determination

**1**

| | | |
|---|---|---|
| **Train ownership** | ▪ Train repayment<br>▪ Costs of own and external capital<br>▪ Insurance costs | ▪ UIC weighting factor – 9 % of the acquisition costs[1]<br>▪ Acquisition costs base on the train Zefiro 250 (15 million EUR) |
| **Maintenance and cleaning** [5] | ▪ Fixed costs maintenance<br>▪ Variable costs maintenance<br>▪ Fixed costs maintenance workshop<br>▪ Exterior and interior cleaning costs | ▪ Maintenance costs 1,175 EUR per train meter and year[1]<br>▪ Maintenance costs 0.98 EUR per train meter and km[1]<br>▪ Cleaning costs 1.13 EUR per train meter and year[1] (factor Night Trains) – factors for several kinds of train[2] |
| **Energy** | ▪ Traction energy<br>▪ Energy returned to network<br>▪ Sales specific value | ▪ Energy price 0.12 EUR per kWh[1]<br>▪ Energy coefficient Pi 1.11 (traction and returned)[1]<br>▪ Sales specific value 1.5 % of the traction costs[1] |
| **Operation personnel** | ▪ Personnel costs train driver<br>▪ Personnel costs conductor | ▪ Costs train driver 40,000 EUR per year[2]<br>▪ Conductor 30,000 EUR per year[2]<br>▪ Shift train driver 4 hours \| conductor 4.5 hours[2]<br>▪ Number of conductors 2 - 4[2]<br>▪ Working days per year 210[2] |
| **Infrastructure costs** | ▪ Track access charges<br>▪ Station charges | ▪ In depending on the line and country between 9 EUR and 22 EUR per train-km[2] (average per corridor), station 0.84 EUR per PAX and station[1] |

- Preparation of the **basic cost data** for the calculation (unit costs)
- Preparation of the **basic framework conditions** as e.g. performance and train categories
- **Cost assumptions** mainly base on the **UIC study** „Relationship between rail service operating direct costs and speed" (12/2010) and **Consultant assumptions**

**2**




- Calculation of the **costs per seat-km for each corridor / line in 2012**
- **Comparison** of the costs according to different **Night Train categories** as well as **airlines**
- **Risk analysis** for testing the **robustness of the results for 2012**

**3**

| | Rail | | | Air | | | Assumptions |
|---|---|---|---|---|---|---|---|
| | 2012 | Trend | 2025 | 2012 | Trend | 2025 | |
| **Energy/Fuel** | 10 % | 110 | 11 % | 30 % | 200 | 60 % | Crude oil price +100 %, electric energy price +50 %, reduction of consumption: rail traffic -40 %, air traffic -30 %, introduction of kerosene tax and VAT |
| **Vehicle** | 26 % | 120 | 31 % | 13 % | 120 | 16 % | More complex technology, optimizations close to physical limits lead to intensive maintenance |
| **Operating staff** | 4 % | 100 | 4 % | 13 % | 110 | 14 % | Reduction of allowed working time for pilots from 2015 |
| **Infrastructure*** | 60 % | 120 | 72 % | 44 % | 120 | 53 % | More extensive user financing due to limited state finances and reduction of subsidies |
| | | | 118% | | | 143% | |

- Definition of the **main influences** as well as of their **impact** in the projection of the costs **to 2025** according to railway and air traffic
- **Projection** of the **costs per seat-km to the year 2025**
- **Risk analysis** for testing the **robustness of the results for 2025**

# Example Madrid - London illustrates two constraints to compete with LCCs: travel distance and load factor

Costs

## Cost comparison Madrid - London

| | Train | Plane |
|---|---|---|
| **Balanced cost level per seat-km...** Owing to rising energy costs VLDNT will almost hit easyJet's cost level per seat-km in 2025. — EUR-Cent/Seat-km 2025 | 8.21 | 7.35 |
| **...but higher costs per PAX** In relation to transported PAX VLDNT costs are more than twice as high compared to easyJet. — Costs per PAX per trip [EUR] | 361* | 147 |
| **Reasons: distance & load factor** Air route is significant shorter than rail route. Rail load factors are regularly much lower than in airline business. — Travel Distance (km) | 2,200 | 1,400 |
| Empty seats/beds (%) | 50 | 13 |

**Imperative load factor: 153 %**

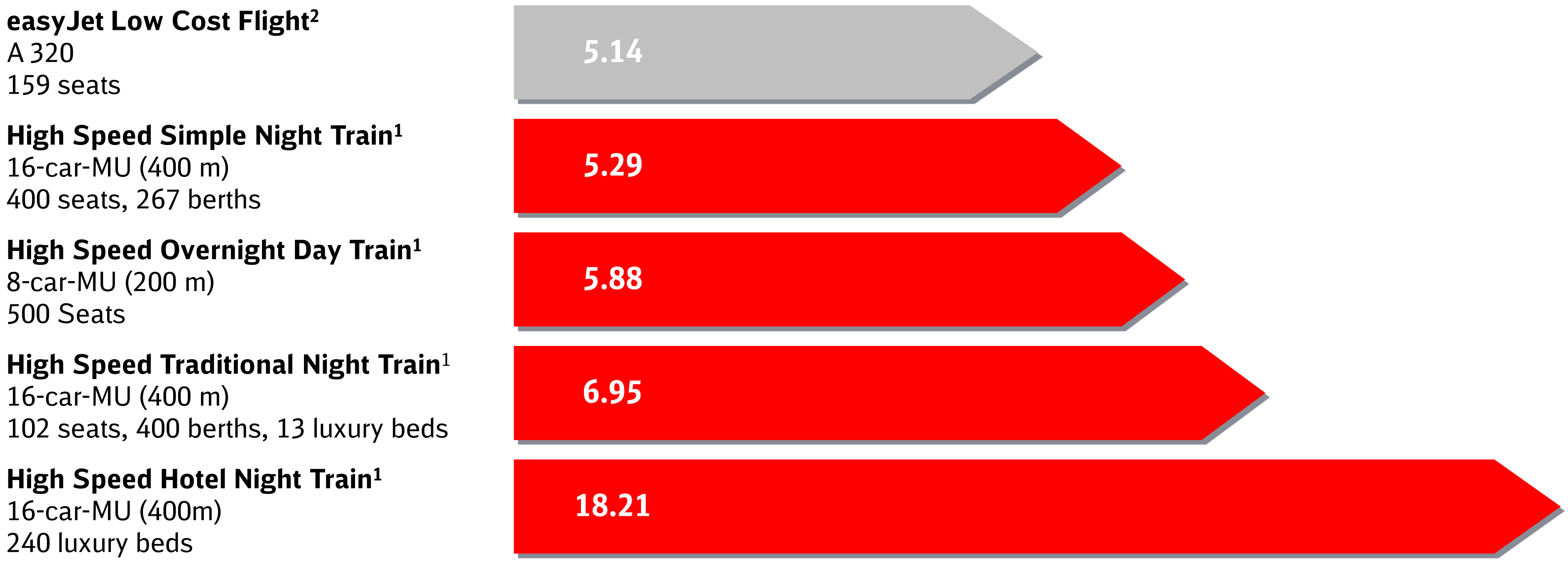
Matching easyJet's total costs per PAX VLDNT have to achieve an impossible load factor of 153 %

* Based on a conservative load factor assumption of 50 % for VLDNT

# The costs for Night Trains exceed the costs of the Low-Cost-Airlines regardless whether the chosen comfort level – case Madrid to London

**Costs – Example**

**Costs per available seat-kilometre, Case EUROPE: Madrid - London**
[EUR-Cent per seat-kilometre, 2012]




[1] Route- specific calculation on the adapted basis „Relationship between rail service operating direct costs and speed" (UIC 2010)
[2] Network average based on financial reports 2011, without Marketing & Selling

Schematic representation

# By 2025, the development of several cost components will further enlarge the costs for both railway and air traffic

Costs – Example

## Cost development until 2025, Madrid - London, easyJet vs. HS Traditional NT

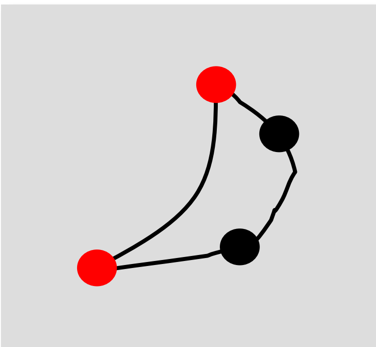
| | Rail | | | Air | | | Assumptions[1] |
|---|---|---|---|---|---|---|---|
| | 2012 | Trend[3] | 2025 | 2012 | Trend[3] | 2025 | |
| **Energy/Fuel** | 10 % | 110 | 11 % | 30 % | 200 | 60 % | Crude oil price, increase in electric energy, reduction of consumption: rail traffic as well as air traffic, introduction of kerosene tax and VAT |
| **Vehicle** | 26 % | 120 | 31 % | 13 % | 120 | 16 % | More complex technology, optimizations close to physical limits lead to intensive maintenance |
| **Operating staff** | 4 % | 100 | 4 % | 13 % | 110 | 14 % | Reduction of allowed working time for pilots from 2015 |
| **Infrastructure[2]** | 60 % | 120 | 72 % | 44 % | 120 | 53 % | More extensive user financing due to limited state finances and reduction of subsidies, Increase in cost for flight control |
| | | | **118 %** | | | **143 %** | |
| **Madrid - London Total Cost EUR-Cent / seat-km** | 7.0 | 120 | 8.2 | 5.1 | 140 | 7.3 | **Cost disadvantage for railway** |

[1] Based on international sources and Consultant assumptions (see Backup) ; [2] easyjet: includes 6 % „Other Costs"; [3] Assumptions by the Consultant using available information

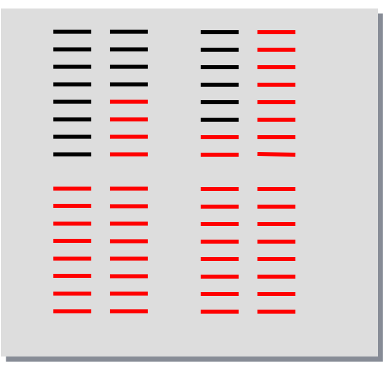
# Diversion and occupancy factors are neglected, the comparison of the „available seat costs“ distorts the actual competitive situation

Costs

## Diversion-/ occupancy factor



- **Air routes** are much closer to **linear distance** between origin and destinations than railway infrastructure.
- Plus, the inclusion of **multiple airline routes into one Night Train route** leads to additional diversions.



- In comparison to rail traffic, the **characteristic occupancy curve of air** traffic is located much **higher**, especially in case of LCCs.
- Even superior occupancy rates in HSR* remain under the specific values of Low Cost carries
- Downside of economies of scale: **higher occupancy risk** due to the larger seat capacity in **rail traffic**

* cf. „External Costs of Transport in Europe. Update study for 2008” (UIC 2011)

# Comparing the costs in 2025 –Madrid to London – the rail cannot reach the level of airlines using the current cost framework conditions

Costs – Example

## Intermodal cost comparison Madrid – London 2025

| | Travel Distance km | Total Cost per ASK EUR Ct/seat-km | Seat Cost per Travel EUR | Load Factor % | Total Cost per PAX EUR | Load factor to match TC easyJet |
|---|---|---|---|---|---|---|
| easyJet | 1,400 | 7.35 | 103 | 87 | 118 | |
| HS Overnight Day Train | 2,200 | 6.95 | 153 | 50 | 306 | 129 |
| HS Simple Night Train | 2,200 | 6.26 | 138 | 50 | 275 | 116 |
| **HS Traditional Night Train** | **2,200** | **8.21** | **181** | **50** | **361** | **153** |
| HS Hotel Night Train | 2,200 | 21.52 | 473 | 50 | 947 | 400 |

- **„Seat Cost per Travel“** of HS Traditional Night Train exceeds easyJet‘s relevant benchmark
- For example, **an occupancy rate of 153 % would be required at the relation London - Madrid in case of HS Traditional Night Trains in order to reach the same costs per PAX** than the chosen benchmark easyJet

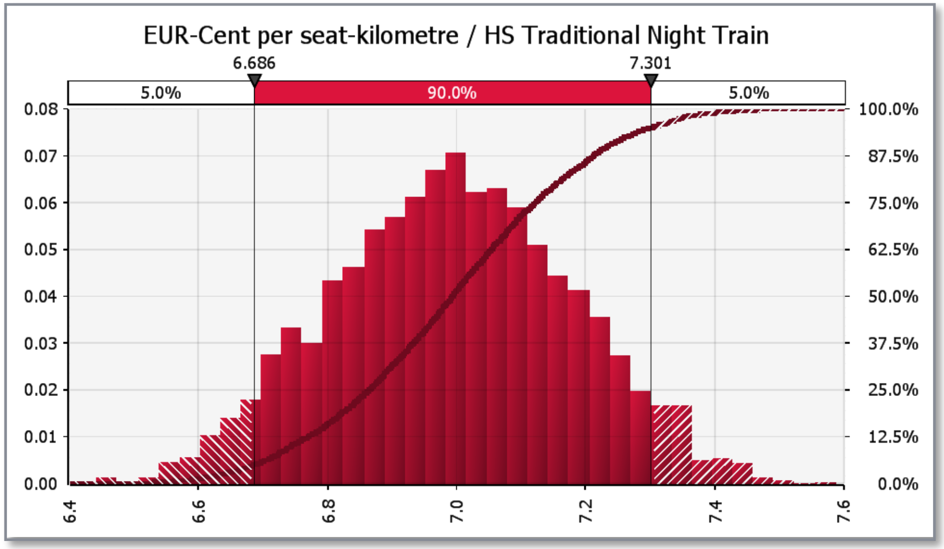
# Estimation arises robust results - risk assessment shows opportunities for decreasing / increasing of the estimated cost figures



## Risk assessment Madrid – London 2012 / 2025

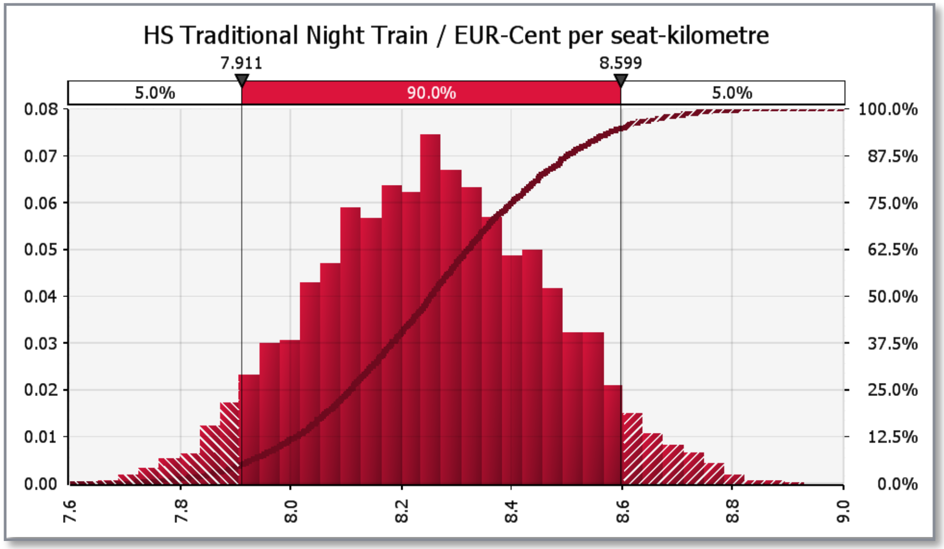
### Costs assessment 2012

- Actual projected value of 6.95 EUR-cent per seat-km
- Mean value of 6.99 EUR-cent per seat-km and a standard variance of 0.18 EUR-cent per seat-km
- 90 % confidence interval 6.69 – 7.30 EUR-cent per seat-km




### Cost forecast 2025 (without assumed changes for 2012)

- Actual projected value of 8.21 EUR-cent per seat-km
- Mean value of 8.25 EUR-cent per seat-km and a standard variance of 0.21 EUR-cent per seat-km
- 90 % confidence interval 7.91 – 8.60 EUR-cent per seat-km

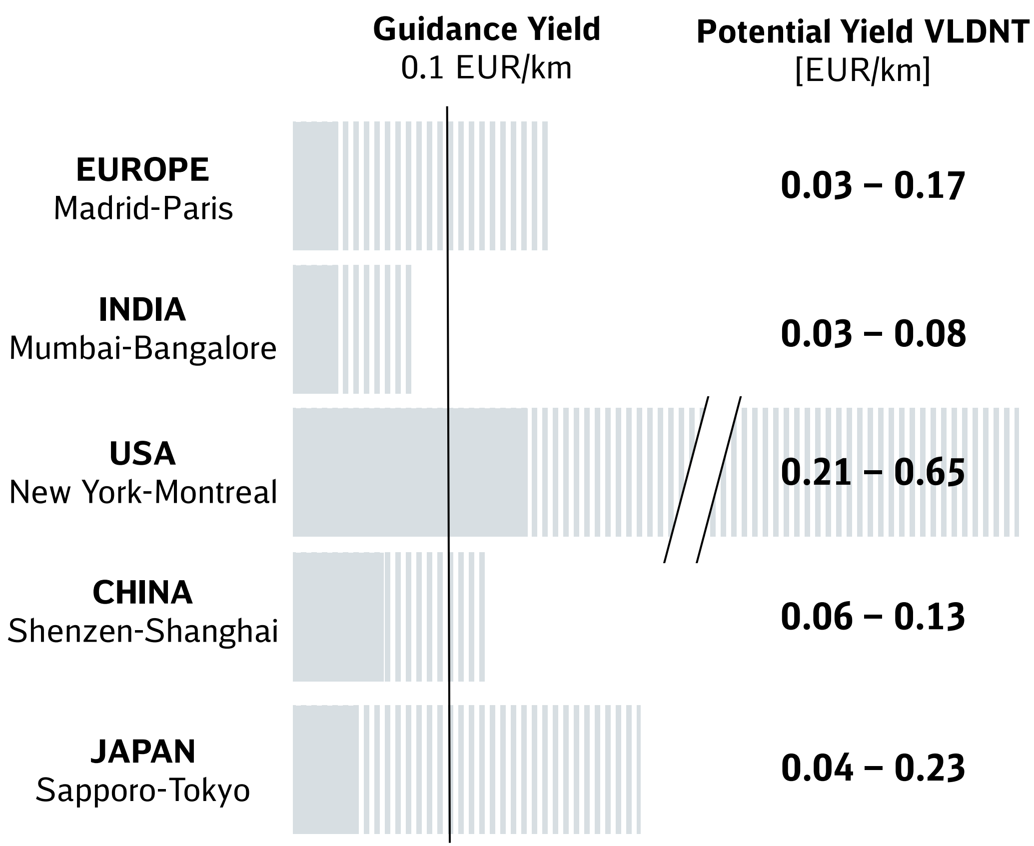


# Study of current air fares illustrates a wide spectrum of potentially achievable yields by VLDNT – predominantly starting at very low levels

Mobility Networks Logistics

Prices

## Potential VLDNT yields based on current air fare




- Air fare analysis based on **180 price requests** (3 travel types, 4 booking dates in advance, 3 trip dates)
- Focus on city pairs with **high demand** on VLDNT corridors showing **low required substitution rates**
- Results illustrate a **high bandwidth of air fares**
- Transferred to VLDNT market these results implies **unsteady yields** that are **far lower than EUR/km-revenues of airlines** due to far longer distances on the same connections (**rail detours vs. approx. linear distance**)
- **Different cost structures** of all analyzed markets **prohibits a direct comparison** of the potential VLDNT routes

# Fares of Madrid-Paris air market start at very low levels due to high competition in current market

Mobility Networks Logistics

Prices

## EUROPE West Corridor: Madrid - Paris

| | Air (One-way: 1,100 km) Price Range [EUR] | Yield [EUR/km] | Rail (One-way: 1,850 km) Potential Yield VLDNT [EUR/km] |
|---|---|---|---|
| BUSINESS TRAVEL 1 day | **105 - 620** | 0.05 - 0.28 | **0.03 – 0.17** |
| WEEKEND TRIP Fri-Sun | **111 - 606** | 0.05 – 0.28 | **0.03 – 0.16** |
| VACATION TRIP Sat-Sat, 14 d | **127 - 400** | 0.06 – 0.18 | **0.03 – 0.11** |

- Significant **longer route distance** of VLDNT lowering rail yields compared to air traffic
- **Very low basic yields**
- Relatively **high upper yield benchmarks**

# Similar to the European case study the potential yield for the VLDNT Mumbai – Bangalore suffers from the big detour of rail routing

Prices

## INDIA South Corridor: Mumbai - Bangalore

| | Price Range [EUR] | Yield [EUR/km] | Potential Yield VLDNT [EUR/km] |
|---|---|---|---|
| | Air – One-way: 850 km | | Rail – One-way: 1,400 km |
| BUSINESS TRAVEL 1 day | **90 - 176** | 0.05 - 0.10 | **0.03 – 0.06** |
| WEEKEND TRIP Fri-Sun | **83 - 230** | 0.05 – 0.14 | **0.03 – 0.08** |
| VACATION TRIP Sat-Sat, 14 d | **84 - 226** | 0.05 – 0.13 | **0.03 – 0.08** |

- Significant **longer route distance** of VLDNT lowering rail yields compared to air traffic
- **Very low basic yields**
- Also **upper yield benchmark** remains **very low**

# New York – Montreal air connection shows low airline competition and small capacities, low demand handicaps VLDNT services in principle

DB Mobility Networks Logistics

Prices

## USA East Coast: New York - Montreal

| | Air: One-way: 550 km | | Rail: One-way: 650 km |
|---|---|---|---|
| | **Price Range** [EUR] | **Yield** [EUR/km] | **Potential Yield VLDNT** [EUR/km] |
| BUSINESS TRAVEL 1 day | **258 - 801** | 0.23 - 0.73 | **0.21 – 0.65** |
| WEEKEND TRIP Fri-Sun | **281 - 801** | 0.26 – 0.73 | **0.23 – 0.65** |
| VACATION TRIP Sat-Sat, 14 d | **280 - 610** | 0.25 – 0.55 | **0.23 – 0.49** |

- **Best flight-train distance-ratio** of all analysed connections
- **Air market: Low airline competition** and **small capacities** result in high yields
- **Challenge:** low current demand handicaps VLDNT services in principle

# Fares of Shenzen-Shanghai air market show comparatively high basic levels

Mobility Networks Logistics

Prices

## CHINA South-East Corridor: Shenzen - Shanghai

Air — One-way: 1,250 km

Rail — One-way: 1,700 km

| | Price Range [EUR] | Yield [EUR/km] | Potential Yield VLDNT [EUR/km] |
|---|---|---|---|
| BUSINESS TRAVEL 1 day | **207 - 395** | 0.08 - 0.16 | **0.06 – 0.12** |
| WEEKEND TRIP Fri-Sun | **215 - 429** | 0.09 – 0.17 | **0.06 – 0.13** |
| VACATION TRIP Sat-Sat, 14 d | **209 - 389** | 0.08 – 0.16 | **0.06 – 0.11** |

- Significant **longer route distance** of VLDNT lowering rail yields compared to air traffic
- Comparatively **high basic air fares**
- Potential **yields** for VLDNT **in narrowest corridor** of all studied cases

# Japanese case study demonstrates a higher-than-average price range of air fares

Mobility Networks Logistics

Prices

## JAPAN Japan Link: Sapporo - Tokyo

Air — One-way: 850 km

Rail — One-way: 1,050 km

| | Price Range [EUR] | Yield [EUR/km] | Potential Yield VLDNT [EUR/km] |
|---|---|---|---|
| BUSINESS TRAVEL 1 day | **101 - 191** | 0.06 - 0.11 | **0.05 – 0.09** |
| WEEKEND TRIP Fri-Sun | **83 - 483** | 0.05 - 0.28 | **0.04 – 0.23** |
| VACATION TRIP Sat-Sat, 14 d | **83 - 236** | 0.05 - 0.14 | **0.04 – 0.11** |

- Rail distance **merely 20 % longer** than flight distance
- Compared to other cases very **wide price range**

# Agenda

## Overall working approach

**1 Analysis of the current situation**

- Consideration of **Night Train routes** and analysis of the **current situation** as well as the **development in the past** (preparation of maps)
- **Comparison** of the **rail** and **air** network and traffic volumes
- **Preparation** of **an overview of revenue and cost structures** of Night Trains
- Preparation of an **environmental viewpoint** considering Night Trains

**2 Survey of infrastructure and operation conditions**

- Infrastructure **availability** (network)
- **Capacity** and potential **path conflicts**

**3 Identification of opportunities for Night Trains in 2025**


# Rail traffic's independency from oil, less energy consumption and new technologies continue the environmental lead compared with air traffic

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**Environment – Summary**

## Comparison of environmental characteristics

| | | |
|---|---|---|
| **Post-fossil future:** Renewable sources can be rail's main power supply | Energy source 2025 | **Fossil future:** Air traffic probably long-term dependent on oil |
| **Rail traffic is more energy efficient** and greenhouse gas emissions are far below those of air traffic | $CO_2$ per PAX per trip<br>**30 kg*** (rail) / **290 kg** (air) | Despite shorter distances **medium-haul flight with higher emissions** and additional damages caused by **Radiative Forcing Index (RFI)** |
| **Rail traffic will keep the environmental lead,** greener power supply not yet included | Energy use 2025 vs. 2012<br>**- 50 %** (rail) / **- 40 %** (air) | Air traffic will become **more environmentally friendly in future** |

* Average $CO_2$ emission in kilogram per trip per person with current rolling stock, sample of European city connections of around 2,000 km

# Current $CO_2$ emissions for airplanes on investigated air routes are in general between 190 and 215 g/pkm

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**Environment**

| **Region:** / **Corridor:** | Europe West | Japan Central North | India West-South | China South-East | USA East Coast |
|---|---|---|---|---|---|
| From | **Madrid** | **Sapporo** | **Mumbai** | **Hong Kong** | **Ottawa** |
| **Considered aircrafts** | B737 | A320; B737/767/777 | A319/320; B737 | A300/319/320/ A321/330; B737 | A319; Canadair*; DHC-8**; Emb. 170/190* |
| **Flight distance** in km (with accuracy of ±50km) | ~1,350 | ~1,650 | ~900 | ~1,300 | ~800 |
| **$CO_2$ emission** | | | | | |
| kg per trip per person*** | 245 – 280 | 290 – 345 | 180 – 205 | 230 – 290 | 135 – 185 |
| g per pkm | 185 – 215 | 175 - 210 | 200 – 225 | 175 – 220 | 170 – 230 |
| To | **London** | **Fukuoka** | **Bangalore** | **Shanghai** | **Washington** |

Source: https://www.atmosfair.de/en/home/

* Calculation base: Embraer 145 because of similar turbines;

** Calculation base: ATR 210 because of same turboprops;

*** load factor is considered

# Current $CO_2$ emissions for trains on potential HST night lines are in general between 15 and 45 g/pkm

Mobility Networks Logistics

**Environment**

| **Region:** **Corridor:** | Europe West | Japan Central North | India West-South | China South-East | USA East Coast |
|---|---|---|---|---|---|
| From | Madrid | Sapporo | Mumbai | Hong Kong | Ottawa |
| To | London | Fukuoka | Bangalore | Shanghai | Washington |
| **Rail Distance** in km (with accuracy of ±50km) | ~2,200 | ~2,100 | ~1,400 | ~1,700 | ~1,200 |
| **$CO_2$ emission** | | | | | |
| kg per trip per person | 24 – 29 | 42 – 95 | n/a | 26 – 68 | 120 – 135 |
| g per pkm | 11-13 | 20 - 45 | n/a | 15 - 40 | 101 - 115 |
| | Emission determined on the basis of DB UmweltMobilCheck | Average emission for Japan according to Hayashi (2007) and Kato & Shinbahra (2006) Link | According to "$CO_2$ emissions from passenger transport in India 1950-51 to 2020-21" from Prof. S.K. Singh, Institut of Management Lucknow/India | Average emission according to UIC 's"Carbon Footprint of High Speed Rail" and | According to "Optimal Emissions from Cummuting, Business Travel and Product Transport"; Unites States Environmental Protection Agency, 2008 |

# Agenda

Mobility Networks Logistics

- First general results and recommendations
- Background and purpose of the study
- Analysis of the current situation
- **Survey of infrastructure and operation conditions**
- Identification of opportunities for Night Trains in 2025
- Backup

# Agenda

DB Mobility Networks Logistics

## ❶ Analysis of the current situation

- Consideration of **Night Train routes** and analysis of the **current situation** as well as the **development in the past** (preparation of maps)
- **Comparison** of the **rail** and **air** network and traffic volumes
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## ❷ Survey of infrastructure and operation conditions

- Infrastructure **availability** (network)
- **Capacity** and potential **path conflicts**


## ❸ Identification of opportunities for Night Trains in 2025

# Europe: Due to different operators and systems in Europe, the limitations varies in each country

Infrastructure check

## Infrastructure and operation limitations

| | | | |
|---|---|---|---|
| **OPERATIONS** |  | Intersection capacity – capacity overload in rush hour times in various European cities | ⚠ ⚠ ⚠ |
| |  | Rolling stock requirements – max gradient: 35 mm per metre i. e. Cologne – Frankfurt: gradient of 40 ‰; Regulations for crossing with freight traffic | ⚠ ⚠ |
| **NIGHT OPERATIONS** |  | Maintenance – Germany: blocking periods of tracks at night i. e. Hannover-Würzburg 45 – 240 min; Italy: closures only at night; Spain: closures only at night - on each of 4 HSL 4 hours | ⚠ ⚠ ⚠ |
| |  | Freight train operations – France, Italy, UK: exclusively passenger traffic on HSL; Spain: some parts of HSL are foreseen for mixed traffic; Germany: freight traffic mostly operating at night | ⚠ ⚠ |
| **SECURITY** |   6) | Border control – controls in UK, no controls between member states of the Schengen agreement | ⚠ |
| |  7) | Check-In facilities – France, UK: security checks to Channel tunnel; France/British frontier controls take place in control zones | ⚠ |
| **INTER-OPERABILITY** |  8) | Interoperability – Electrification on all HSL 25 kV AC, except Germany with 15 kV AC; Signaling systems: many different systems, common ERMTS under construction | ⚠ ⚠ ⚠ |

# India: General capacity constraints lead to a challenging operation environment

Infrastructure check

## Infrastructure and operation limitations

| | | | Infrastructure check |
|---|---|---|---|
| **OPERATIONS** |  | Intersection capacity – n/a | n/a |
| |  | Rolling stock requirements – n/a | n/a |
| **NIGHT OPERATIONS** |  | Maintenance – permanent construction activities; high number of single tracks; less enlargement and modernization works lead to capacity constraints and interruptions of Night Train operations | ⚠ ⚠ ⚠ |
| |  | Freight train operations – freight and passenger traffic shares tracks on the lines Mahisasan – Shahbazpur and Radhikapur - Birol | ⚠ |
| **SECURITY** |  6) | Border control – no border crossing HSL-corridors | ✓ |
| |  7) | Check-In facilities – no constraints for HST operation | ✓ |
| **INTER-OPERABILITY** |  8) | Interoperability – gauge of 1 676 mm is norm, but HSL planned on standard gauges | ⚠ |

# USA: There are projects to enhance capacities and to reduce bottlenecks

**Infrastructure check**

## Infrastructure and operation limitations

| | | | |
|---|---|---|---|
| **OPERATIONS** |  | Intersection capacity – busiest rail junction is the Harold Interlocking, currently there are projects to enhance capacities and to reduce bottlenecks between Amtrak and Long Island Railroad (LIRR) | ⚠ ⚠ ⚠ |
| |  | Rolling stock requirements – no special bottlenecks | ✓ |
| **NIGHT OPERATIONS** |  | Maintenance level corresponds to the regulated requirements | ⚠ ⚠ |
| |  | Amtrak has „dispatching priority“ (priority against freight trains) | ⚠ |
| **SECURITY** |   6) | Border control – controls inside the train on the border to Canada by customs and immigration officials; delays caused by the controls are possible | ⚠ |
| |  7) | Check-In facilities – no constraints to HST; for border-crossing journey, passengers need to arrive about 1 h before departure for customs and border protection processing | ⚠ |
| **INTER-OPERABILITY** |  8) | Interoperability – no electrification in the USA outside the Amtrak-owned Northeast Corridor (NEC) from Washington; same gauges in Canada and USA (1435 mm) | ⚠ |

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Logistics

# China: Rising traffic density in metropolitan areas and maximum incline on PDL are not insuperable obstacles

Infrastructure check

## Infrastructure and operation limitations

### OPERATIONS

Platform and depot capacity – rising traffic density in metropolitan areas — Infrastructure check: ⚠ ⚠

Rolling stock requirements – maximum incline on PDL: 20 ‰ — Infrastructure check: ⚠ ⚠

### NIGHT OPERATIONS

Maintenance – limited use of PDL infrastructure by CRH1E Night Train Shanghai – Beijing — Infrastructure check: ⚠

Freight train operations – no freight traffic on PDL, mixed traffic on conventional network, focus on bulk cargo (coal); almost no container traffic — Infrastructure check: ✓

### SECURITY


Border control – domestic traffic, few border crossing restrictions between Hong Kong and Shenzhen — Infrastructure check: ⚠


Check-In facilities – security control before access to station's departure area; package scanning, no constraints for High Speed Train operation — Infrastructure check: ✓

### INTER-OPERABILITY


Interoperability – standard gauge and 25 kV/50 kHz on main corridors, Chinese Train Control System CTCS, Chinese loading gauge on all PDL — Infrastructure check: ✓

# Japan: Very high traffic density leads to bottleneck situations in the evening and morning

DB Mobility Networks Logistics

## Infrastructure and operation limitations

| | | | Infrastructure check |
|---|---|---|---|
| OPERATIONS |  | Intersection capacity – very high traffic density between Osaka and Tokyo, no half trains allowed, Unpunctual trains are not accepted | ⚠ ⚠ ⚠ |
| |  | Rolling stock requirements – maximum incline: 20 ‰, maximum train length: 400 m, very strict noise emission standards, speed limit 250 km/h in several curves if train isn‘t equipped with tilting technology | ⚠ ⚠ ⚠ |
| NIGHT OPERATIONS |  | Maintenance – no passenger service between midnight and 6:00 am; night trains currently use conventional routes | ⚠ |
| |  | Freight train operations – no freight traffic on HSL | ✓ |
| SECURITY |  6) | Border control – domestic traffic only, no border control required | ✓ |
| |  7) | Check-In facilities – no special luggage or access control | ✓ |
| INTER-OPERABILITY |  8) | Interoperability – Standard gauge on major Shinkansen corridors, double deck trains possible, two different power supply systems (25 kV / 50 Hz, 25 kV / 60 Hz) | ⚠ ⚠ |

# Agenda

First general results and recommendations

Background and purpose of the study

Analysis of the current situation

Survey of infrastructure and operation conditions

**Identification of opportunities for Night Trains in 2025**

Backup

# Agenda

**1 Analysis of the current situation**

- Consideration of **Night Train routes** and analysis of the **current situation** as well as the **development in the past** (preparation of maps)
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**2 Survey of infrastructure and operation conditions**

- Infrastructure **availability** (network)
- **Capacity** and potential **path conflicts**

**3 Identification of opportunities for Night Trains in 2025**


# Pure Night Train product remains critical for the business daily traffic

Identification of opportunities

## SWOT analysis

### Strengths

- Only wide-body aircrafts provide the same capacity as a night train. However, this type of aircraft is not suitable for short- and middle-distance flights due to higher energy consumption (no jetstreams, shorter cruise- phase)
- Arrival before first aircraft, early business meetings without overnight hotel stay possible

### Weaknesses

- Night Train travel time is still significantly higher than airline travel time
- In case of exclusive Night Train use, passengers stay two nights away from the house, possibly more working hours at the destination than actually needed
- Solvent freight traffic occupies the routes at night, HSR night train decreases the capacity of the network (mixed traffic)

### Opportunities

- Improvements in information and communication technology lead to better time usability during the journey (on-board infotainment system, portable devices) The disadvantage of higher travel time is qualified
- The Night Train has a far better energy balance than air traffic. With regard to CSR- Reportings and company and personal image, this factor gets more and more important.
- Day and night use of rolling stock decreases operating costs

### Threats

- High amount of infrastructure charges
- Efficiency of airlines increases faster than expected and compensates the increasing fuel costs.
- Energy efficient turbofan engines
- Introduction of standing room in air traffic
- Train traffic‘s noise production results in nocturnal production stops

# Agenda

Mobility
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- First general results and recommendations
- Background and purpose of the study
- Analysis of the current situation
- Survey of Infrastructure Conditions
- Identification of Opportunities for Night Trains in 2025
- **Backup**

# Agenda

Mobility Networks Logistics

**Backup**

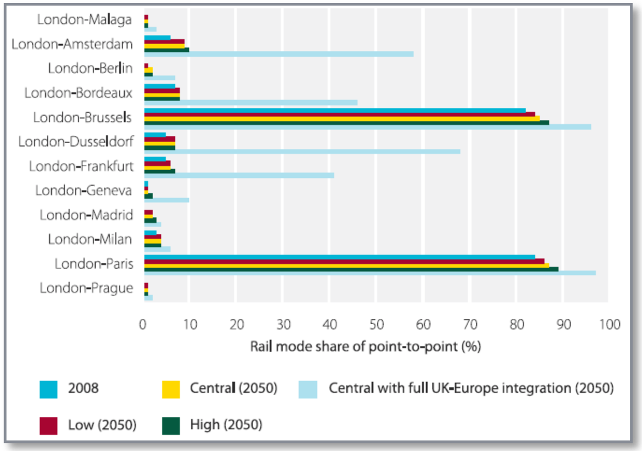
**Background and purpose of the study**

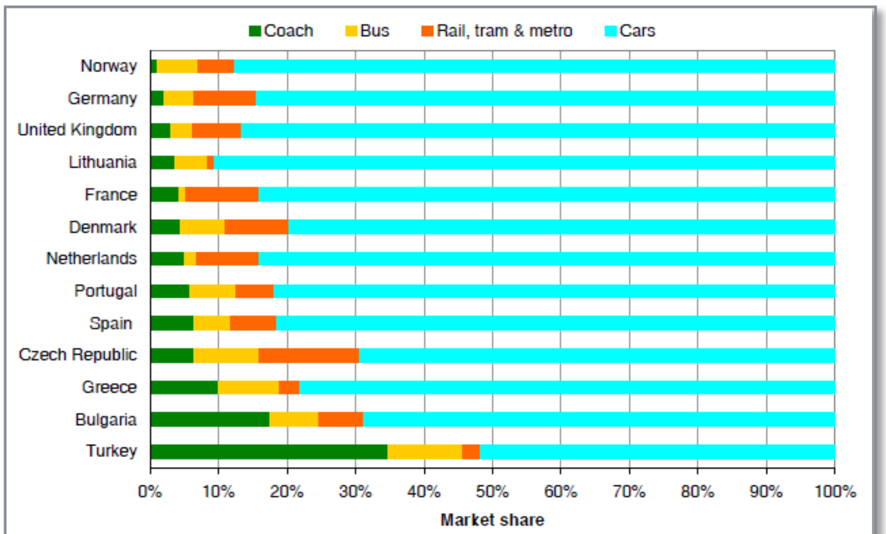
Analysis of the current situation (potential)

Analysis of the current situation (costs and prices)

Analysis of the current situation (environment)

# Data on very long distance passenger transport is fragmentary available but statistics demonstrate very low mode shares of rail and coach




## RAIL

- Currently Rail mode share on typical very long distance connections (e.g. London-Madrid/Malaga/Milan) is close to 0 %

(Steer Davies Gleave 2009)

## COACH

- There is no data focussing on mode share in the very long distance market comparing car, coach, train and plane.
- Even in countries with strong coach competition overall mode share of coach is relatively low.

(European Commission 2009)

# Agenda

**Backup**

Background and purpose of the study

**Analysis of the current situation (potential)**

Analysis of the current situation (costs and prices)

Analysis of the current situation (environment)

# First Step: Gravitation model for identifying the relevant demand connections

Mobility Networks Logistics

Corridors

## Classical gravitation model - approach

### Starting Point

- Classic **gravitation model indicates** that the amount of **traffic between two cities increases with rising population**
  (derivation: focus on the most populated cities / regions) - “Masses attract each other”
- Approach **disregards other travel motivations** of certain destinations (e.g. EU- administration in Brussels)
- Existing **models for European metropolitan areas** - **not available for all** investigation **areas** (e.g. India, Japan, USA)

### Approach

- Classification of the **cities into categories** (range of categories is **specific for each region**)
- Example Europe[1]:
  A –population > 3 mio → red spot;
  B –population 2-3 mio → yellow spot;
  C –population 1-2 mio → green spot
  **Means for preparing the corridors**:
  - Support of HSR map material provided by UIC (planned status is taken for granted 2025)
  - Rail distances between the cities

[1] Source: e.g. http://de.wikipedia.org/wiki/Liste_der_gr%C3%B6%C3%9Ften_St%C3%A4dte_der_Europ%C3%A4ischen_Union)

# The application of the gravitation has advantages – simplicity – but also disadvantages as using only number of inhabitants as decision

Mobility Networks Logistics

Corridors

## Classical gravitation model - Methodology evaluation

| Advantages | Disadvantages |
| --- | --- |
| ▪ **Classical first** step approach<br>▪ **Simple model** approach “Masses attract each other”<br>▪ **Applicable** for all **considered countries / regions** using the same approach<br>▪ **Good database** for the chosen characteristic „number of inhabitants“<br>▪ **Avoiding data gaps** and difficulties in comparison between the considered countries (secure data basis) | ▪ Gravitation **only means** “Masses attract each other” using the **number of inhabitants**<br>▪ **Additional characteristics** / information **are not considered** (economic, tourism, …)<br>▪ **Only cities** considered without analysing metropolises (e.g. Ruhr area) |

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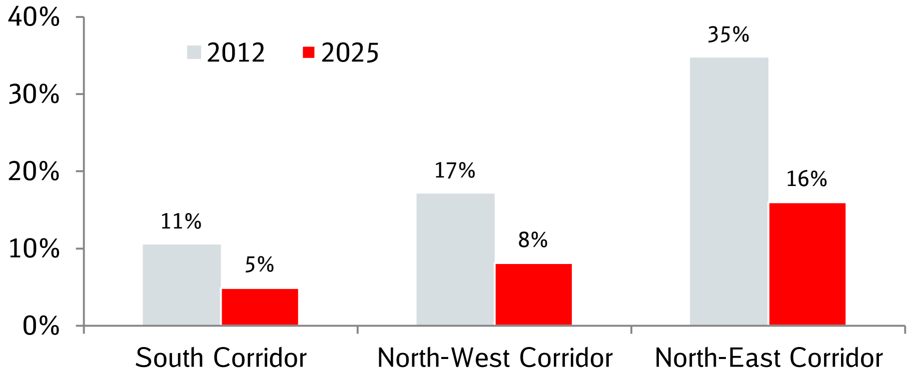
# In the case of India the "South Corridor" serves as a good for starting the business

Potential India

## Summary substitution rate High Speed Night Train - INDIA

### Assessed substitution rate

- **"South Corridor"** (Mumbai - Pune --- Hyderabad - Bangalore – Chennai) indicates the **best opportunities for a market entrance** in India




### Risk assessment

- Assessment also shows **good results in worst cases**
- Risk assessment by applying **Monte Carlo Simulation**
- **Varying of the variables** (load factor | flights per week | share transfer | growth rate 2025)

| **Corridor HS Night Trains** | **2025 [90 % significance]** | |
|---|---|---|
| | Min | Max |
| North East | 11 % | 24 % |
| North West | 5 % | 12 % |
| South | 3 % | 7 % |

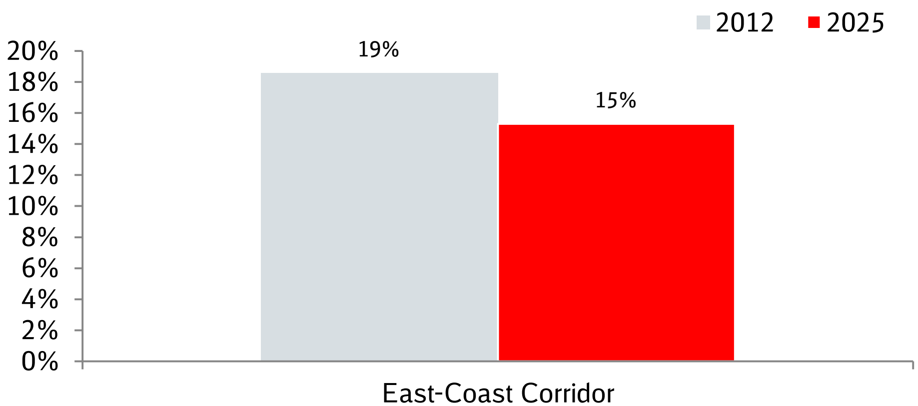
# In the case of USA only one corridor was defined and analysed but the results are not that good

Potential USA

## Summary potential analysis High Speed Night Train - USA

### Assessed substitution rate

- Only **one corridor** was considered – "**East Coast Corridor**" from Washington via Philadelphia, New York, Montreal to Ottawa
- Result **does not show that good figures** for a market entrance in comparison to other countries




### Risk assessment

- Risk assessment by applying **Monte Carlo Simulation**
- **Varying of variables** (load factor | flights per week | share transfer | growth rate 2025)

| Corridor HS Night Trains | 2025 [90 % significance] | |
|---|---|---|
| | Min | Max |
| East Coast | 11 % | 21 % |

# In the case of China, the "South East Axis" serves as a good opportunity for entering the market

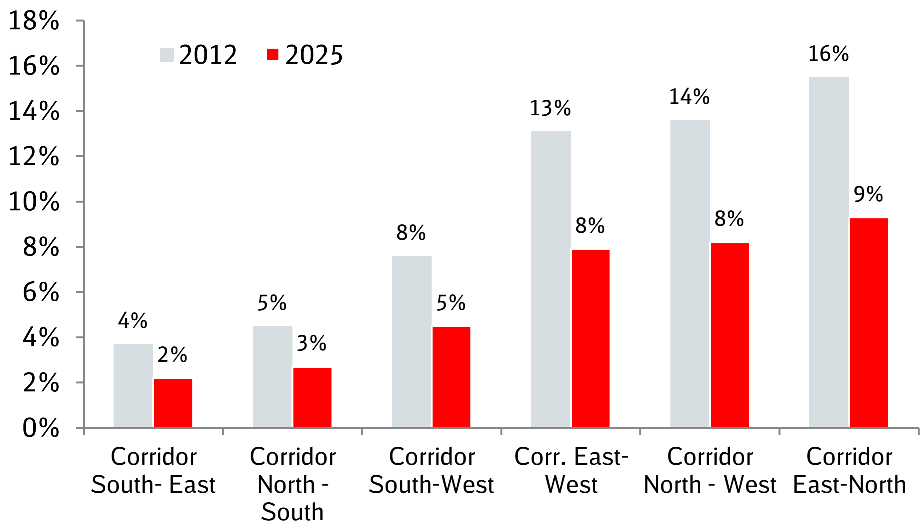
Mobility Networks Logistics

**Potential China**

## Summary substitution rate High Speed Night Train - CHINA

### Assessed substitution rate

- **"South East Axis"** (Hong Kong - Shenzhen - Dongguan - Guangzhou --- Ningbo - Hangzhou – Shanghai) indicates the **best opportunities for a market entrance** in China




### Risk assessment

- Assessment also shows **robust values in worst cases**
- Risk assessment by applying **Monte Carlo Simulation**
- **Varying of variables** (load factor | flights per week | share transfer | growth rate 2025)

| **Corridor HS Night Trains** | **2025 [90 % significance]** | |
|---|---|---|
| | Min | Max |
| South East | 2 % | 3 % |
| North South | 2 % | 3 % |
| South West | 3 % | 6 % |
| East West | 5 % | 11 % |
| North West | 6 % | 11 % |
| East North | 7 % | 13 % |

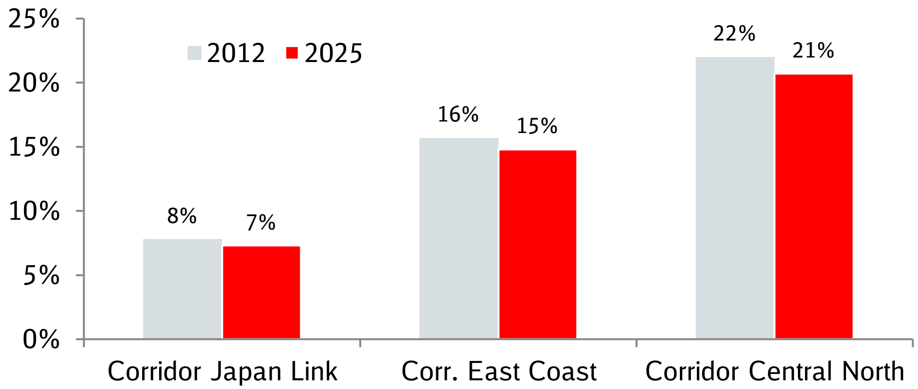
# In the case of Japan the "Japan Link" serves as a good opportunity for entering the market

Potential Japan

## Summary potential analysis High Speed Night Train - Japan

### Assessed substitution rate

- "**Japan Link**" corridor (Sapporo---Tokyo-Nagoya-Osaka-Hiroshima-Fukuoka) indicates the **best opportunities** for a market entrance in Japan

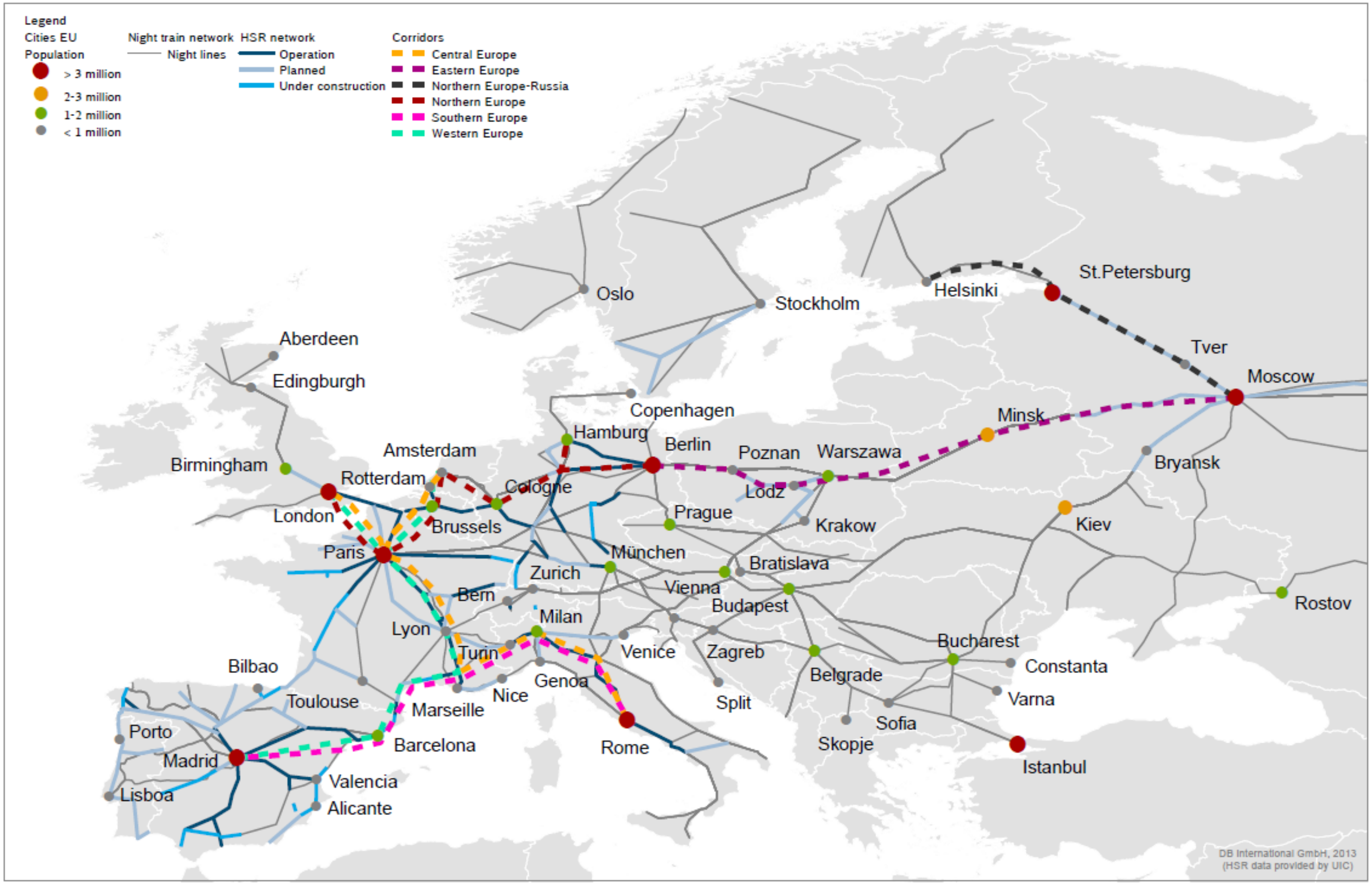



### Risk assessment

- Assessment also shows **good results in worst cases for the preferred corridor**
- Risk assessment by applying **Monte Carlo Simulation**
- **Varying of variables** (load factor | flights per week | share transfer | growth rate 2025)

| **Corridor HS Night Trains** | **2025 [90 % significance]** | |
|---|---|---|
| | Min | Max |
| Japan Link | 5 % | 10 % |
| East Coast | 10 % | 20 % |
| Central North | 14 % | 27 % |

# EUROPE


Legend
Cities EU
Population
> 3 million
2-3 million
1-2 million
< 1 million
Night train network
Night lines
HSR network
Operation
Planned
Under construction
Corridors
Central Europe
Eastern Europe
Northern Europe-Russia
Northern Europe
Southern Europe
Western Europe
Oslo
Stockholm
Helsinki
St.Petersburg
Tver
Moscow
Aberdeen
Edingburgh
Copenhagen
Hamburg
Berlin
Poznan
Warszawa
Minsk
Birmingham
Amsterdam
Rotterdam
Cologne
Lodz
Bryansk
London
Brussels
Prague
Krakow
Kiev
Paris
München
Bratislava
Zurich
Vienna
Budapest
Rostov
Bern
Milan
Lyon
Turin
Venice
Zagreb
Bucharest
Constanta
Bilbao
Genoa
Belgrade
Toulouse
Nice
Split
Varna
Marseille
Sofia
Porto
Skopje
Madrid
Barcelona
Rome
Istanbul
Valencia
Lisboa
Alicante
DB International GmbH, 2013
(HSR data provided by UIC)

# EUROPE North Corridor: 13 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation



**Europe North HSR**

| | |
|---|---|
| Direct flights (per day and direction): | 39 |
| Capacity (seats per day): | 5,800 |
| PAX (per day): | 4,550 |
| (1) **PAX without connecting flight (per day):** | **2,950** |


| | |
|---|---|
| Potential HT London - Hamburg (per day): | 1,100 |
| Potential HT London - Berlin (per day): | 1,850 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 250 |
| (2) **Occupancy rate of 75 %:** | **375** |


**Required air traffic substitution rate:** (2) from (1) = **13 %**

* Calculation base: Bombardier ZEFIRO 250

# EUROPE North Corridor 2025: The required substitution rate could decline from 13% in 2012 to 10% in 2025 (conservative perspective)

Mobility Networks Logistics

Europe North HSR

**London Paris** – **Hanover Hamburg Berlin**

| ✈ | **2012** | **2025** Airbus Forecast 2012-31: +3.4 % p.a. | **2025** DBI feat. Airbus 2012-25: +2 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 39 | not specified | not specified |
| Capacity (Seats per day) | 5,800 | not specified | not specified |
| PAX (per day) | 4,550 | 7,050 | 5,900 |
| PAX without connecting flights (per day) | 2,950 | 4,550 | 3,800 |
| **Required air traffic substitution rate** | **13 %** | **8 %** | **10 %** |

- Airbus forecasts a growth of 3.6 % up to 2021 and 3.1 % after 2021 considering on inner-European routes
- No information regarding the separation to existing and new routes

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# EUROPE West Corridor: 4 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

**Europe West HSR**

| | |
|---|---|
| Direct flights (per day and direction): | 105 |
| Capacity (seats per day): | 16,750 |
| PAX (per day): | 13,250 |
| ① **PAX without connecting flight (per day):** | **9,450** |

Madrid / Barcelona / Saragossa — Paris / London / Brussels / Antwerp / Rotterdam / Amsterdam

| | |
|---|---|
| Potential HT Madrid-Amsterdam (per day): | 4,700 |
| Potential HT Madrid-London (per day): | 4,750 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 250 |
| ② **Occupancy rate of 75 %:** | **375** |

Madrid / Barcelona / Saragossa — Paris — London / Brussels / Antwerp / Rotterdam / Amsterdam

**Required air traffic substitution rate:** ② from ① = **4 %**

* Calculation base: Bombardier ZEFIRO 250

# EUROPE West Corridor 2025: The required substitution rate could decline from 4 % in 2012 to 3 % in 2025 (conservative perspective)

Europe West HSR

**Madrid**
**Barcelona**
**Saragossa**

**Paris**
**London**
**Brussels**
**Antwerp**
**Rotterdam**
**Amsterdam**

| | **2012** | **2025** Airbus Forecast 2012-31: +3.4 % p.a. | **2025** DBI feat. Airbus 2012-25: +2 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 105 | not specified | not specified |
| Capacity (Seats per day) | 16,750 | not specified | not specified |
| PAX (per day) | 13,250 | 20,450 | 17,150 |
| PAX without connecting flights (per day) | 9,450 | 14,600 | 12,200 |
| **Required air traffic substitution rate** | **4 %** | **3 %** | **3 %** |

- Airbus forecasts a growth of 3.6 % up to 2021 and 3.1 % after 2021 considering on inner-European routes
- No information regarding the separation to existing and new routes

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# EUROPE South Corridor: 11 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

DB Mobility Networks Logistics

**Europe South HSR**

| | |
|---|---|
| Direct flights (per day and direction): | 34 |
| Capacity (seats per day): | 5,750 |
| PAX (per day): | 4,550 |
| ① **PAX without connecting flight (per day):** | **3,350** |

**Madrid Barcelona Saragossa** — **Milan Rome**

| | |
|---|---|
| Potential BT Madrid – Rome (per day): | 3,350 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 250 |
| ② **Occupancy rate of 75 %:** | **375** |

**Madrid Barcelona Saragossa** — **Milan**

**Required air traffic substitution rate:** ② from ① = **11 %**

* Calculation base: Bombardier ZEFIRO 250

# EUROPE South Corridor 2025: The required substitution rate could decline from 11 % in 2012 to 9 % in 2025 (conservative perspective)

**Europe South HSR**

**Madrid Barcelona Zaragoza** – **Milan Rome**

| | **2012** | **2025** Airbus Forecast 2012-31: +3.4 % p.a. | **2025** DBI feat. Airbus 2012-25: +2 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 34 | not specified | not specified |
| Capacity (Seats per day) | 5,750 | not specified | not specified |
| PAX (per day) | 4,550 | 7,050 | 5,900 |
| PAX without connecting flights (per day) | 3,350 | 5,150 | 4,350 |
| **Required air traffic substitution rate** | **11 %** | **7 %** | **9 %** |

- Airbus forecasts a growth of 3.6 % up to 2021 and 3.1 % after 2021 considering on inner-European routes
- No information regarding the separation to existing and new routes

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# EUROPE South Corridor²: 21 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

Mobility Networks Logistics

² Europe South CNT

| | |
|---|---|
| Direct flights (per day and direction): | 19 |
| Capacity (seats per day): | 3,000 |
| PAX (per day): | 2,400 |
| ① **PAX without connecting flight (per day):** | **1,800** |

**Madrid Barcelona Saragossa** — **Milan**

| | |
|---|---|
| Potential BT Madrid – Milan (per day): | 1,800 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 250 |
| ② **Occupancy rate of 75 %:** | **375** |

**Madrid Barcelona Saragossa** — **Milan**

**Required air traffic substitution rate:** ② from ① = **21 %**

* Calculation base: Bombardier ZEFIRO 250

# EUROPE South Corridor² 2025: The required substitution rate could decline from 21 % in 2012 to 16 % in 2025 (conservative perspective)

DB Mobility Networks Logistics

² Europe South CNT

**Madrid Barcelona Zaragoza** – **Milan**

| | 2012 | 2025<br>Airbus Forecast<br>2012-31: +3.4 % p.a. | 2025<br>DBI feat. Airbus<br>2012-25: +2 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 19 | not specified | not specified |
| Capacity (Seats per day) | 3,000 | not specified | not specified |
| PAX (per day) | 2,400 | 3,700 | 3,100 |
| PAX without connecting flights (per day) | 1,800 | 2,800 | 2,350 |
| **Required air traffic substitution rate** | **21 %** | **13 %** | **16 %** |

- Airbus forecasts a growth of 3.6 % up to 2021 and 3.1 % after 2021 considering on inner-European routes
- No information regarding the separation to existing and new routes

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

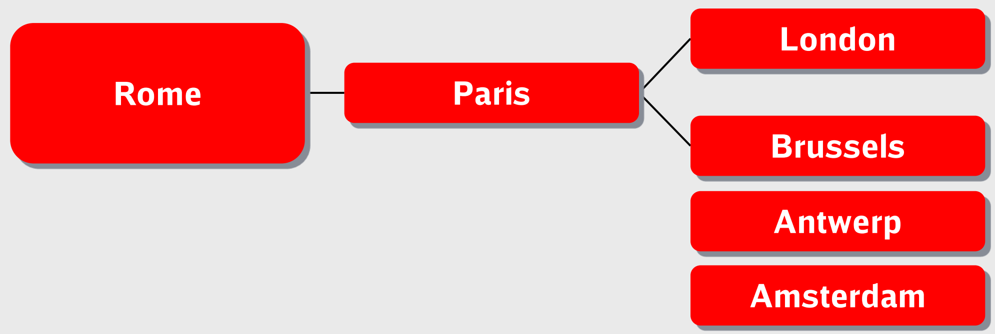
DB Mobility Networks Logistics

# EUROPE Corridor: 10 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

**Europe HSR and CNT**

| | |
|---|---|
| Direct flights (per day and direction): | 39 |
| Capacity (seats per day): | 6,650 |
| PAX (per day): | 5,250 |
| ① **PAX without connecting flight (per day):** | **3,850** |


| | |
|---|---|
| Potential BT Rome – London (per day): | 2,050 |
| Potential BT Rome – Amsterdam (per day): | 1,800 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 250 |
| ② **Occupancy rate of 75 %:** | **375** |




**Required air traffic substitution rate:** ② from ① = **10 %**

* Calculation base: Bombardier ZEFIRO 250

Mobility
Networks
Logistics

# EUROPE Corridor 2025: The required substitution rate could decline from 10 % in 2012 to 8 % in 2025 (conservative perspective)

**Europe HSR and CNT**

**Rome**

**Paris**
**London**
**Brussels**
**Antwerp**
**Amsterdam**

| | 2012 | 2025 Airbus Forecast 2012-31: +3.4 % p.a. | 2025 DBI feat. Airbus 2012-25: +2 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 39 | not specified | not specified |
| Capacity (Seats per day) | 6,650 | not specified | not specified |
| PAX (per day) | 5,250 | 8,100 | 6,800 |
| PAX without connecting flights (per day) | 3,850 | 5,950 | 5,000 |
| **Required air traffic substitution rate** | **10 %** | **6 %** | **8 %** |

- Airbus forecasts a growth of 3.6 % up to 2021 and 3.1 % after 2021 considering on inner-European routes
- No information regarding the separation to existing and new routes

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# EUROPE East Corridor: 55 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation



**Europe East HSR**

| | |
|---|---|
| Direct flights (per day and direction): | 8 |
| Capacity (seats per day): | 1,200 |
| PAX (per day): | 950 |
| ① **PAX without connecting flight (per day):** | **680** |

Berlin — Warsaw Moscow

| | |
|---|---|
| Potential BT Berlin – Moscow (per day): | 700 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 250 |
| ② **Occupancy rate of 75 %:** | **375** |

Rome — Warsaw Moscow

**Required air traffic substitution rate:** ② from ① = **55 %**

* Calculation base: Bombardier ZEFIRO 250

# EUROPE East Corridor 2025: The required substitution rate could decline from 55 % in 2012 to 42 % in 2025 (conservative perspective)

Europe East HSR

Berlin

Warsaw
Moscow

| | 2012 | 2025<br>Airbus Forecast<br>2012-31: +3.4 % p.a. | 2025<br>DBI feat. Airbus<br>2012-25: +2 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 8 | not specified | not specified |
| Capacity (Seats per day) | 1,200 | not specified | not specified |
| PAX (per day) | 950 | 1,450 | 1,250 |
| PAX without connecting flights (per day) | 700 | 1,100 | 900 |
| **Required air traffic substitution rate** | **55 %** | **34 %** | **42 %** |

- Airbus forecasts a growth of 3.6 % up to 2021 and 3.1 % after 2021 considering  on inner-European routes
- No information regarding  the separation to existing and new routes

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# EUROPE East Corridor[2] : 197 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

[2] Europe East CNT

| | | |
|---|---|---|
| Direct flights (per day and direction): | 3 | |
| Capacity (seats per day): | 350 | Warsaw – Moscow |
| PAX (per day): | 300 | |
| (1) **PAX without connecting flight (per day):** | **200** | |

| | | |
|---|---|---|
| Potential BT Warsaw – Moscow (per day): | 200 | |
| Half-train (HT) (per day and direction): | 2 | |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 250 | Warsaw – Moscow |
| (2) **Occupancy rate of 75 %:** | **375** | |

**Required air traffic substitution rate:** (2) from (1) = **197 %**

* Calculation base: Bombardier ZEFIRO 250

# EUROPE East Corridor² 2025: The required substitution rate could decline from 197 % in 2012 to 150 % in 2025 (conservative perspective)

² Europe East CNT

Warsaw – Moscow

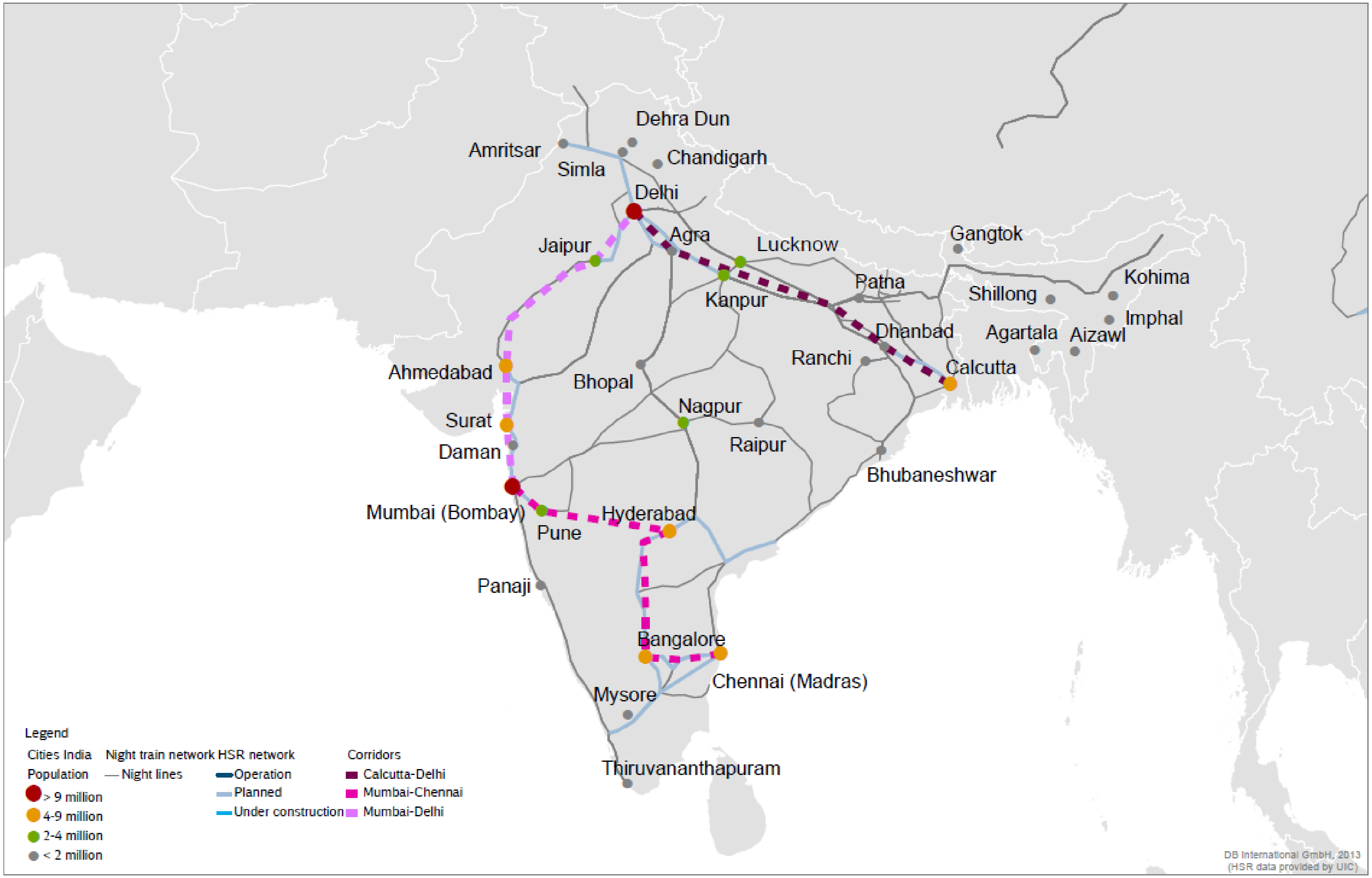
| | 2012 | 2025 Airbus Forecast 2012-31: +3.4 % p.a. | 2025 DBI feat. Airbus 2012-25: +2 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 3 | not specified | not specified |
| Capacity (Seats per day) | 350 | not specified | not specified |
| PAX (per day) | 300 | 450 | 400 |
| PAX without connecting flights (per day) | 200 | 300 | 250 |
| **Required air traffic substitution rate** | **197 %** | **125 %** | **150 %** |

- Airbus forecasts a growth of 3.6 % up to 2021 and 3.1 % after 2021 considering on inner-European routes
- No information regarding the separation to existing and new routes

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# INDIA



Dehra Dun
Amritsar
Chandigarh
Simla
Delhi
Jaipur
Agra
Lucknow
Gangtok
Kanpur
Patna
Shillong
Kohima
Imphal
Dhanbad
Agartala
Aizawl
Ranchi
Calcutta
Ahmedabad
Bhopal
Nagpur
Surat
Raipur
Daman
Bhubaneshwar
Mumbai (Bombay)
Hyderabad
Pune
Panaji
Bangalore
Chennai (Madras)
Mysore
Thiruvananthapuram
Legend
Cities India
Population
> 9 million
4-9 million
2-4 million
< 2 million
Night train network
Night lines
HSR network
Operation
Planned
Under construction
Corridors
Calcutta-Delhi
Mumbai-Chennai
Mumbai-Delhi
DB International GmbH, 2013
(HSR data provided by UIC)

# INDIA North-East Corridor: 35 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation



| | |
|---|---|
| Direct flights (per day and direction): | 14 |
| Capacity (seats per day): | 2,400 |
| PAX (per day): | 1,800 |
| (1) **PAX without connecting flight (per day):** | **1,350** |

**Kolkata Dhanbad** — **Kanpur / Lucknow Agra Delhi**

| | |
|---|---|
| Potential BT Kolkata – Delhi (per day): | 1,350 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| (2) **Occupancy rate of 75 %:** | **465** |

**Kolkata Dhanbad** — **Kanpur / Lucknow Agra Delhi**

**Required air traffic substitution rate:** (2) from (1) = **35 %**

* Calculation base: Bombardier ZEFIRO 250

# INDIA North-East Corridor 2025: The required substitution rate could decline from 35 % in 2012 to 16 % in 2025 (conservative perspective)





**Kolkata Dhanbad**

**Kanpur / Lucknow Agra Delhi**

| | **2012** | **2025** Airbus Forecast 2012-31: +8.5 % p.a. | **2025** DBI feat. Airbus 2012-25: +6 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 14 | not specified | not specified |
| Capacity (Seats per day) | 2,400 | not specified | not specified |
| PAX (per day) | 1,800 | 5,200 | 3,850 |
| PAX without connecting flights (per day) | 1,350 | 3,900 | 2,900 |
| **Required air traffic substitution rate** | **35 %** | **12 %** | **16 %** |

- Airbus forecasts a growth of 2021 6.4 %, up to 2021 and 5.2 % after 2021 considering  in Asia / Pacific region
- Assumption India: 8.5 %

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# INDIA North-East Corridor²: 474 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation



² INDIA North- East Corridor CNT

| | |
|---|---|
| Direct flights (per day and direction): | 2 |
| Capacity (seats per day): | 200 |
| PAX (per day): | 150 |
| ① **PAX without connecting flight (per day):** | **100** |

Kolkata Dhanbad — Kanpur / Lucknow

| | |
|---|---|
| Potential BT Kolkata – Lucknow (per day): | 100 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| ② **Occupancy rate of 75 %:** | **465** |

Kolkata Dhanbad — Kanpur / Lucknow

**Required air traffic substitution rate:** ② from ① = **474 %**

* Calculation base: Bombardier ZEFIRO 250

# INDIA North-East Corridor² 2025: The required substitution rate could decline from 474 % in 2012 to 233 % in 2025 (conservative perspective)

Mobility Networks Logistics

² INDIA North- East Corridor CNT

**Kolkata Dhanbad**

**Kanpur / Lucknow**

| | **2012** | **2025** Airbus Forecast 2012-31: +8.5 % p.a. | **2025** DBI feat. Airbus 2012-25: +6 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 2 | not specified | not specified |
| Capacity (Seats per day) | 200 | not specified | not specified |
| PAX (per day) | 150 | 450 | 300 |
| PAX without connecting flights (per day) | 100 | 300 | 200 |
| **Required air traffic substitution rate** | **474 %** | **155 %** | **233 %** |

- Airbus forecasts a growth of 2021 6.4 %, up to 2021 and 5.2 % after 2021 considering in Asia / Pacific region
- Assumption India: 8.5 %

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# INDIA North-West Corridor: 17 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

DB Mobility Networks Logistics

INDIA North- West Corridor HSR

Direct flights (per day and direction): 31

Capacity (seats per day): 5,000

PAX (per day): 3,750

(1) **PAX without connecting flight (per day): 2,700**

Mumbai Surat Ahmedabad — Jaipur Delhi

Potential BT Mumbai – Jaipur (per day): 2,700

Half-train (HT) (per day and direction): 2

Capacity* (seats/beds per day): (HSR Alternative) 2 x 310

(2) **Occupancy rate of 75 %: 465**

Mumbai Surat Ahmedabad — Jaipur Delhi

**Required air traffic substitution rate:** (2) from (1) = **17 %**

* Calculation base: Bombardier ZEFIRO 250

# INDIA North-West Corridor 2025: The required substitution rate could decline from 17 % in 2012 to 8 % in 2025 (conservative perspective)

INDIA North- West Corridor HSR

**Mumbai**
**Surat**
**Ahmedabad**

**Jaipur**
**Delhi**

| | **2012** | **2025** Airbus Forecast 2012-31: +8.5 % p.a. | **2025** DBI feat. Airbus 2012-25: +6 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 31 | not specified | not specified |
| Capacity (Seats per day) | 5,000 | not specified | not specified |
| PAX (per day) | 3,750 | 10,850 | 8,000 |
| PAX without connecting flights (per day) | 2,700 | 7,800 | 5,750 |
| **Required air traffic substitution rate** | **17 %** | **6 %** | **8 %** |

- Airbus forecasts a growth of 2021 6.4 %, up to 2021 and 5.2 % after 2021 considering in Asia / Pacific region
- Assumption India: 8.5 %

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# INDIA North-West Corridor[2] : 55 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

DB Mobility Networks Logistics

² INDIA North- West Corridor CNT

| | |
|---|---|
| Direct flights (per day and direction): | 10 |
| Capacity (seats per day): | 1,550 |
| PAX (per day): | 1,150 |
| (1) **PAX without connecting flight (per day):** | **850** |

**Surat Ahmedabad** — **Jaipur Delhi**

| | |
|---|---|
| Potential BT Surat – Delhi (per day): | 850 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| (2) **Occupancy rate of 75 %:** | **465** |

**Surat Ahmedabad** — **Jaipur Delhi**

**Required air traffic substitution rate:** (2) from (1) = **55 %**

* Calculation base: Bombardier ZEFIRO 250

# INDIA North-West Corridor² 2025: The required substitution rate could decline from 55 % in 2012 to 26 % in 2025 (conservative perspective)

² INDIA North- West Corridor CNT

**Surat Ahmedabad**

**Jaipur Delhi**

| | 2012 | 2025 Airbus Forecast 2012-31: +8.5 % p.a. | 2025 DBI feat. Airbus 2012-25: +6 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 10 | not specified | not specified |
| Capacity (Seats per day) | 1,550 | not specified | not specified |
| PAX (per day) | 1,150 | 3,300 | 2,450 |
| PAX without connecting flights (per day) | 850 | 2,450 | 1,800 |
| **Required air traffic substitution rate** | **55 %** | **19 %** | **26 %** |

- Airbus forecasts a growth of 2021 6.4 %, up to 2021 and 5.2 % after 2021 considering in Asia / Pacific region
- Assumption India: 8.5 %
- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

Source: http://www.airbus.com/company/market/forecast/

# INDIA South Corridor: 11 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation



INDIA South Corridor HSR

| | |
|---|---|
| Direct flights (per day and direction): | 54 |
| Capacity (seats per day): | 8,350 |
| PAX (per day): | 6,250 |
| (1) **PAX without connecting flight (per day):** | **4,400** |

Mumbai, Pune — Hyderabad, Bangalore, Chennai

| | |
|---|---|
| Potential BT Mumbai – Chennai (per day): | 4,400 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| (2) **Occupancy rate of 75 %:** | **465** |

Mumbai, Pune — Hyderabad, Bangalore, Chennai

**Required air traffic substitution rate:** (2) from (1) = **11 %**

* Calculation base: Bombardier ZEFIRO 250

# INDIA South Corridor 2025: The required substitution rate could decline from 11 % in 2012 to 5 % in 2025 (conservative perspective)





**Mumbai Pune**

**Hyderabad Bangalore Chennai**

| | 2012 | 2025 Airbus Forecast 2012-31: +8.5 % p.a. | 2025 DBI feat. Airbus 2012-25: +6 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 54 | not specified | not specified |
| Capacity (Seats per day) | 8,350 | not specified | not specified |
| PAX (per day) | 6,250 | 18,050 | 13,350 |
| PAX without connecting flights (per day) | 4,400 | 12,700 | 9,400 |
| **Required air traffic substitution rate** | **11 %** | **4 %** | **5 %** |

- Airbus forecasts a growth of 2021 6.4 %, up to 2021 and 5.2 % after 2021 considering  in Asia / Pacific region
- Assumption India: 8.5 %

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# INDIA South Corridor² 42 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

Mobility Networks Logistics

² INDIA South Corridor CNT

| | |
|---|---|
| Direct flights (per day and direction): | 14 |
| Capacity (seats per day): | 2,150 |
| PAX (per day): | 1,600 |
| (1) **PAX without connecting flight (per day):** | **1,100** |

**Mumbai Pune** — **Hyderabad**

| | |
|---|---|
| Potential BT Mumbai – Hyderabad (per day): | 1,100 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| (2) **Occupancy rate of 75 %:** | **465** |

**Mumbai Pune** — **Hyderabad**

**Required air traffic substitution rate:** (2) from (1) = **42 %**

* Calculation base: Bombardier ZEFIRO 250

# INDIA South Corridor² 2025: The required substitution rate could decline from 42 % in 2012 to 20 % in 2025 (conservative perspective)

Mobility Networks Logistics

² INDIA South Corridor CNT

**Mumbai Pune**

**Hyderabad**

| | 2012 | 2025 Airbus Forecast 2012-31: +8.5 % p.a. | 2025 DBI feat. Airbus 2012-25: +6 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 14 | not specified | not specified |
| Capacity (Seats per day) | 2,150 | not specified | not specified |
| PAX (per day) | 1,600 | 4,600 | 3,400 |
| PAX without connecting flights (per day) | 1,100 | 3,200 | 2,350 |
| **Required air traffic substitution rate** | **42 %** | **15 %** | **20 %** |

- Airbus forecasts a growth of 2021 6.4 %, up to 2021 and 5.2 % after 2021 considering in Asia / Pacific region
- Assumption India: 8.5 %

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

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# USA

DB Mobility Networks Logistics

# USA East-Coast Corridor: 19 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

**USA East- Coast Corridor HSR**

| | |
|---|---|
| Direct flights (per day and direction): | 43 |
| Capacity (seats per day): | 3,050 |
| PAX (per day): | 2,450 |
| 1 **PAX without connecting flight (per day):** | **2,000** |

**Washington Philadelphia New York** — **Montreal Ottawa**

| | |
|---|---|
| Potential BT Washington – Ottawa (per day): | 2,000 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 250 |
| 2 **Occupancy rate of 75 %:** | **375** |

**Washington Philadelphia New York** — **Montreal Ottawa**

**Required air traffic substitution rate:** 2 from 1 = **19 %**

* Calculation base: Bombardier ZEFIRO 250

# USA East-Coast Corridor 2025: The required substitution rate could decline from 19 % in 2012 to 15 % in 2025 (conservative perspective)



USA East- Coast Corridor HSR

**Washington Philadelphia New York**

**Montreal Ottawa**

| | 2012 | 2025<br>Airbus Forecast<br>2012-31: +2.3 % p.a. | 2025<br>DBI feat. Airbus<br>2012-25: +1.5 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 43 | not specified | not specified |
| Capacity (Seats per day) | 3,050 | not specified | not specified |
| PAX (per day) | 2,450 | 3,300 | 2,950 |
| PAX without connecting flights (per day) | 2,000 | 2,700 | 2,450 |
| **Required air traffic substitution rate** | **19 %** | **14 %** | **15 %** |

- Airbus forecasts a growth of 2,3 % (2012-31) considering the USA

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# USA East-Coast Corridor² : 32 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

DB Mobility Networks Logistics

² USA East- Coast Corridor CNT

| | |
|---|---|
| Direct flights (per day and direction): | 26 |
| Capacity (seats per day): | 2,350 |
| PAX (per day): | 1,900 |
| (1) **PAX without connecting flight (per day):** | **1,200** |

**New York** — **Montreal Ottawa**

| | |
|---|---|
| Potential BT New York – Ottawa (per day): | 1,190 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 250 |
| (2) **Occupancy rate of 75 %:** | **375** |

**New York** — **Montreal Ottawa**

**Required air traffic substitution rate:** (2) from (1) = **32 %**

* Calculation base: Bombardier ZEFIRO 250

# USA East-Coast Corridor² 2025: The required substitution rate could decline from 32 % in 2012 to 26 % in 2025 (conservative perspective)

² USA East- Coast Corridor CNT

**New York**

**Montreal Ottawa**

| | 2012 | 2025 Airbus Forecast 2012-31: +2.3 % p.a. | 2025 DBI feat. Airbus 2012-25: +1.5 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 26 | not specified | not specified |
| Capacity (Seats per day) | 2,350 | not specified | not specified |
| PAX (per day) | 1,900 | 2,550 | 2,300 |
| PAX without connecting flights (per day) | 1,200 | 1,600 | 1,450 |
| **Required air traffic substitution rate** | **32 %** | **23 %** | **26 %** |

- Airbus forecasts a growth of 2,3 % (2012-31) considering the USA
- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

Source: http://www.airbus.com/company/market/forecast/

# CHINA

Mobility Networks Logistics

# CHINA East-West Corridor: 13 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

DB Mobility Networks Logistics

**China East- West Corridor HSR**

| | |
|---|---|
| Direct flights (per day and direction): | 32 |
| Capacity (seats per day): | 5,900 |
| PAX (per day): | 4,850 |
| (1) **PAX without connecting flight (per day):** | **3.550** |

Chengdu Chongqing — Hefei Nanjing Shanghai

| | |
|---|---|
| Potential BT Chengdu - Shanghai(per day): | 3,550 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| (2) **Occupancy rate of 75 %:** | **465** |

Chengdu Chongqing — Hefei Nanjing Shanghai

**Required air traffic substitution rate:** (2) from (1) = **13 %**

* Calculation base: Bombardier ZEFIRO 250

# CHINA East-West Corridor 2025: The required substitution rate could decline from 13 % in 2012 to 8 % in 2025 (conservative perspective)



China East- West Corridor HSR

**Chengdu Chongqing** – **Hefei Nanjing Shanghai**

| | 2012 | 2025<br>Airbus Forecast<br>2012-31: +8.5 % p.a. | 2025<br>DBI feat. Airbus<br>2012-25: +6 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 32 | not specified | not specified |
| Capacity (Seats per day) | 5,900 | not specified | not specified |
| PAX (per day) | 4,850 | 10,750 | 8,100 |
| PAX without connecting flights (per day) | 3,550 | 7,850 | 5,900 |
| **Required air traffic substitution rate** | **13 %** | **6 %** | **8 %** |

- Airbus forecasts a growth of 2021 6.4 %, up to 2021 and 5.2 % after 2021 considering  in Asia / Pacific region
- Assumption China : 8.5 %

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

Mobility
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# CHINA East-North Corridor: 16 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

China East- North Corridor HSR

| | |
|---|---|
| Direct flights (per day and direction): | 30 |
| Capacity (seats per day): | 5,000 |
| PAX (per day): | 4,100 |
| ① **PAX without connecting flight (per day):** | **3,000** |

Shenyang, Tianjin — Nanjing, Shanghai, Hangzhou

| | |
|---|---|
| Potential BT Shenyang – Hangzhou (per day): | 3,000 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| ② **Occupancy rate of 75 %:** | **465** |

Shenyang, Tianjin — Nanjing, Shanghai, Hangzhou

**Required air traffic substitution rate:** ② from ① = **16 %**

* Calculation base: Bombardier ZEFIRO 250

# CHINA East-North Corridor 2025: The required substitution rate could decline from 16 % in 2012 to 9 % in 2025 (conservative perspective)

China East- North Corridor HSR

**Shenyang Tianjin**

**Nanjing Shanghai Hangzhou**

| | 2012 | 2025 Airbus Forecast 2012-31: +8.5 % p.a. | 2025 DBI feat. Airbus 2012-25: +6 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 30 | not specified | not specified |
| Capacity (Seats per day) | 5,000 | not specified | not specified |
| PAX (per day) | 4,100 | 9,050 | 6,850 |
| PAX without connecting flights (per day) | 3,000 | 6,650 | 5,000 |
| **Required air traffic substitution rate** | **16 %** | **7 %** | **9 %** |

- Airbus forecasts a growth of 2021 6.4 %, up to 2021 and 5.2 % after 2021 considering in Asia / Pacific region
- Assumption China : 8.5 %

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

Mobility
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# CHINA South-West Corridor: 8 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

China South- West Corridor HSR

| | |
|---|---|
| Direct flights (per day and direction): | 58 |
| Capacity (seats per day): | 10,000 |
| PAX (per day): | 8,200 |
| 1 **PAX without connecting flight (per day):** | **6,150** |

Hong Kong
Shenzhen
Dongguan
Guangzhou
— Chengdu
Chongqing

| | |
|---|---|
| Potential BT Hong Kong–Chongqing (per day): | 6,150 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| **Occupancy rate of 75 %:** | **465** |

2

Hong Kong
Shenzhen
Dongguan
Guangzhou
— Chengdu
Chongqing

**Required air traffic substitution rate:** 2 from 1 = **8 %**

* Calculation base: Bombardier ZEFIRO 250

# CHINA South-West Corridor 2025: The required substitution rate could decline from 8 % in 2012 to 5 % in 2025 (conservative perspective)

DB Mobility Networks Logistics

China South- West Corridor HSR

**Hong Kong**
**Shenzhen**
**Dongguan**
**Guangzhou**

**Chengdu**
**Chongqing**

| | **2012** | **2025** Airbus Forecast 2012-31: +8.5 % p.a. | **2025** DBI feat. Airbus 2012-25: +6 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 58 | not specified | not specified |
| Capacity (Seats per day) | 10,000 | not specified | not specified |
| PAX (per day) | 8,200 | 18,150 | 13,650 |
| PAX without connecting flights (per day) | 6,150 | 13,600 | 10,250 |
| **Required air traffic substitution rate** | **8 %** | **3 %** | **5 %** |

- Airbus forecasts a growth of 2021 6.4 %, up to 2021 and 5.2 % after 2021 considering  in Asia / Pacific region
- Assumption China : 8.5 %

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# CHINA North-South Corridor: 5 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

**China North- South Corridor HSR**

| | |
|---|---|
| Direct flights (per day and direction): | 63 |
| Capacity (seats per day): | 17,100 |
| PAX (per day): | 14,000 |
| 1 **PAX without connecting flight (per day):** | **10,350** |

**Beijing Tianjin** — **Guangzhou Dongguan Shenzhen Hong Kong**

| | |
|---|---|
| Potential BT Beijing – Hong Kong (per day): | 10,350 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| 2 **Occupancy rate of 75 %:** | **465** |

**Beijing Tianjin** — **Guangzhou Dongguan Shenzhen Hong Kong**

**Required air traffic substitution rate:** 2 from 1 = **5 %**

* Calculation base: Bombardier ZEFIRO 250

# CHINA North-South Corridor 2025: The required substitution rate could decline from 5 % in 2012 to 3 % in 2025 (conservative perspective)



**Beijing Tianjin**

**Guangzhou Dongguan Shenzhen Hong Kong**

| | 2012 | 2025<br>Airbus Forecast<br>2012-31: +8.5 % p.a. | 2025<br>DBI feat. Airbus<br>2012-25: +6 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 63 | not specified | not specified |
| Capacity (Seats per day) | 17,100 | not specified | not specified |
| PAX (per day) | 14,000 | 31,000 | 23,300 |
| PAX without connecting flights (per day) | 10,350 | 22,900 | 17,250 |
| **Required air traffic substitution rate** | **5 %** | **3 %** | **3 %** |

- Airbus forecasts a growth of 2021 6.4 %, up to 2021 and 5.2 % after 2021 considering in Asia / Pacific region
- Assumption China : 8.5 %

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# CHINA North-West Corridor: 14 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation



China North- West Corridor HSR

| | |
|---|---|
| Direct flights (per day and direction): | 34 |
| Capacity (seats per day): | 5,350 |
| PAX (per day): | 4,350 |
| (1) **PAX without connecting flight (per day):** | **3,400** |

Chongqing Chengdu — Taiyuan Beijing Tianjin

| | |
|---|---|
| Potential BT Chongqing – Tianjin (per day): | 3,400 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| (2) **Occupancy rate of 75 %:** | **465** |

Chongqing Chengdu — Taiyuan Beijing Tianjin

**Required air traffic substitution rate:** (2) from (1) = **14 %**

* Calculation base: Bombardier ZEFIRO 250

# CHINA North-West Corridor 2025: The required substitution rate could decline from 14 % in 2012 to 8 % in 2025 (conservative perspective)

DB Mobility Networks Logistics

China North- West Corridor HSR

Chongqing
Chengdu

Taiyuan
Beijing
Tianjin

| | 2012 | 2025 Airbus Forecast 2012-31: +8.5 % p.a. | 2025 DBI feat. Airbus 2012-25: +6 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 34 | not specified | not specified |
| Capacity (Seats per day) | 5,350 | not specified | not specified |
| PAX (per day) | 4,350 | 9,650 | 7,250 |
| PAX without connecting flights (per day) | 3,400 | 7,500 | 5,650 |
| **Required air traffic substitution rate** | **14 %** | **6 %** | **8 %** |

- Airbus forecasts a growth of 2021 6.4 %, up to 2021 and 5.2 % after 2021 considering in Asia / Pacific region
- Assumption China : 8.5 %

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# CHINA South-East Corridor: 4 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

Mobility
Networks
Logistics

**China South- East Corridor HSR**

| | |
|---|---|
| Direct flights (per day and direction): | 104 |
| Capacity (seats per day): | 21,600 |
| PAX (per day): | 17,700 |
| (1) **PAX without connecting flight (per day):** | **12,700** |

**Hong Kong Shenzhen Dongguan Guangzhou** — **Ningbo Hangzhou Shanghai**

Potential BT Hong Kong – Shanghai (per day): 12,700

| | |
|---|---|
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| (2) **Occupancy rate of 75 %:** | **465** |

**Hong Kong Shenzhen Dongguan Guangzhou** — **Ningbo Hangzhou Shanghai**

**Required air traffic substitution rate:** (2) from (1) = **4 %**

* Calculation base: Bombardier ZEFIRO 250

# CHINA South-East Corridor 2025: The required substitution rate could decline from 4 % in 2012 to 2 % in 2025 (conservative perspective)

China South- East Corridor HSR

**Hong Kong**
**Shenzhen**
**Dongguan**
**Guangzhou**

| | 2012 | 2025 Airbus Forecast 2012-31: +8.5 % p.a. | 2025 DBI feat. Airbus 2012-25: +6 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 104 | not specified | not specified |
| Capacity (Seats per day) | 21,600 | not specified | not specified |
| PAX (per day) | 17,700 | 39,150 | 29,450 |
| PAX without connecting flights (per day) | 12,700 | 28,100 | 21,150 |
| **Required air traffic substitution rate** | **4 %** | **2 %** | **2 %** |

- Airbus forecasts a growth of 2021 6.4 %, up to 2021 and 5.2 % after 2021 considering in Asia / Pacific region
- Assumption China : 8.5 %

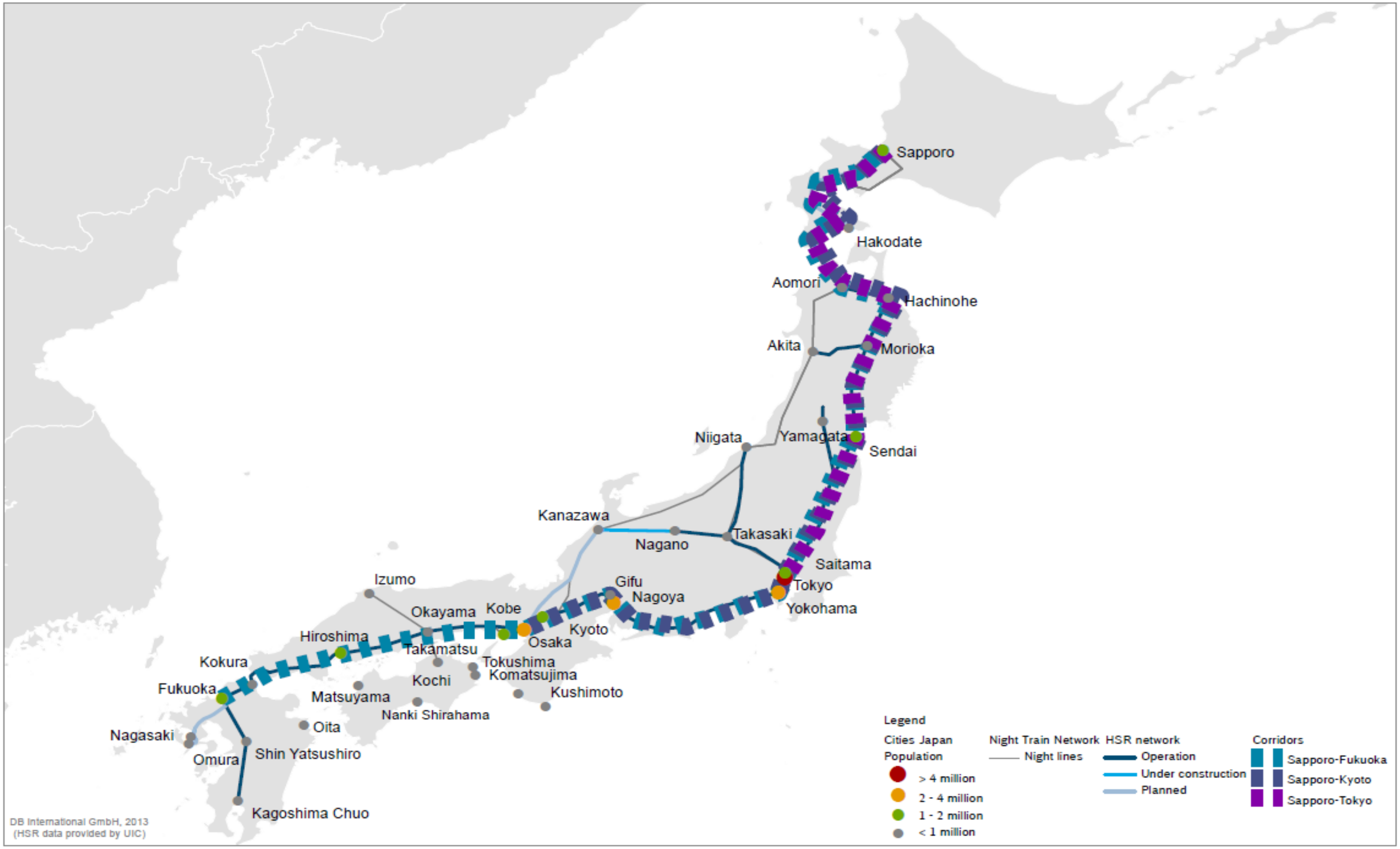
Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

**Ningbo**
**Hangzhou**
**Shanghai**

# JAPAN

Mobility Networks Logistics



# JAPAN Link Corridor: 8 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

DB Mobility Networks Logistics

**Japan Link Corridor HSR**

| | |
|---|---|
| Direct flights (per day and direction): | 72 |
| Capacity (seats per day): | 15,100 |
| PAX (per day): | 8,750 |
| 1 **PAX without connecting flight (per day):** | **5,950** |

Sapporo — Tokyo, Nagoya, Osaka, Hiroshima, Fukuoka

| | |
|---|---|
| Potential BT Sapporo – Fukuoka (per day): | 5,950 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| 2 **Occupancy rate of 75 %:** | **465** |

Sapporo — Tokyo, Nagoya, Osaka, Hiroshima, Fukuoka

**Required air traffic substitution rate:** 2 from 1 = **8 %**

* Calculation base: Bombardier ZEFIRO 250

# JAPAN Link Corridor 2025: The required substitution rate could decline from 8 % in 2012 to 7 % in 2025 (conservative perspective)

**Japan Link Corridor HSR**

**Sapporo**

**Tokyo**
**Nagoya**
**Osaka**
**Hiroshima**
**Fukuoka**

| | **2012** | **2025** Airbus Forecast 2012-31: +1.9 % p.a. | **2025** DBI feat. Airbus 2012-25: +0.5 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 72 | not specified | not specified |
| Capacity (Seats per day) | 15,100 | not specified | not specified |
| PAX (per day) | 8,750 | 11,200 | 9,350 |
| PAX without connecting flights (per day) | 5,950 | 7,600 | 6,350 |
| **Required air traffic substitution rate** | **8 %** | **6 %** | **7 %** |

- Airbus forecasts an annual growth of 1.9 % between 2012 and 2031
- No information regarding the separation to existing and new routes

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# JAPAN Link Corridor² : 32 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

Mobility Networks Logistics

² Japan Link Corridor CNT

| | |
|---|---|
| Direct flights (per day and direction): | 20 |
| Capacity (seats per day): | 3,600 |
| PAX (per day): | 2,100 |
| (1) **PAX without connecting flight (per day):** | **1,450** |

Sapporo — Hiroshima Fukuoka

| | |
|---|---|
| Potential BT Sapporo – Fukuoka (per day): | 1,450 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| (2) **Occupancy rate of 75 %:** | **465** |

Sapporo — Hiroshima Fukuoka

**Required air traffic substitution rate:** (2) from (1) = **32 %**

* Calculation base: Bombardier ZEFIRO 250

# JAPAN Link Corridor² 2025: The required substitution rate could decline from 32 % in 2012 to 30 % in 2025 (conservative perspective)

Mobility Networks Logistics

² Japan Link Corridor CNT

**Sapporo**

**Hiroshima Fukuoka**

| | **2012** | **2025** Airbus Forecast 2012-31: +1.9 % p.a. | **2025** DBI feat. Airbus 2012-25: +0.5 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 20 | not specified | not specified |
| Capacity (Seats per day) | 3,600 | not specified | not specified |
| PAX (per day) | 2,100 | 2,700 | 2,250 |
| PAX without connecting flights (per day) | 1,450 | 1,850 | 1,550 |
| **Required air traffic substitution rate** | **32 %** | **25 %** | **30 %** |

- Airbus forecasts an annual growth of 1.9 % between 2012 and 2031
- No information regarding the separation to existing and new routes

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# JAPAN Central-North Corridor: 22 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation

Japan Central- North Corridor HSR

| | |
|---|---|
| Direct flights (per day and direction): | 29 |
| Capacity (seats per day): | 4,950 |
| PAX (per day): | 2,850 |
| (1) **PAX without connecting flight (per day):** | **2,100** |

Sapporo — Nagoya / Kyoto / Osaka / Kobe

| | |
|---|---|
| Potential BT Sapporo – Kobe (per day): | 2,100 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| (2) **Occupancy rate of 75 %:** | **465** |

Sapporo — Nagoya / Kyoto / Osaka / Kobe

**Required air traffic substitution rate:** (2) from (1) = **22 %**

* Calculation base: Bombardier ZEFIRO 250

# JAPAN Central-North Corridor 2025: The required substitution rate could decline from 22 % in 2012 to 21 % in 2025 (conservative perspective)

Mobility Networks Logistics

**Japan Central- North Corridor HSR**

**Sapporo**

**Nagoya Kyoto Osaka Kobe**

| | **2012** | **2025** Airbus Forecast 2012-31: +1.9 % p.a. | **2025** DBI feat. Airbus 2012-25: +0.5 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 29 | not specified | not specified |
| Capacity (Seats per day) | 4,950 | not specified | not specified |
| PAX (per day) | 2,850 | 3,650 | 3,050 |
| PAX without connecting flights (per day) | 2,100 | 2,700 | 2,250 |
| **Required air traffic substitution rate** | **22 %** | **17 %** | **21 %** |

- Airbus forecasts an annual growth of 1.9 % between 2012 and 2031
- No information regarding the separation to existing and new routes

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# JAPAN East-Coast Corridor: 16 % of the air traffic volume has to be substituted by rail traffic to reach an occupancy rate of 75 % in NT operation



**Japan East- Coast Corridor HSR**

| | |
|---|---|
| Direct flights (per day and direction): | 37 |
| Capacity (seats per day): | 7,400 |
| PAX (per day): | 4,300 |
| ① **PAX without connecting flight (per day):** | **2,950** |

Sapporo — Sendai, Saitama, Tokyo, Yokohama

| | |
|---|---|
| Potential BT Sapporo – Yokohama (per day): | 2,950 |
| Half-train (HT) (per day and direction): | 2 |
| Capacity* (seats/beds per day): (HSR Alternative) | 2 x 310 |
| ② **Occupancy rate of 75 %:** | **465** |

Sapporo — Sendai, Saitama, Tokyo, Yokohama

**Required air traffic substitution rate:** ② from ① = **16 %**

* Calculation base: Bombardier ZEFIRO 250

# JAPAN East-Coast Corridor 2025: The required substitution rate could decline from 16 % in 2012 to 15 % in 2025 (conservative perspective)

Mobility
Networks
Logistics

**Japan East- Coast Corridor HSR**

**Sapporo**

**Sendai**
**Saitama**
**Tokyo**
**Yokohama**

| | **2012** | **2025** Airbus Forecast 2012-31: +1.9 % p.a. | **2025** DBI feat. Airbus 2012-25: +0.5 % p.a. |
|---|---|---|---|
| Direct flights (per day and direction) | 37 | not specified | not specified |
| Capacity (Seats per day) | 7,400 | not specified | not specified |
| PAX (per day) | 4,300 | 5,500 | 4,600 |
| PAX without connecting flights (per day) | 2,950 | 3,750 | 3,150 |
| **Required air traffic substitution rate** | **16 %** | **12 %** | **15 %** |

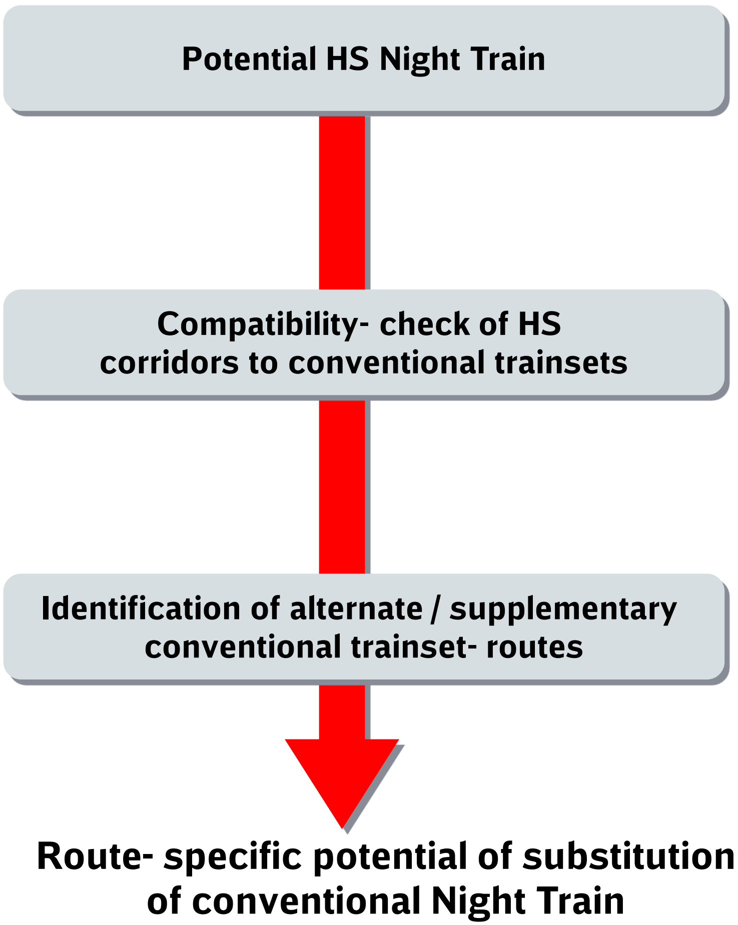
- Airbus forecasts an annual growth of 1.9 % between 2012 and 2031
- No information regarding the separation to existing and new routes

Source: http://www.airbus.com/company/market/forecast/

- DBI applies a conservative lower growth for the existing busy routes
- Buffer for a lower increase in economic included, e.g. growing oil price, de-globalisation etc.

# Market analysis conventional trainset: Similar approach based on determined corridors and estimations about air traffic

**Potential**




- **Status quo:**
  **Analysis of potential of HS Night Train corridors**
  Identified corridors are based upon the estimation that the „Very Long Distance Night Train Connections“ are operated with high- speed rolling stock
- **Step 2: Compatibility- check of high- speed corridors to conventional trainsets.** Based on the elaborated corridors, this part of the survey estimates which routes could be operated by conventional trainsets using HSR infrastructure
  Travel time should not pass the given limit of 12 hours

  Therefore:
  Estimation of an average operating speed during the overnight main run that could be realized by a conventional night train using HSR infrastructure (expert opinion CNL or DBI)
- **Step 3:**
  **Estimation of supplemental/ alternative corridors if necessary**
  Initial examination of the regions Europe and China and identification of realistic alternative corridors that are suitable for conventional night trains
  Estimation of potential analogue to the HSR Night Train approach

# Finishing analyse of potential of substitution: Route examination HSR Night Train

Potential

## Detailed Approach – working status

**Potential of each air traffic route**

↓

**Route sums for new Night Train relations**

↓

**Share of passenger segments in air traffic**

↓

**Substitution effects of HS traffic for further argumentation**

↓

**Route- specific potential of substitution**

- **Status quo:**
  Analysis of potential of several air links. **Daily potential of substitution** for each air link ist **identified**
- **Step 2: Route sums**
  **Complex situation in Europe**: Several trains run together for a while and seperate at the end of the main run. This trains have to be calculated seperately.
- **Step 3: Context research I – target groups air traffic**
  Business travellers risk to enlarge a 1-day-trip to 3-day-trip by using the night train. Thus, the share of price- sensitive clients of the segments tourism and VFR (visiting friends & relatives) has to be identified.
- **Step 4: Context research II – substitution effect high- speed traffic**
  Substitution effects of established high- speed links such as Madrid- Barcelona, Paris- London, Paris- Marseille have to be identified.

# Third step: Estimation of potential of substitution by HSR Night Train in the agreed countries will be finished soon

Potential

## Detailed Approach – working status

**Data sheet of air connections for each corridor**

↓

**Identification of flight frequency**

↓

**Aircraft capacities**

↓

**Estimation on degree of capacity utilisation**

↓

**Markdown for transfer passengers**

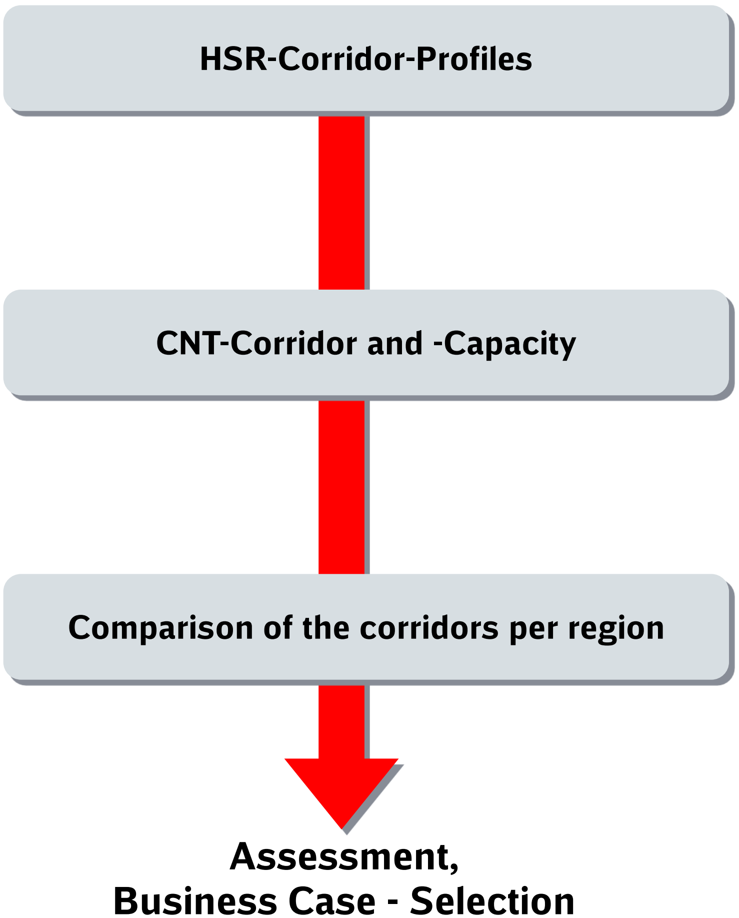
↓

**Potential of substitution**

- **Step1: Current situation**
  All **scheduled flights on the corridors** (e.g. European and Chinese HSR corridors are identified
- **Step 2: Determination of the flight frequencies**
  Unknown **flight frequencies are estimated** as weekday service with the value „5“. In the light of the analysis made up to now, this value is conservative, espacially in China. In case of additional time quota, the analysis will be continued.
- **Step 3: Determination of the aircraft capacity**
- **Step 4: Occupancy rate**
  Based on IATA data for 2011 the **European PLF (Passenger Load Factor)** is defined as 79 %, China has a PLF of 82 %
  (see http://www.iata.org/pressroom/pr/pages/2012-02-01-01.aspx).
- **Step 5: Person switching | deduction**
- **Step 6: Substitution potential per flight connection (per day)**
  The potential is calculated with the identified values of frequency, seat capacity, degree of capacity utilisation and rate of transfer passengers.

# Comparison of the prepared route alternatives on the basis of the main parameter „Air traffic substitution rate“

**Potential**




- **Step 1**: Complete preparation of the HSR corridors
  Calculation base ZEFIRO 250
  (Alternative: train features of an ideal Night Train 2025)
- **Step 2**: Determination of CNT-Routes and train capacities
  (For improvement of the comparability the same seating capacity is assumed; Alternative: Research for the current CNL- or EN-trains features
- **Step 3**: Comparison Night Trains (HSR and CNT)
- **Step 4**: Deduction of potential Business Case-Routes
  On the basis of necessary substitution rates routes for Business Cases will be selected

# For the preparation of the potential, several assumptions have been made

Potential

## General assumptions deriving substitution potential

| | |
|---|---|
| **Flights per week** | ▪ Weekly number of flights is based on a random analysis (Date: 01.02.2013)<br>▪ Afterwards 5 flights per week are assumed (considering the daily PAX volume (relevant for Night Train except persons switched) the frequency was considered) |
| **Share transfer** | ▪ The share transfer between the airports was estimated as follows:<br>– Secondary Airport – Hub Airport: 35 %<br>– Hub Airport – Hub Airport: 25 %<br>– Secondary Airport – Secondary Airport: 10 % |
| **Growth up to 2025** | ▪ Airbus Forecast – Europe: 3.4 %; China: 6. 3%; USA 2.3 %; Japan 1.9 %; India 8.5 %<br>▪ DBI feat. Airbus – Europe: 2 %; China: 4 %; USA 1.5 %; Japan 0.5 %; India 6 % |
| **Other matters** | ▪ Passenger Load Factor (PLF): PLF-Europe = 0.79; PLF-China = 0.82; PLF-USA = 0.81; PLF-Japan = 0.58; PLF-India = 0.75<br>▪ Survey day (air connection picked out) is representative for a usual weekday<br>▪ High-Speed-Night-Train-Traffic means less < 12 hours |

# Simplified assumption for transfer passenger rate: 35-25-10-formula considering the share of transfer passengers as not shiftable to night trains

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**Potential**

| | **Share Transfer PAX** in % |
|---|---|
| London | 35 |
| Paris | 33 |
| Frankfurt | 52 |
| München | 37 |
| Zurich | 35 |
| Amsterdam | 42 |
| Vienna | 30 |
| Berlin Tegel | 4 |
| London Gatwick | 13 |
| London Luton | 4 |
| London Stansted | 9 |
| Birmingham | 2 |

Three categories of flight connections are estimated in order so simplify the calculations:

- **Secondary Airport – Hub Airport**
  Classic feeder lines represent a high share of the total traffic amount.
  **Transfer quote: 35 %**
- **Hub Airport – Hub Airport**
  Well- developed offer of nonstop routes. In general, low probability of transfer traffic. Exception: Special traffic such as British Airways / IBERAI partnership at Madrid with focus on flights to South America (list of worldwide Hub airports see http://en.wikipedia.org/wiki/Airline_hub, special case Europe: only Fortress Hubs are counted as "real" hubs)
  **Transfer quote: 25 %**
- **Secondary Airport – Secondary Airport**
  air connection between two airports having no hub- function for any of the established alliances (Oneworld, Skyteam, Star Alliance), see http://en.wikipedia.org/wiki/Airline_hub
  Typically high amount of O&D traffic: passengers originated close to the departure airport heading to a destination close to the arrival airport.
  **Transfer quote: 10 %**

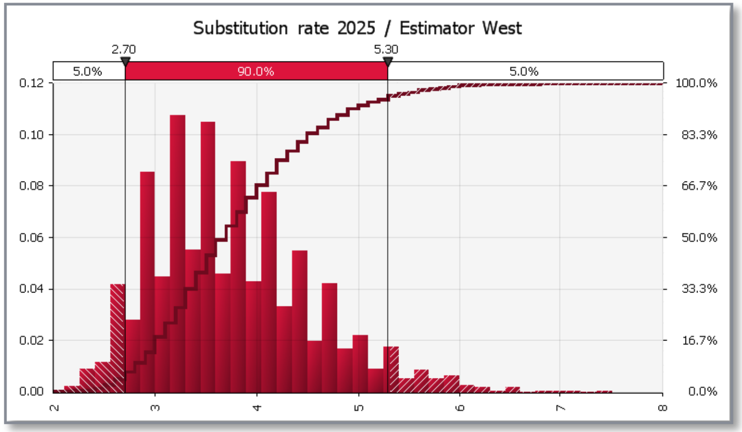
Sources: http://de.slideshare.net/ppspub/the-airport-metamorphosis-frankfurt-airports-approach-to-bring-back-the-charm-of-traveling, slide 20; http://www.airliners.de/wirtschaft/kennzahlen/ber-will-mit-umsteigern-wachsen/26962; http://www.caa.co.uk/docs/5/Connecting_Passengers_at_UK_Airports.pdf

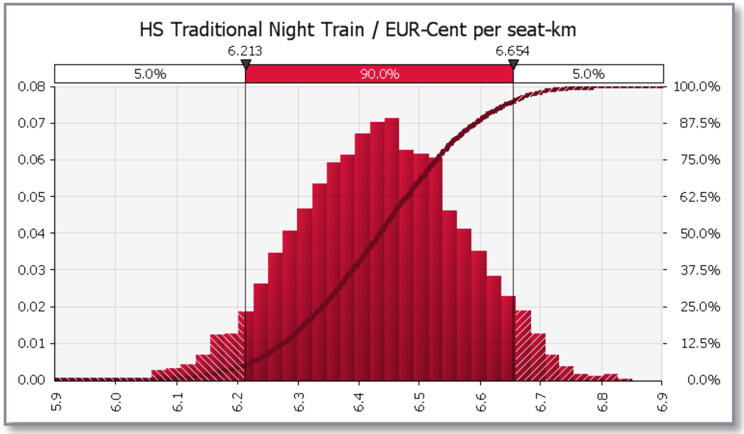
# The used risk analysis bases on the Monte Carlo Method; ranges for the considered variables are defined by triangle function (expert estimation)

Potential | Costs – risk assessment

## Risk analysis – general assumptions

- Applied **tool** for risk analysis **@Risk**
- Analysis was applied for the **potential and cost analysis**
- Definition of **ranges for the following characteristics potential analysis** – sensitivity test
  - Load factor flight
  - Flights per week
  - Share transfer 1, 2, 3
  - Growth rate 2025 (DBI assumption)
- Definition of **ranges for the following characteristics business case (costs)** – sensitivity test
  - Personnel costs
  - Energy prices
  - Track access charges (highest influence)
- **Final result** for the mean value, the standard variance and the 90 % confidence interval



# The ranges for the risk assessment have been defined by own assumptions as well as on the basis of expert discussions



## Risk analysis – general assumptions

### Cost assessment 2012

- **Sensitivity analysis** indicates the highest influence by the infrastructure costs
- Definition of the distribution by **expert assumptions**
- Ranges for the basics are defined as follows:
  - **Energy price** (0.09 | 0.12 | 0.15 EUR/kwh)
  - **Personnel costs** train driver (35,000 | 40,000 | 60,000 EUR per year)
  - **Personnel costs** conductor (25,000 | 30,000 | 50,000 EUR per year)
  - **Track access charges** depending on the considered connection and the current cost level e.g. 20 | 24 | 28 EUR / train-km

### Cost projection 2025

- Ranges for the forecast are defined as follows:

**Energy**
- Railway (90 | 110 | 120 %)
- Air (180 | 200 | 220 %)

**Vehilcles**
- Railway (110 | 120 | 140 %)
- Air (110 | 120 | 140 %)

**Operating staff**
- Rail (100 | 100 | 110 %)
- Air (110 | 110 | 120 %)

**Infrastructure**
- Rail (110 | 120 | 130 %)
- Air (110 | 120 | 130 %)

# Agenda

**Backup**

Background and purpose of the study

Analysis of the current situation (potential)

**Analysis of the current situation (costs and prices)**

Analysis of the current situation (environment)

# Depending on the comfort standard, HSR rolling stock could under-match the costs per available seat-kilometre of Airlines in some cases

Costs

## Costs per available seat-kilometre, Case EUROPE: Amsterdam - Rome
[EUR-Cent per seat-kilometre, 2012]

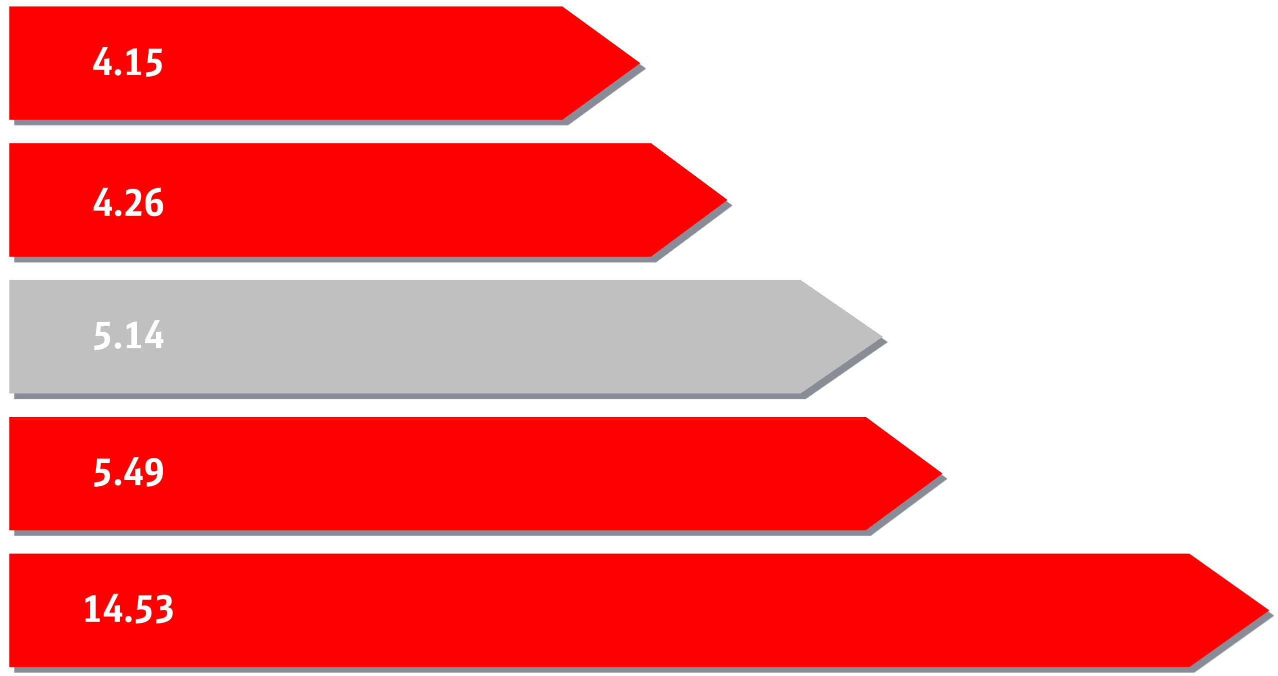
**High Speed Simple Night Train[1]**
16-car-MU (400 m)
400 seats, 267 berths

**High Speed Overnight Day Train[1]**
8-car-Multiple Unit (MU) (200 m)
500 Seats

**easyJet Low Cost Flight[2]**
A 320
159 seats

**High Speed Traditional Night Train[1]**
16-car-MU (400 m)
102 seats, 400 berths, 13 luxury beds

**High Speed Hotel Night Train[1]**
16-car-MU (400m)
240 luxury beds




[1] Route- specific calculation on the adapted basis „Relationship between rail service operating direct costs and speed" (UIC 2010)
[2] Network average based on financial reports 2011, without Marketing & Selling

Schematic representation

# By 2025, the development of several cost components could lead to a cost advantage of the Night Train in comparison to the air traffic

DB Mobility Networks Logistics

Costs

## Cost development until 2025, Amsterdam - Rome, easyJet vs. HS Traditional NT

| | Rail | | | Air | | | Assumptions[1] |
|---|---|---|---|---|---|---|---|
| | 2012 | Trend[3] | 2025 | 2012 | Trend[3] | 2025 | |
| **Energy/Fuel** | 12 % | 110 | 14 % | 30 % | 200 | 60 % | Crude oil price, increase in electric energy, reduction of consumption: rail traffic as well as air traffic, introduction of kerosene tax and VAT |
| **Vehicle** | 36 % | 120 | 44 % | 13 % | 120 | 16 % | More complex technology, optimizations close to physical limits lead to intensive maintenance |
| **Operating staff** | 7 % | 100 | 7 % | 13 % | 110 | 14 % | Reduction of allowed working time for pilots from 2015 |
| **Infrastructure[2]** | 45 % | 120 | 54 % | 44 % | 120 | 53 % | More extensive user financing due to limited state finances and reduction of subsidies, Increase in cost for flight control |
| | | | 117 % | | | 143 % | |
| **Amsterdam - Rome Total Cost EUR-Cent / seat-km** | 5.5 | 120 | 6.4 | 5.1 | 140 | 7.3 | **Cost advantage for rail** |

[1] Based on international sources and Consultant assumptions (see Backup) [2] easyjet: includes 6 % „Other Costs“
[2] Assumptions by the Consultant using available information

# In order to have a competitive and cost-effective pricing, NT has to reach a higher occupancy rate than the daily long distance HSR traffic

DB Mobility Networks Logistics

Costs

## Intermodal cost comparison Amsterdam – Rome 2025

| | Travel Distance km | Total Cost per ASK Ct/seat-km | Seat Cost per Travel EUR | Load Factor % | Total Cost per PAX EUR | Load factor to match TC easyJet % |
|---|---|---|---|---|---|---|
| easyJet | 1,400 | 7.35 | **103** | 87 | 118 | |
| HS Overnight Day Train | 1,800 | 5.01 | **90** | 50 | 180 | 76 |
| HS Simple Night Train | 1,800 | 4.87 | **88** | 50 | 175 | 74 |
| **HS Traditional Night Train** | **1,800** | **6.44** | **116** | **50** | **232** | **98** |
| HS Hotel Night Train | 1,800 | 17.06 | **307** | 50 | 614 | 260 |

- **„Seat Cost per Travel"** of HS Traditional Night Train exceeds easyJet's relevant benchmark
- For example, **an occupancy rate of 98 % would be required at the relation Amsterdam - Rome considering HS Traditional Night Trains in order to reach the same costs per PAX** than the chosen benchmark easyJet

# Estimation arises robust results - risk assessment shows opportunities for decreasing / increasing of the current estimated cost figures

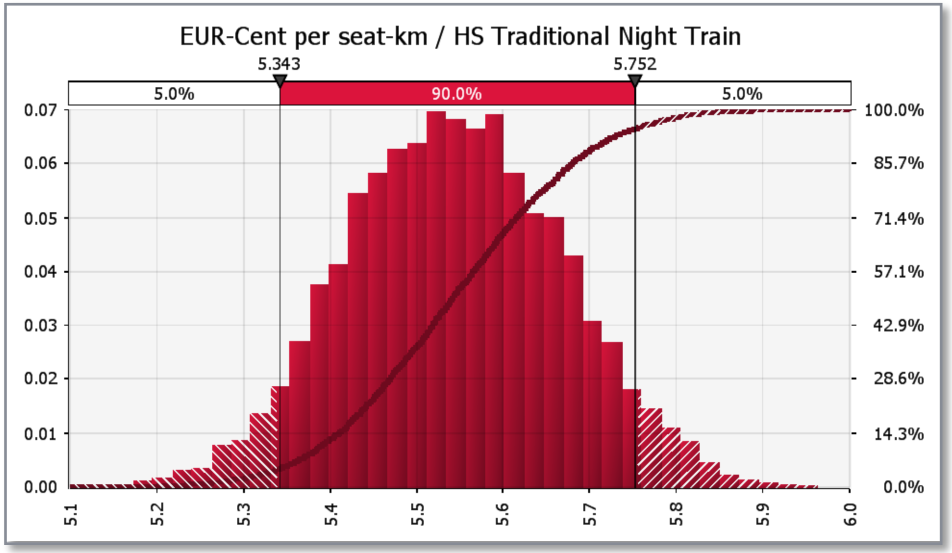
Mobility Networks Logistics

**Costs – risk assessment**

## Risk assessment Amsterdam – Rome 2012 / 2025

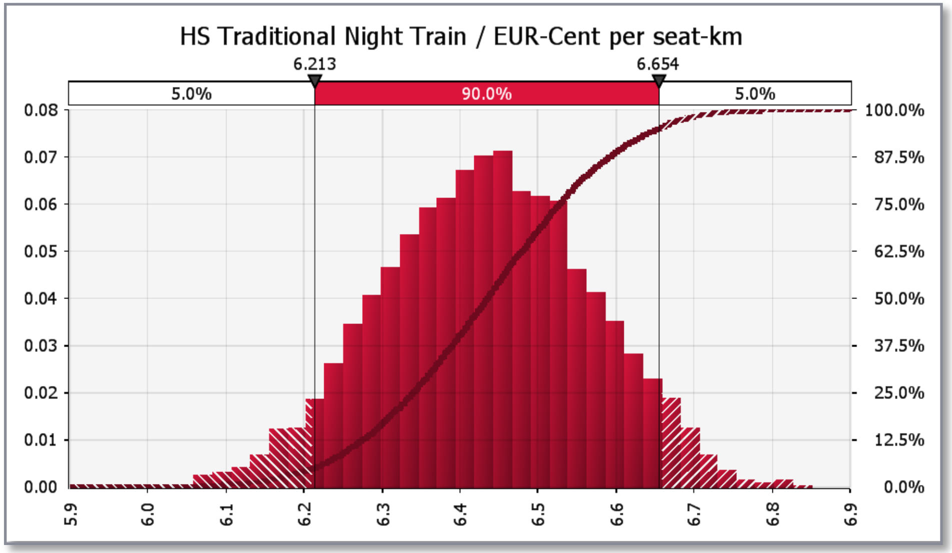
### Costs assessment 2012

- Actual projected value of 5.49 EUR-cent per seat-km
- Mean value of 5.54 EUR-cent per seat-km and a standard variance of 0.12 EUR-cent per seat-km
- 90 % confidence interval 5.34 - 5.75 EUR-cent per seat-km




### Cost forecast 2025 (without assumed changes for 2012)

- Actual projected value of 6.44 EUR-cent per seat-km
- Mean value of 6.43 EUR-cent per seat-km and a standard variance of 0.13 EUR-cent per seat-km
- 90 % confidence interval 6.21 - 6.65 EUR-cent per seat-km



# The costs for Night Trains exceed the costs of the Low-Cost-Airlines regardless whether the chosen comfort level

**Costs**

## Costs per available seat-kilometre, Case EUROPE: London - Berlin
[EUR-Cent per seat-kilometre, 2012]

**easyJet Low Cost Flight**[2]
A 320
159 seats

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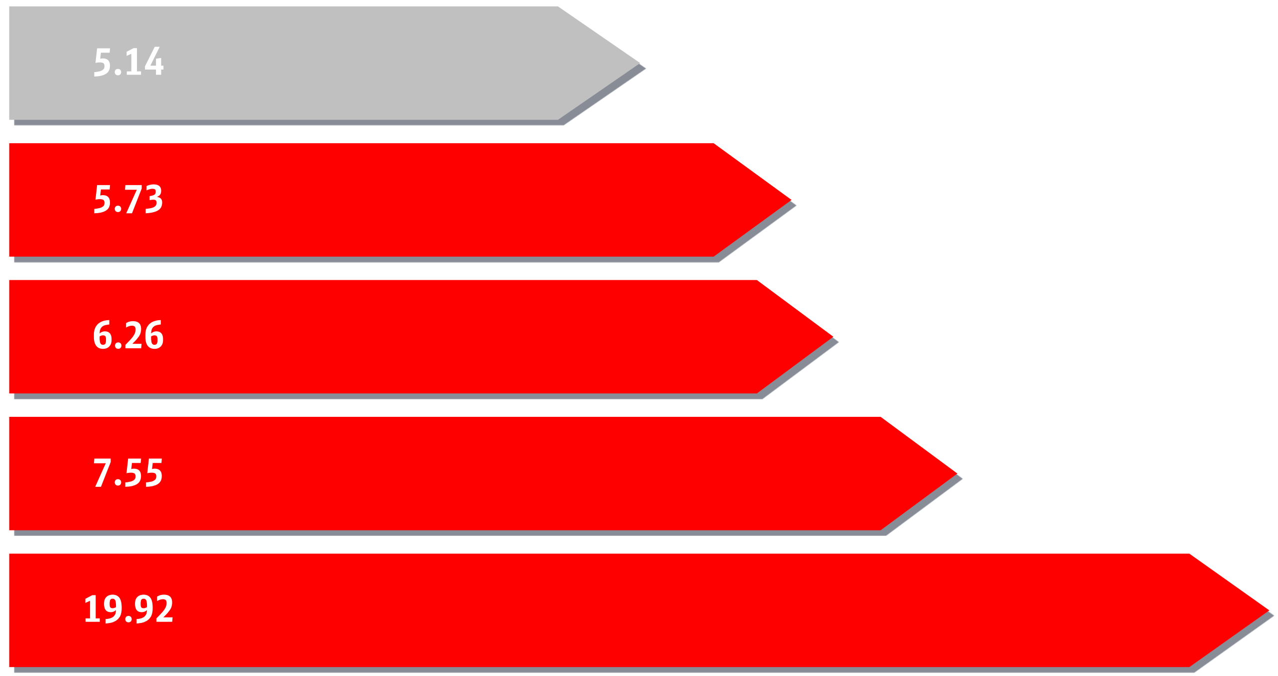



[1] Route- specific calculation on the adapted basis „Relationship between rail service operating direct costs and speed" (UIC 2010)
[2] Network average based on financial reports 2011, without Marketing & Selling

Schematic representation

Mobility Networks Logistics

# By 2025, the development of several cost components will further enlarge the costs for both railway traffic as well as air traffic

Costs

## Cost development until 2025, London - Berlin, easyJet vs. HS Traditional NT

| | Rail 2012 | Rail Trend[3] | Rail 2025 | Air 2012 | Air Trend[3] | Air 2025 | Assumptions[1] |
|---|---|---|---|---|---|---|---|
| **Energy/Fuel** | 9 % | 110 | 10 % | 30% | 200 | 60% | Crude oil price, increase in electric energy, reduction of consumption: rail traffic as well as air traffic, introduction of kerosene tax and VAT |
| **Vehicle** | 29 % | 120 | 35 % | 13% | 120 | 16% | More complex technology, optimizations close to physical limits lead to intensive maintenance |
| **Operating staff** | 6 % | 100 | 6 % | 13% | 110 | 14% | Reduction of allowed working time for pilots from 2015 |
| **Infrastructure[2]** | 56 % | 120 | 67 % | 44% | 120 | 53 % | More extensive user financing due to limited state finances and reduction of subsidies, Increase in cost for flight control |
| | | | 118 % | | | 143 % | |
| **London - Berlin Total Cost EUR-Cent / seat-km** | 7.6 | 120 | 8.9 | 5.1 | 140 | 7.3 | **Cost disadvantage for railway** |

[1] Based on international sources and Consultant assumptions (see Backup) [2] easyjet: includes 6 % „Other Costs“
[3] Assumptions by the Consultant using available information

# In order have to a competitive and cost-effective pricing, the NT has to reach a higher occupancy than the daily long distance HSR traffic

Costs

## Intermodal cost comparison London – Berlin 2025

| | Travel Distance km | Total Cost per ASK Ct/seat-km | Seat Cost per Travel EUR | Load Factor % | Total Cost per PAX EUR | Load factor to match TC easyJet % |
|---|---|---|---|---|---|---|
| easyJet | 1,000 | 7.35 | 73 | 87 | 84 | |
| HS Overnight Day Train | 1,500 | 7.39 | 111 | 50 | 222 | 131 |
| HS Simple Night Train | 1,500 | 6.75 | 101 | 50 | 203 | 120 |
| **HS Traditional Night Train** | **1,500** | **8.90** | **134** | **50** | **267** | **158** |
| HS Hotel Night Train | 1,500 | 23.50 | 352 | 50 | 705 | 417 |

- **„Seat Cost per Travel“** of HS Traditional Night Train exceeds easyJet‘s relevant benchmark
- For example, **an occupancy rate of 158 % would be required at the relation London - Berlin considering HS Traditional Night Trains in order to reach the same costs per PAX** than the chosen benchmark easyJet

# Estimation arises robust results - risk assessment shows opportunities for decreasing / increasing of the current estimated cost figures

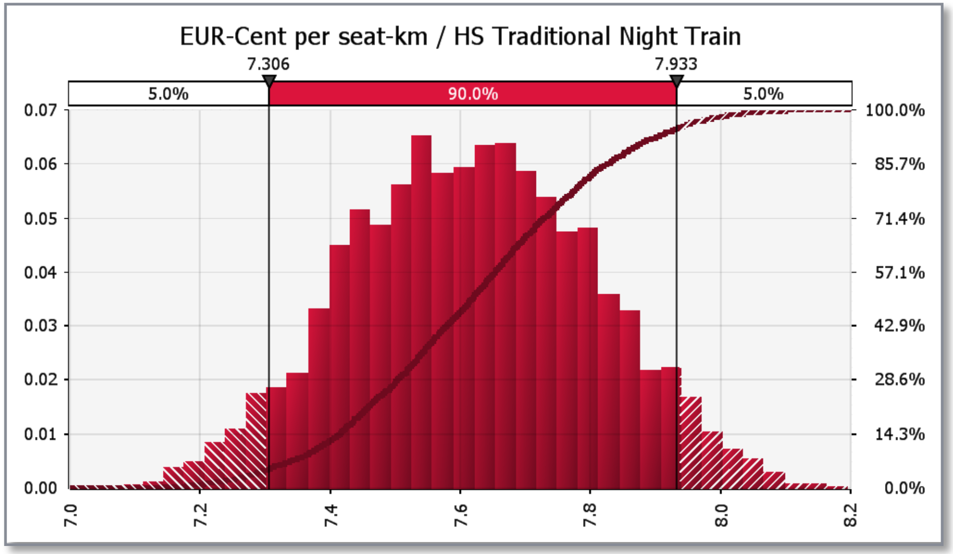
Mobility Networks Logistics

Costs – risk assessment

## Risk assessment London – Berlin 2012 / 2025

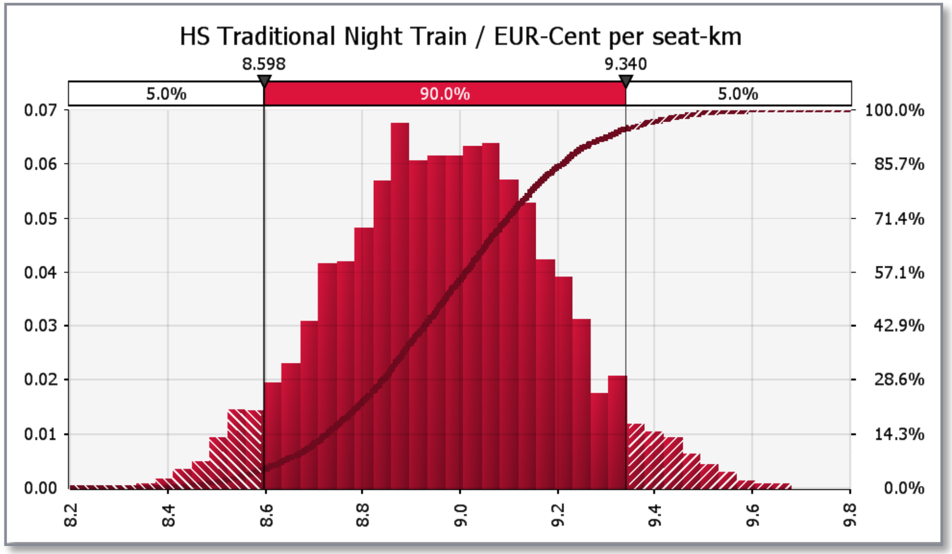
### Costs assessment 2012

- Actual projected value of 7.55 EUR-cent per seat-km
- Mean value of 7.62 EUR-cent per seat-km and a standard variance of 0.19 EUR-cent per seat-km
- 90 % confidence interval 7.31 - 7.93 EUR-cent per seat-km




### Cost forecast 2025 (without assumed changes for 2012)

- Actual projected value of 8.90 EUR-cent per seat-km
- Mean value of 8.97 EUR-cent per seat-km and a standard variance of 0.22 EUR-cent per seat-km
- 90 % confidence interval 8.60- 9.34 EUR-cent per seat-km



# The costs for Night Trains exceed the costs of the Low-Cost-Airlines regardless whether the chosen comfort level

Costs

**Costs per available seat-kilometre, Case EUROPE: London - Hamburg**
[EUR-Cent per seat-kilometre, 2012]

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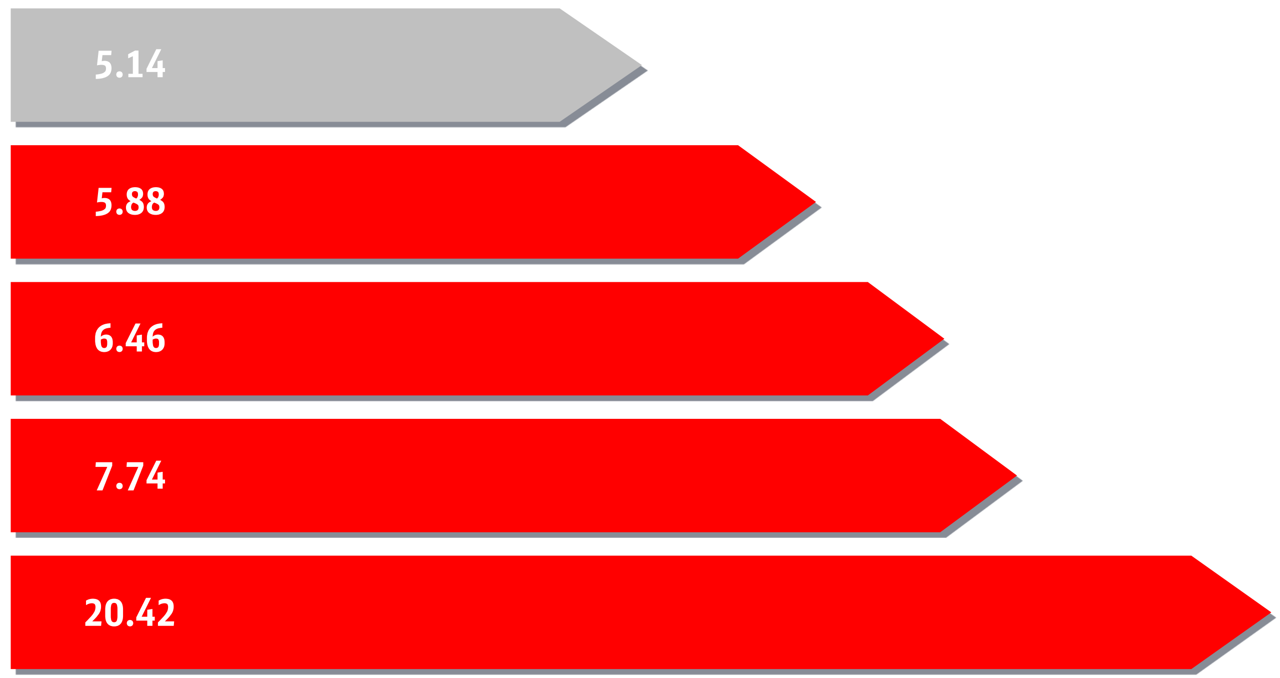


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Schematic representation

# By 2025, the development of several cost components will further enlarge the costs for both means of transport – disadvantage for railway

DB Mobility Networks Logistics

Costs

## Cost development until 2025, London - Hamburg, easyJet vs. HS Traditional NT

| | Rail | | | Air | | | Assumptions[1] |
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| **Vehicle** | 29 % | 120 | 34 % | 13 % | 120 | 16 % | More complex technology, optimizations close to physical limits lead to intensive maintenance |
| **Operating staff** | 6 % | 100 | 6 % | 13 % | 110 | 14 % | Reduction of allowed working time for pilots from 2015 |
| **Infrastructure[2]** | 57 % | 120 | 68 % | 44% | 120 | 53 % | More extensive user financing due to limited state finances and reduction of subsidies, Increase in cost for flight control |
| | | | **118 %** | | | **143 %** | |
| **London - Hamburg Total Cost EUR-Cent / seat-km** | 7.7 | 120 | 9.1 | 5.1 | 140 | 7.3 | **Cost disadvantage for railway** |

[1] Based on international sources and Consultant assumptions (see Backup) [2] easyjet: includes 6 % „Other Costs"
[3] Assumptions by the Consultant using available information

# In order to a competitive and cost-effective pricing, the NT has to reach a higher occupancy than the daily long distance HSR traffic

Mobility Networks Logistics

Costs

## Intermodal cost comparison London – Hamburg 2025

| | Travel Distance km | Total Cost per ASK Ct/seat-km | Seat Cost per Travel EUR | Load Factor % | Total Cost per PAX EUR | Load factor to match TC easyJet % |
|---|---|---|---|---|---|---|
| easyJet | 800 | 7.35 | 59 | 87 | 68 | |
| HS Overnight Day Train | 1,500 | 7.62 | 114 | 50 | 229 | 169 |
| HS Simple Night Train | 1,500 | 6.93 | 104 | 50 | 208 | 154 |
| **HS Traditional Night Train** | **1,500** | **9.14** | **137** | **50** | **274** | **203** |
| HS Hotel Night Train | 1,500 | 24.10 | 361 | 50 | 723 | 535 |

- **„Seat Cost per Travel“** of HS Traditional Night Train exceeds easyJet‘s relevant benchmark
- For example, **an occupancy rate of 203 % would be required at the relation London - Hamburg in case of HS Traditional Night Trains in order to reach the same costs per PAX** than the chosen benchmark easyJet

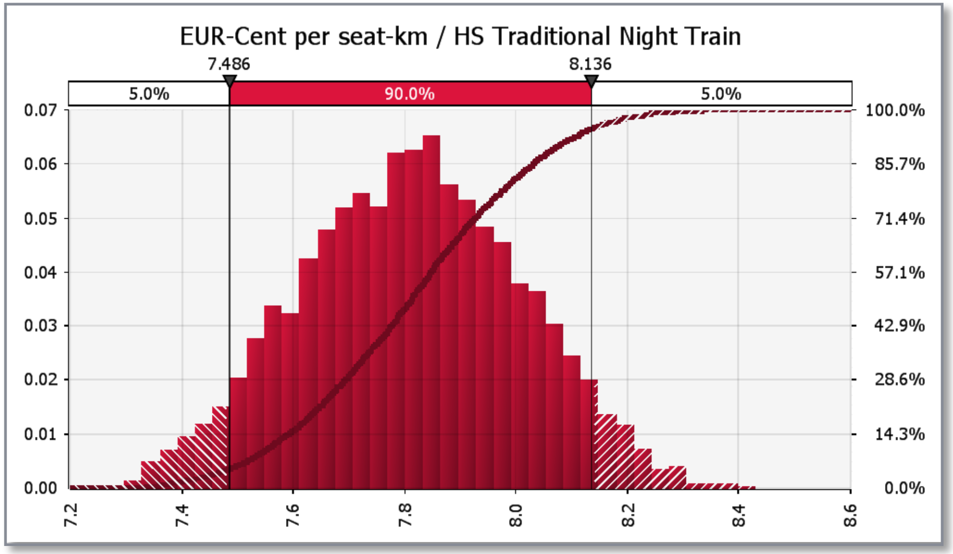
# Estimation arises robust results - risk assessment shows opportunities for decreasing / increasing of the current estimated cost figures



## Risk assessment London – Hamburg 2012 / 2025

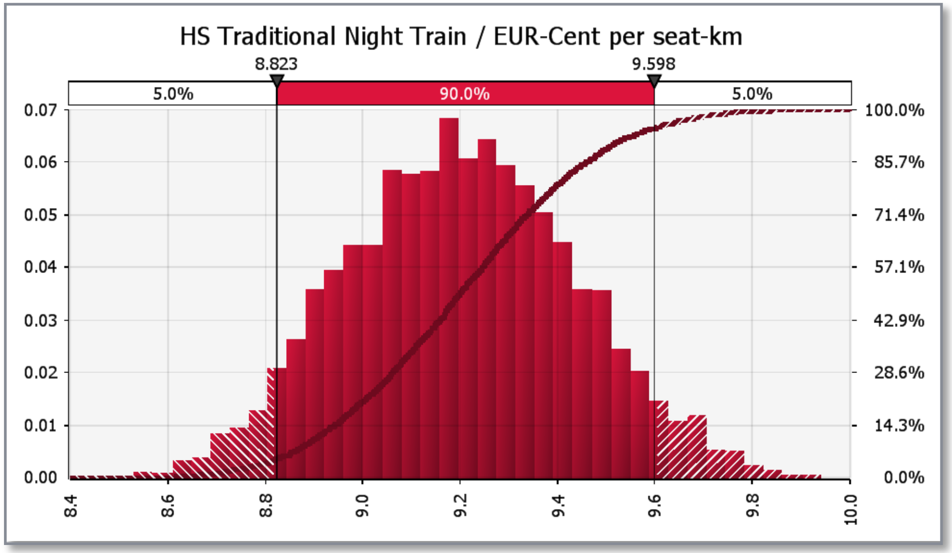
### Costs assessment 2012

- Actual projected value of 7.74 EUR-cent per seat-km
- Mean value of 7.81 EUR-cent per seat-km and a standard variance of 0.20 EUR-cent per seat-km
- 90 % confidence interval 7.49 – 8.14 EUR-cent per seat-km




### Cost forecast 2025 (without assumed changes for 2012)

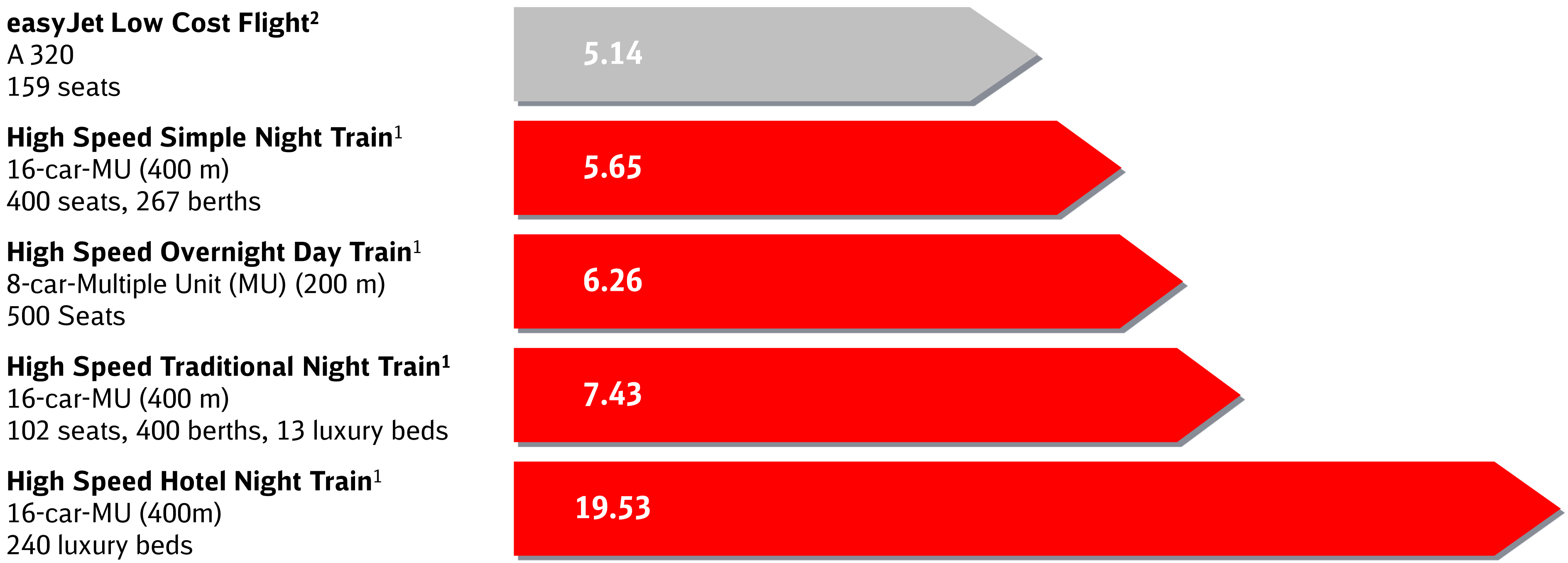
- Actual projected value of 9.14 EUR-cent per seat-km
- Mean value of 9.20 EUR-cent per seat-km and a standard variance of 0.23 EUR-cent per seat-km
- 90 % confidence interval 8.82 – 9.60EUR-cent per seat-km



# The costs for Night Trains exceed the costs of the Low-Cost-Airlines regardless whether the chosen comfort level

Costs

**Costs per available seat-kilometre, Case EUROPE: London - Rome**
[EUR-Cent per seat-kilometre, 2012]




[1] Route- specific calculation on the adapted basis „Relationship between rail service operating direct costs and speed" (UIC 2010)
[2] Network average based on financial reports 2011, without Marketing & Selling

Schematic representation

# By 2025, the development of several cost components will further enlarge the costs for both means of transport – disadvantage for railway

DB Mobility Networks Logistics

Costs

## Cost development until 2025, London - Rome, easyJet vs. HS Traditional NT

| | Rail | | | Air | | | Assumptions[1] |
|---|---|---|---|---|---|---|---|
| | 2012 | Trend[3] | 2025 | 2012 | Trend[3] | 2025 | |
| **Energy/Fuel** | 9 % | 110 | 10 % | 30 % | 200 | 60 % | Crude oil price, increase in electric energy, reduction of consumption: rail traffic as well as air traffic, introduction of kerosene tax and VAT |
| **Vehicle** | 27 % | 120 | 32 % | 13 % | 120 | 16 % | More complex technology, optimizations close to physical limits lead to intensive maintenance |
| **Operating staff** | 5 % | 100 | 5 % | 13 % | 110 | 14 % | Reduction of allowed working time for pilots from 2015 |
| **Infrastructure[2]** | 59 % | 120 | 71 % | 44 % | 120 | 53 % | More extensive user financing due to limited state finances and reduction of subsidies, Increase in cost for flight control |
| | | | **118 %** | | | **143 %** | |
| **London - Rome** **Total Cost** **EUR-Cent / seat-km** | 7.4 | 120 | 8.8 | 5.1 | 140 | 7.3 | ➡ **Cost disadvantage for railway** |

[1] Based on international sources and Consultant assumptions (see Backup) [2] easyjet: includes 6 % „Other Costs"
[3] Assumptions by the Consultant using available information

Mobility Networks Logistics

# In order to have a competitive and cost-effective pricing, the NT has to reach a higher occupancy than the daily long distance HSR traffic

Costs

## Intermodal cost comparison London – Rome 2025

| | Travel Distance km | Total Cost per ASK Ct/seat-km | Seat Cost per Travel EUR | Load Factor % | Total Cost per PAX EUR | Load factor to match TC easyJet % |
|---|---|---|---|---|---|---|
| easyJet | 1,500 | 7.35 | **110** | 87 | 127 | |
| HS Overnight Day Train | 1,800 | 7.40 | **133** | 50 | 266 | 105 |
| HS Simple Night Train | 1,800 | 6.67 | **120** | 50 | 240 | 95 |
| **HS Traditional Night Train** | **1,800** | **8.77** | **158** | **50** | **316** | **125** |
| HS Hotel Night Train | 1,800 | 23.06 | **415** | 50 | 830 | 328 |

- **„Seat Cost per Travel“** of HS Traditional Night Train exceeds easyJet‘s relevant benchmark
- For example, **an occupancy rate of 125 % would be required at the relation London - Rome in case of HS traditional Night Train in order to reach the same costs per PAX** than the chosen benchmark easyJet

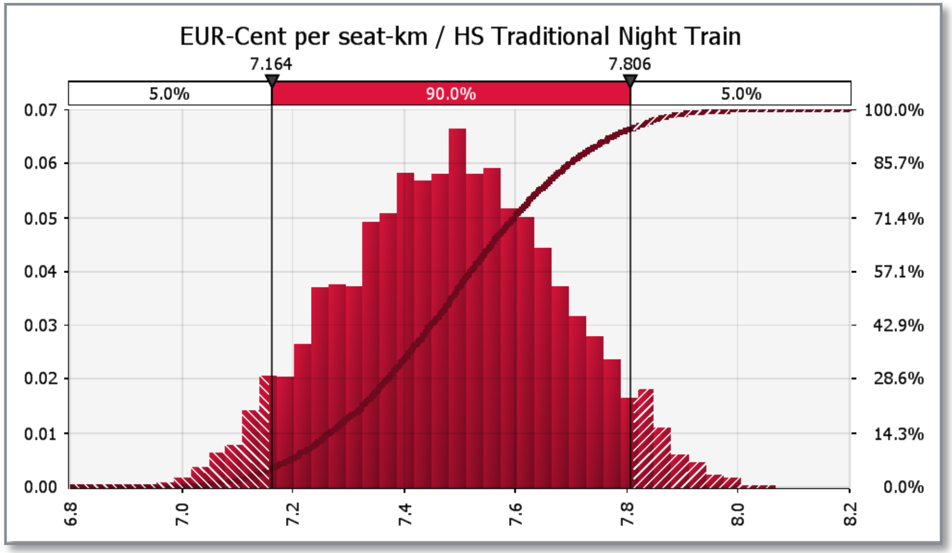
# Estimation arises robust results - risk assessment shows opportunities for decreasing / increasing of the current estimated cost figures



## Risk assessment London – Rome 2012 / 2025

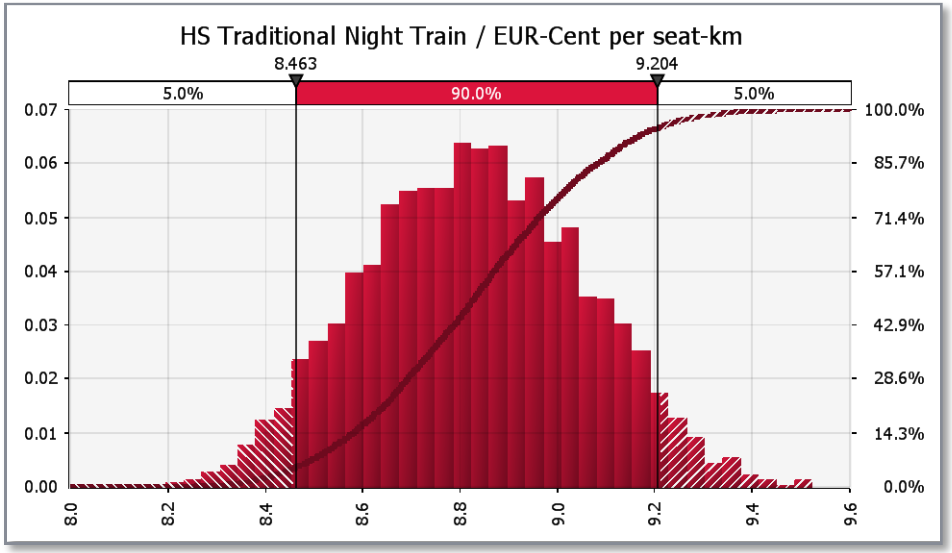
### Costs assessment 2012

- Actual projected value of 7.43 EUR-cent per seat-km
- Mean value of 7.48 EUR-cent per seat-km and a standard variance of 0.19 EUR-cent per seat-km
- 90 % confidence interval 7.16 – 7.80 EUR-cent per seat-km




### Cost forecast 2025 (without assumed changes for 2012)

- Actual projected value of 8.77 EUR-cent per seat-km
- Mean value of 8.83 EUR-cent per seat-km and a standard variance of 0.23 EUR-cent per seat-km
- 90 % confidence interval 8.46 – 9.20EUR-cent per seat-km



# The costs for Night Trains exceed the costs of the Low-Cost-Airlines regardless whether the chosen comfort level

Mobility
Networks
Logistics

Costs

**Costs per available seat-kilometre, Case EUROPE: Madrid - Amsterdam**
[EUR-Cent per seat-kilometre, 2012]

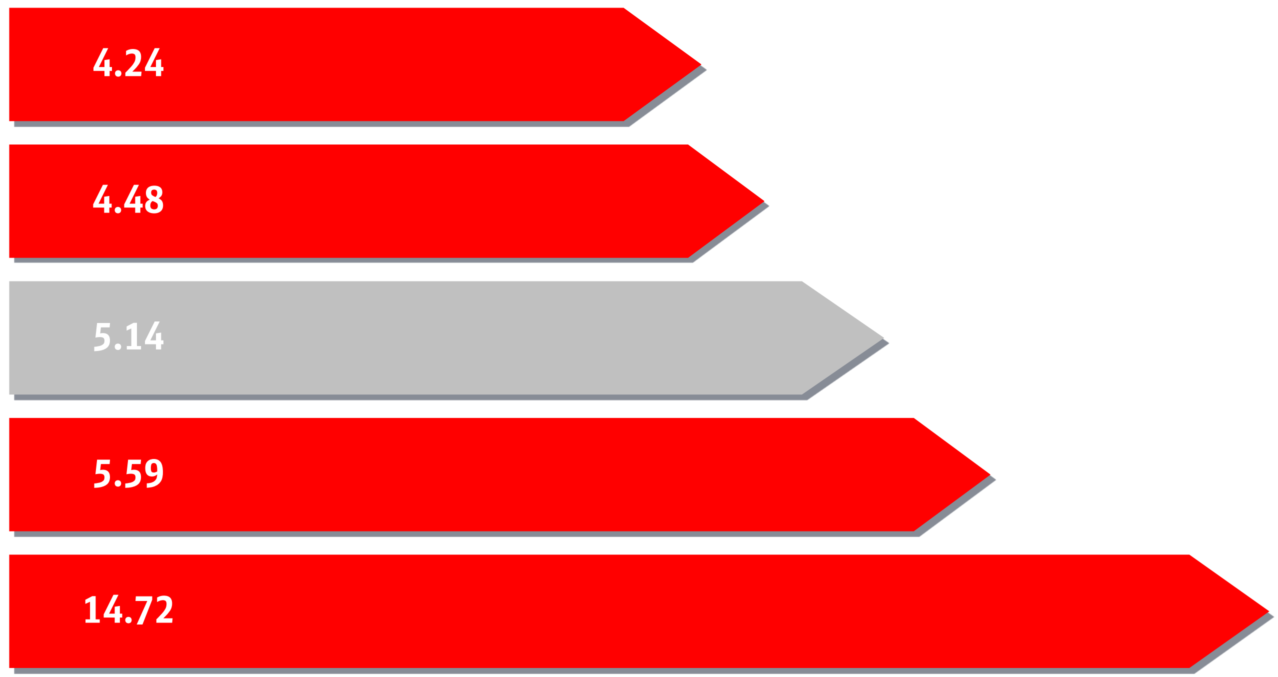
**High Speed Simple Night Train***
16-car-MU (400 m)
400 seats, 267 berths

**High Speed Overnight Day Train***
8-car-Multiple Unit (MU) (200 m)
500 Seats

**easyJet Low Cost Flight****
A 320
159 seats

**High Speed Traditional Night Train***
16-car-MU (400 m)
102 seats, 400 berths, 13 luxury beds

**High Speed Hotel Night Train***
16-car-MU (400m)
240 luxury beds




[1] Route- specific calculation on the adapted basis „Relationship between rail service operating direct costs and speed" (UIC 2010)
[2] Network average based on financial reports 2011, without Marketing & Selling

Schematic representation

# By 2025, the development of several cost components could lead to a cost advantage of the Night Train in comparison to the air traffic

DB Mobility Networks Logistics

**Costs**

## Cost development until 2025, Madrid - Amsterdam, easyJet vs. HS Traditional NT

| | Rail | | | Air | | | Assumptions[1] |
|---|---|---|---|---|---|---|---|
| | 2012 | Trend[3] | 2025 | 2012 | Trend[3] | 2025 | |
| **Energy/Fuel** | 12 % | 110 | 13 % | 30% | 200 | 60% | Crude oil price, increase in electric energy, reduction of consumption: rail traffic as well as air traffic, introduction of kerosene tax and VAT |
| **Vehicle** | 32 % | 120 | 39 % | 13% | 120 | 16 % | More complex technology, optimizations close to physical limits lead to intensive maintenance |
| **Operating staff** | 5 % | 100 | 5 % | 13% | 110 | 14 % | Reduction of allowed working time for pilots from 2015 |
| **Infrastructure[2]** | 50 % | 120 | 61 % | 44% | 120 | 53 % | More extensive user financing due to limited state finances and reduction of subsidies, Increase in cost for flight control |
| | | | **118 %** | | | **143 %** | |
| **Madrid – Amsterdam Total Cost EUR-Cent / seat-km** | 5.6 | 120 | 6.6 | 5.1 | 140 | 7.4 | ➡ **Cost advantage for railway** |

[1] Based on international sources and Consultant assumptions (see Backup) [2] easyjet: includes 6 % „Other Costs"
[3] Assumptions by the Consultant using available information

# In order to a competitive and cost-effective pricing, the NT has to reach a higher occupancy than the daily long distance HSR traffic

Mobility Networks Logistics

Costs

## Intermodal cost comparison Madrid – Amsterdam 2025

| | Travel Distance km | Total Cost per ASK Ct/seat-km | Seat Cost per Travel EUR | Load Factor % | Total Cost per PAX EUR | Load factor to match TC easyJet % |
|---|---|---|---|---|---|---|
| easyJet | 1,600 | 7.35 | 118 | 87 | 135 | |
| HS Overnight Day Train | 2,200 | 5.28 | 116 | 50 | 232 | 86 |
| HS Simple Night Train | 2,200 | 5.00 | 110 | 50 | 220 | 81 |
| **HS Traditional Night Train** | **2,200** | **6.58** | **145** | **50** | **289** | **107** |
| HS Hotel Night Train | 2,200 | 17.32 | 381 | 50 | 762 | 282 |

- **„Seat Cost per Travel"** of HS Traditional Night Train exceeds easyJet's relevant benchmark
- For example, **an occupancy rate of 107 % would be required at the relation London - Madrid in case of HS Traditional Night Trains in order to reach the same costs per PAX** than the chosen benchmark easyJet

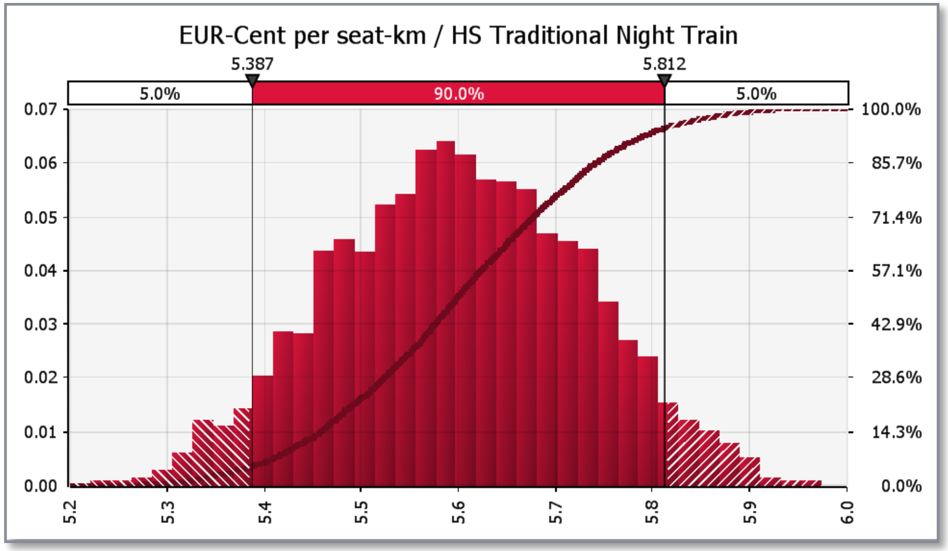
# Estimation arises robust results - risk assessment shows opportunities for decreasing / increasing of the current estimated cost figures

Costs – risk assessment

## Risk assessment Madrid – Amsterdam 2012 / 2025

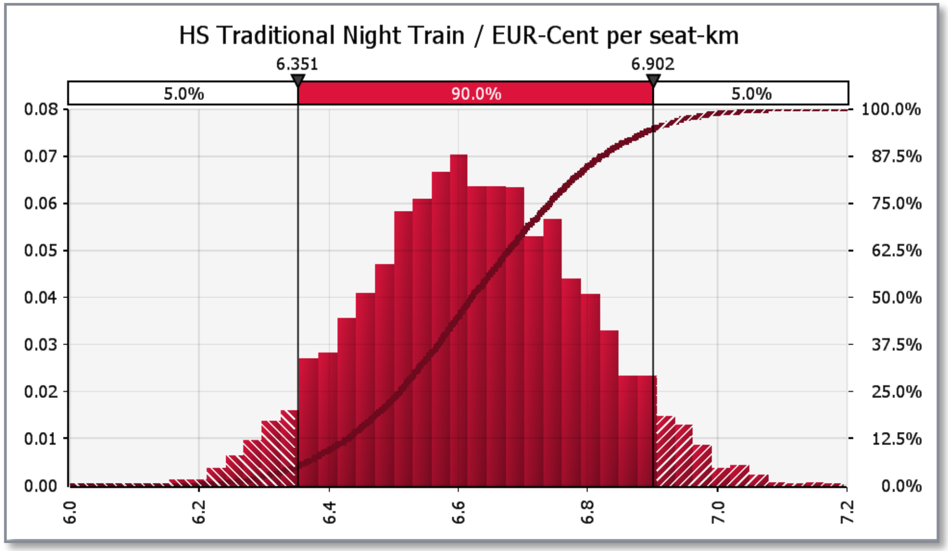
### Costs assessment 2012

- Actual projected value of 5.59 EUR-cent per seat-km
- Mean value of 5.60 EUR-cent per seat-km and a standard variance of 0.13 EUR-cent per seat-km
- 90 % confidence interval 5.39 – 5.81 EUR-cent per seat-km




### Cost forecast 2025 (without assumed changes for 2012)

- Actual projected value of 6.58 EUR-cent per seat-km
- Mean value of 6.62 EUR-cent per seat-km and a standard variance of 0.17 EUR-cent per seat-km
- 90 % confidence interval 6.35 – 6.90 EUR-cent per seat-km



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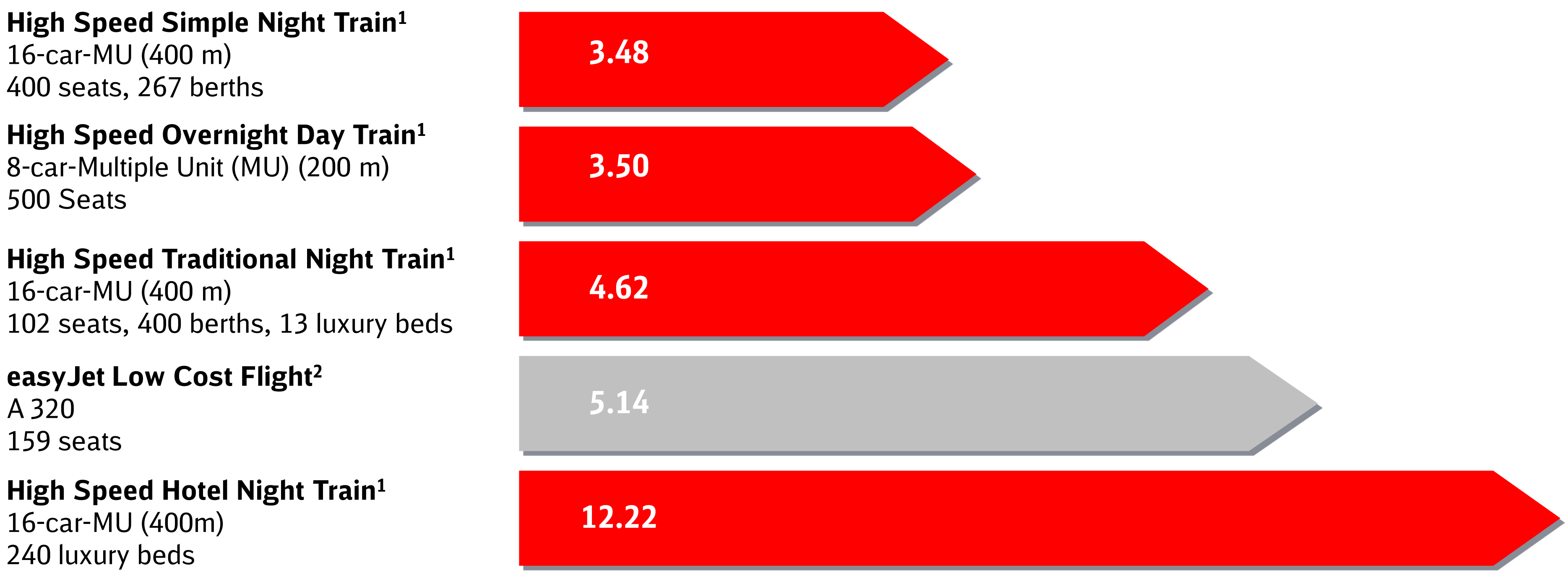
# Depending on comfort standard, HSR Night Train could undermatch the costs per available seat-kilometre of Low-Cost-Airlines as e.g. easyJet

Costs

## Costs per available seat-kilometre, Case EUROPE: Madrid - Rome

[EUR-Cent per seat-kilometre, 2012]




[1] Route- specific calculation on the adapted basis „Relationship between rail service operating direct costs and speed" (UIC 2010)
[2] Network average based on financial reports 2011, without Marketing & Selling

Schematic representation

# By 2025, the development of several cost components could lead to a cost advantage of the Night Train in comparison to the air traffic

DB Mobility Networks Logistics

Costs

## Cost development until 2025, Madrid - Rome, easyJet vs. HS Traditional NT

| | Rail 2012 | Rail Trend[3] | Rail 2025 | Air 2012 | Air Trend[3] | Air 2025 | Assumptions[1] |
|---|---|---|---|---|---|---|---|
| **Energy/Fuel** | 15 % | 110 | 16 % | 30 % | 200 | 60 % | Crude oil price, increase in electric energy, reduction of consumption: rail traffic as well as air traffic, introduction of kerosene tax and VAT |
| **Vehicle** | 39 % | 120 | 47 % | 13 % | 120 | 16 % | More complex technology, optimizations close to physical limits lead to intensive maintenance |
| **Operating staff** | 7 % | 100 | 7% | 13 % | 110 | 14 % | Reduction of allowed working time for pilots from 2015 |
| **Infrastructure[2]** | 40 % | 120 | 48 % | 44 % | 120 | 53 % | More extensive user financing due to limited state finances and reduction of subsidies, Increase in cost for flight control |
| | | | **117 %** | | | **143 %** | |
| **Madrid - Rome Total Cost EUR-Cent / seat-km** | **4.6** | 120 | **5.4** | **5.1** | 140 | **7.3** | → **Cost advantage for railway** |

[1] Based on international sources and Consultant assumptions (see Backup) [2] easyjet: includes 6 % „Other Costs“
[3] Assumptions by the Consultant using available information

# In order to a competitive and cost-effective pricing, the NT has to reach a higher occupancy than the daily long distance HSR traffic

Costs

## Intermodal cost comparison Madrid – Rome 2025

| | Travel Distance km | Total Cost per ASK Ct/seat-km | Seat Cost per Travel EUR | Load Factor % | Total Cost per PAX EUR | Load factor to match TC easyJet % |
|---|---|---|---|---|---|---|
| easyJet | 1,500 | 7.35 | 110 | 87 | 127 | |
| HS Overnight Day Train | 2,200 | 4.09 | 90 | 50 | 180 | 71 |
| HS Simple Night Train | 2,200 | 4.10 | 90 | 50 | 180 | 71 |
| **HS Traditional Night Train** | **2,200** | **5.41** | **119** | **50** | **238** | **94** |
| HS Hotel Night Train | 2,200 | 14.33 | 315 | 50 | 630 | 249 |

- **„Seat Cost per Travel“** of HS Traditional Night Train exceeds easyJet‘s relevant benchmark
- For example, **an occupancy rate of 94 % would be required at the relation Madrid – Rome in case of HS Traditional Night Trains in order to reach the same costs per PAX** than the chosen benchmark easyJet

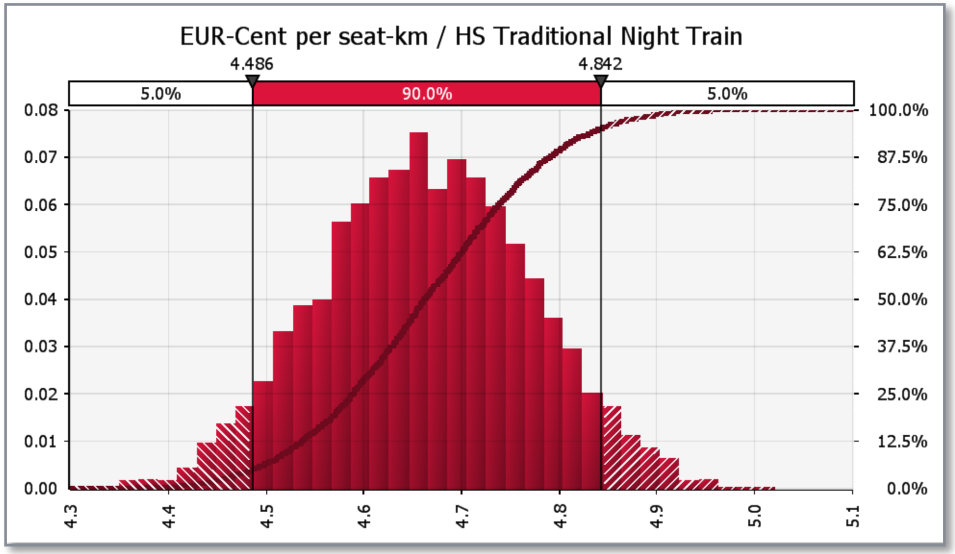
# Estimation arises robust results - risk assessment shows opportunities for decreasing / increasing of the current estimated cost figures



## Risk assessment Madrid – Rome 2012 / 2025

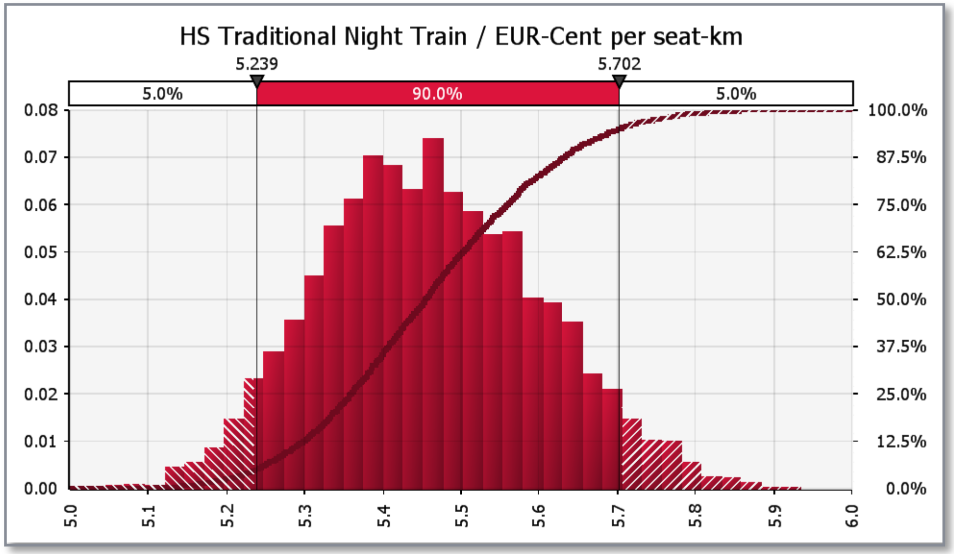
### Costs assessment 2012

- Actual projected value of 4.62 EUR-cent per seat-km
- Mean value of 4.66 EUR-cent per seat-km and a standard variance of 0.11 EUR-cent per seat-km
- 90 % confidence interval 4.49 – 4.84 EUR-cent per seat-km




### Cost forecast 2025 (without assumed changes for 2012)

- Actual projected value of 5.41 EUR-cent per seat-km
- Mean value of 5.46 EUR-cent per seat-km and a standard variance of 0.14 EUR-cent per seat-km
- 90 % confidence interval 5.24 – 5.70 EUR-cent per seat-km



# Considering various assumptions for railway as well as air traffic regarding the development of the main cost driver by 2025

Mobility Networks Logistics

Costs

## Trends of main costs parts in the railway and air traffic

| | Assumptions | Sources |
|---|---|---|
| **Energy/Fuel** | ▪ Oil price +100 % | ▪ Kemfert/IEA 2009 |
| | ▪ Electricity price +30 % | ▪ Consultant |
| | ▪ Decrease in consumption railway -50 % | ▪ DLR 2009, Consultant |
| | ▪ Decrease in consumption air -40 % | ▪ ICAO 2010 |
| | ▪ Kerosene tax 330 EUR / 1,000 l | ▪ European Commission 2005 |
| | ▪ VAT in air traffic | ▪ Country specific, not priced in a quantitative way |
| **Vehicle** | ▪ More complex technology, optimizations close to physical limits lead to intensive maintenance | ▪ Consultant |
| **Operating staff** | ▪ Shortening of flight hours for the pilots | ▪ EU 2012 |
| **Infrastructure** | ▪ Increase in cost for flight control | ▪ Bundesaufsichtsamt für Flugsicherung (BAF) 2012 |
| | ▪ More extensive user financing due to limited state finances and reduction of subsidies in case of air and railway | ▪ Consultant |

# Cost calculation: competitive costs are essential for a successful concurrence to air traffic

**Costs**

**Air traffic costs as benchmark**

↓

**Determination of Night Train costs (per train resp. seat-/berth-/bed)**

↓

**Detailed comparison of each route**

↓

**„Reverse calculation“ Night Train costs as alternative approach**

↓

**Comparison of costs**

- **Status quo: Airline-benchmarking**
  Identification of **easyJet‘s** costs per available seat-kilometre (ASK)
  In order to be long- term competitive, the Night Train has to reach or to undercut the Low- Cost- Carrier costs
- **Step 2:**
  **Cost calculation** for CNT and HSR based on the costs per train kilometre (different costs per seat, berth and bed depending on floor space needed)
- **Step 3:**
  Detailed **comparison** of **selected examples**. Comparison of air traffic and Night Train based on the basis of the general framework of the selected Night Train route
- **Step 4:**
  **Alternative approach**: results of the airline benchmark as objective. If the costs of a night train can‘t be measured due to missing database, the costs determined in the airline benchmark are used as initial value. All known night train costs (e.g. maintenance, route, energy) are subtracted in order to identify the maximum of the unknown operation costs.

# easyJet-Benchmark as focus of the methodic approach for the genesis of a cost structure of air traffic, a direct Night Train competitor

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Costs

**Identification of a suitable air traffic segment**

↓

**Selection of an exemplary airline as benchmark**

↓

**Determination of parameters of costs and outputs**

↓

**Presumptions for development of costs in 2025**

- **Classic middle distance** scheduled airlines are **direct competitors**
- Typical application of Airbus A 320 and Boeing 737 aircraft
- A comparison with the cost structures of airlines comprising long- distance flights would distort the costs and is thus not expedient

---

- **Low- Cost- Carrier (LCC) are increasing** their **market share**
- Even Full Service Airlines convert the non-hub-traffic production similar to LCCs
- Lufthansa announced to release multiple less important lines to Germanwings, the group‘s LCC subsidiary

---

- **Based on the examination made up to now, LCCs will be the typical competitors of Night Trains in 2025**
- esyJet is suitable for a benchmark since central airports of metropolises are approached (in difference to Ryanair)
- easyJet showed constant economic success and cost- effective pricing over the last years
- Due to **the comparison to an airline**, cost determination is **easier** and **database is homogeneous**

# The cost structure of easyJet indicates costs per average seat-kilometre of 5.31 EUR-Cent - 1/3 of the costs are fuel costs

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Costs

## Air Traffic - Benchmark easyJet

| | Pence per ASK | EUR-Cent per ASK* | % |
|---|---|---|---|
| **Operating costs exluding fuel** | **2,98** | **3,43** | **65** |
| Ground operations | 1,33 | 1,53 | 29 |
| Crew | 0,58 | 0,67 | 13 |
| Navigation | 0,41 | 0,47 | 9 |
| Maintenance | 0,26 | 0,30 | 6 |
| Selling & Marketing | 0,15 | 0,17 | 3 |
| Other costs | 0,25 | 0,29 | 5 |
| **Fuel** | **1,32** | **1,52** | **29** |
| **Ownership costs** | **0,32** | **0,37** | **7** |
| Aircraft dry leasing | 0,16 | 0,18 | 3 |
| Depreciation | 0,12 | 0,14 | 3 |
| Amortisation | 0,01 | 0,01 | 0 |
| Interest receivable | (0,01) | (0,01) | 0 |
| Interest payable | 0,03 | 0,03 | 1 |
| Net exchange loss | 0,01 | 0,01 | 0 |
| **Total costs** | **4,62** | **5,31** | |

- In 2011, easyJet announced costs of

**5,31 EUR-Cent/seat-kilometre (ASK – available seat-kilometre)**

- easyJet predominantly uses **156-seat aircraft of the type A319**, which leads to costs per flight kilometre (analogue to train kilometre) of **8,29 EUR/km.**
- **Daily operation length** of each easyJet is around **11.5 hours**
- **Fuel costs** of about **1,5 EUR-Cent/ASK** are based on $818 per ton kerosene (about $120 per Barrel).

* Exchange rate 1,00 GBP = 1,15 EUR (easyjet-Ansatz für 2011), inzwischen 1,22 EUR
Source: http://2011annualreport.easyjet.com/performance-risk/financial-review.aspx

# The cost structure of Ryanair indicates costs per average seat-kilometre of 2.68 EUR-Cent – approx. 40 % are fuel costs

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Costs

## Air Traffic - Benchmark Ryanair

- In 2011, Ryanair achieved CASM (Cost per Average Seat Mile = ASM) of 4.96 EUR-Cent per air mile

1 Air mile = 1.605 km → **2.91 EUR-Cent per ASK (available seat-kilometre)**

- Standardised fleet: **275 Boeing 737-800 with 189 seats per aircraft**
- Cost per flight kilometre: 189 passengers * 0.0291 EUR/km = **5.49 EUR/km per aircraft**
- In 2011 Ryanair payed 820 EUR per metric ton of kerosene, in 2012 about 1,035 EUR are foreseen (+16 %)

**Trends in case of Ryanair:**

- Continuous **fleet expansion**
- Number of sold tickets increases
- **Extension** of the route **network**
- Revenues through ancillary services increase 3x faster than the number of passengers
- But: **expenses on kerosene** present almost 40 % of total operating costs and increased by 37 % since 2010

In the future, **external costs generated by air traffic** could be **internalised using politic measures** (e.g. emission trading)

Source: http://www.ryanair.com/doc/investor/2011/Annual_Report_2011_Final.pdf, p.40, , http://www.ryanair.com/de/about/fleet

Mobility Networks Logistics

# Cross-Check Night Train vs. aircraft: HS Night could distribute costs to more seats due to combined production – occupancy rate crucially

Costs


| | ZEFIRO 250 | A319 |
|---|---|---|
| **Passenger Capacity** | **618** | **156** |
| Seats | 122 | 156 |
| Bed | 480 | 0 |
| Luxury beds | 16 | 0 |

- The class ZEFIRO 250 multiple unit provides a **seat capacity which is almost 4 times higher than a A319 aircraft**
- Train type already operates as a **HS Night Train** in China
- **Cost rate of 33 EUR / kilometre**; costs of the competitor easyJet could be reached
- However, an inherent problem is that each **seat / bed is only sold once per night** which leads to high costs per ticket on long distances:
  - Example: 2,000 km from origin to destination, occupancy rate 75 %
  - Train operating costs per PAX: 33*2,000/(618*0.75)=142 EUR
- **easyJet** generates **20 % of the sales volume through ancillary revenues** (speed boarding, baggage extra charge, onboard duty- free selling…)

Source: http://www.zefiro.bombardier.com/desktop/en/portfolio/zefiro250_1.html?tab=1

DB Mobility Networks Logistics

# Price analysis bases on a scientific secured and already apporved survey design of the „VCD Bahn Test 2012 / 2013“

Prices

## Comparable survey design


### Survey design

- Price comparison between railway and air considering the important connections in Germany
- Evaluation period May to September 2012
- 270 comparable cases, 540 unit prices
- 3 different kinds of travel
- 4 different booking dates
- Methodology and results: http://www.vcd.org/bahntest_2012.html

### Concept

- Preparation by Quotas also involved in the current USEmobility-Project of the European Commission

# Differentiated price analysis: Airline prices will be surveyed considering three classical kinds of travel...

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Prices

## Kinds of travel in the survey

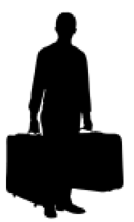
### Business trip

| | | | |
|---|---|---|---|
| 1 day | TUE, WED, THU | until 12 am | after 4 pm |

### Weekend trip

| | | | |
|---|---|---|---|
| 3 days | FR-SUN | until 10 pm | after 12 am |

### Vacation trip



| | | | |
|---|---|---|---|
| 2 weeks | SAT-SAT | until 6 pm | after 8 am |

# ... and three different travel dates in each case using different booking dates in advance

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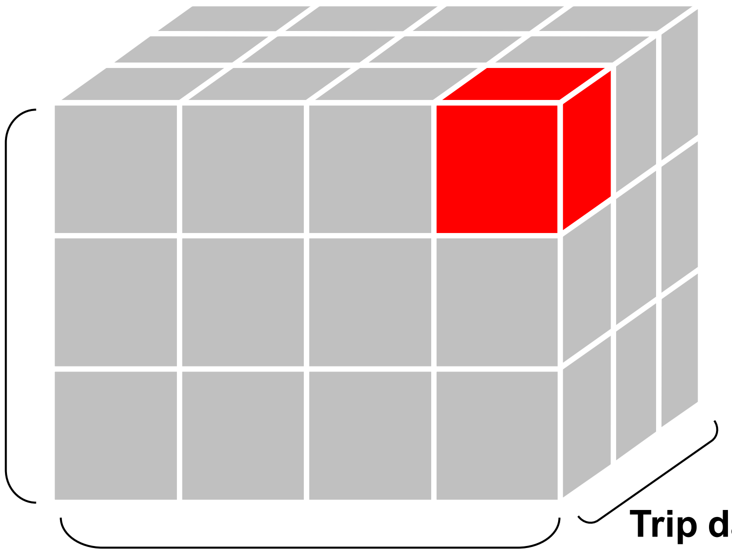
Prices

## Survey sample size

Travel type
Business trip
Weekend trip
Vacation trip



Booking in advance
2 month
4 weeks
7 days
1 day

Trip date
A
B
C

**x 5** connections

**∑ 180 requests**

# On the basis of the flight search engine (tripadvisor) the real final prices (air) will be surveyed considering the strongest nonstop connections

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**Prices**

tripadvisor

1

- Meta search engine tripadvisor for determining the attractive price in depending on the booking date
- Verification of the real price using the linked ticket distributor
- Determination of 180 unit prices


2

- Preparation of average prices (depends on the kind of travel) using different booking dates
- Illustration of the connection realted Best Price ranges

**Yield/pkm**

3

- Application of the Best Price as benchmark for the Very Long Distance Night Trains
- Calculation of  anticipated Yield ranges for the Very Long Distance Night Trains

# The survey extends over a period of two month with regular price requests

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Prices

## Time schedule price requests from February until April 2013

| | Date of trip | Query A<br>8 weeks before departure | Query B<br>4 weeks before departure | Query C<br>7 days before departure | Query D<br>1 day before departure |
|---|---|---|---|---|---|
| **Business trip 1** | Wed. 20.03 | Wed. 23.01. | Wed. 20.02. | Wed. 13.03. | Tue. 19.03. |
| **Business trip 2** | Thu. 21.03 | Thu. 24.01. | Thu. 21.02. | Thu. 14.03. | Wed. 20.03. |
| **Business trip 3** | Tue. 26.03. | Tue. 29.01. | Tue. 26.02. | Tue. 19.03. | Mon. 25.03. |
| **Weekend trip 1** | Fri. 15.- Sun. 17.03. | Mon. 21.01. | Fri. 15.02. | Fri. 08.03. | Fri. 15.03. |
| **Weekend trip 2** | Fri. 22.- Sun. 24.03. | Mon. 28.01. | Fri. 22.02. | Fri. 15.03. | Fri. 22.03. |
| **Weekend trip 3** | Fri. 05.- Sun. 07.04. | Mon. 11.02. | Fri. 08.03. | Fri. 29.03. | |
| **Vacation trip 1** | Sat. 16.- Sat. 30.03. | Mon. 21.01. | Fri. 15.02. | Fri. 08.03. | Fri. 15.03. |
| **Vacation trip 2** | Sat. 23.03 – Sat. 06.04. | Mon. 28.01. | Fri. 22.02. | Fri. 15.03. | Fri. 22.03. |
| **Vacation trip 3** | Sat. 30.03. – Sat.13.04. | Mon. 04.02. | Fri. 29.02. | Fri. 22.03. | Mon. 29.03. |

# Agenda

**Backup**

Background and purpose of the study

Analysis of the current situation (potential)

Analysis of the current situation (costs and prices)

**Analysis of the current situation (environment)**

# Transport sector is responsible for a ¼ of global GHG emissions – further environmental regulations will be the consequence

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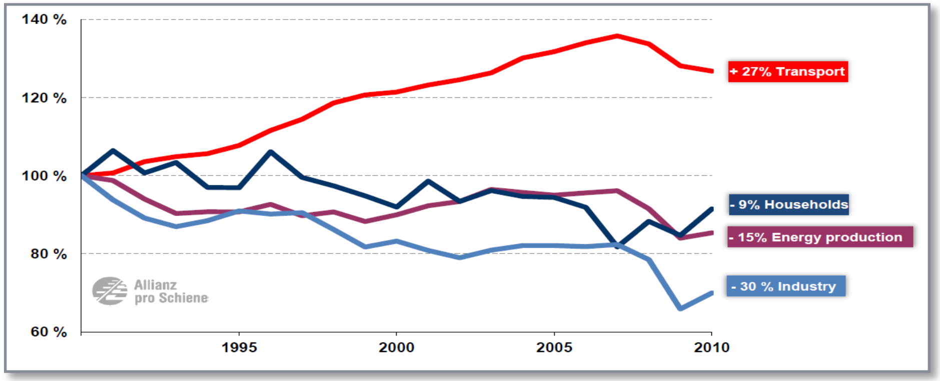
Environment

## Facts of the transport sector

- With 22 % of all worldwide $CO_2$ emissions, the transport sector was the second largest source of man-made Carbon Dioxide ($CO_2$) in 2010
  Source: UIC High Speed Rail and Sustainability
- Forecast shows that Transport emissions continue to rise in upcoming years
- Thus, Transport is the only sector with constantly rising emissions
  - 25 % between 1990 and 2010;
  - 3 % between 2009 and 2010
  - Tendency: rising

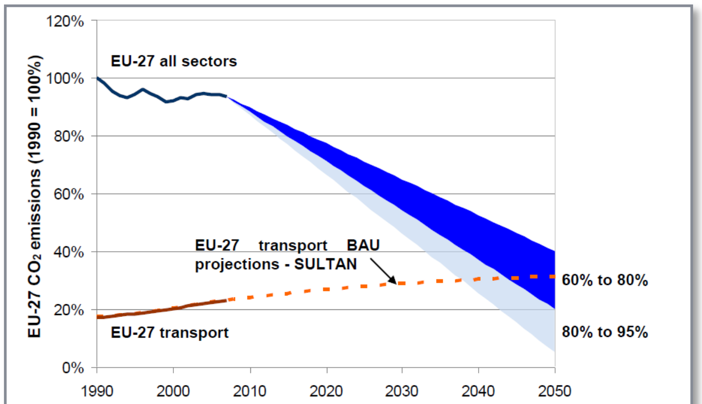
→ **Reducing transport emissions** should be one of the most crucial steps in combating global warming and securing our future

**GHG emissions by sector (EU-27);** 1990 – 2010 in %




Source: Allianz pro Schiene, June2012; Calculations based on figures from the European Environment Agency (EEA).

**Forecast: Transport emissions until 2050 (EU-27)**




Source: EC DG Energy (2010); projections based on data from SULTAN Illustrative Scenarios Tool

# Compared with air, rail has a significant environmental advantage and this has expanded in recent years and is still getting better

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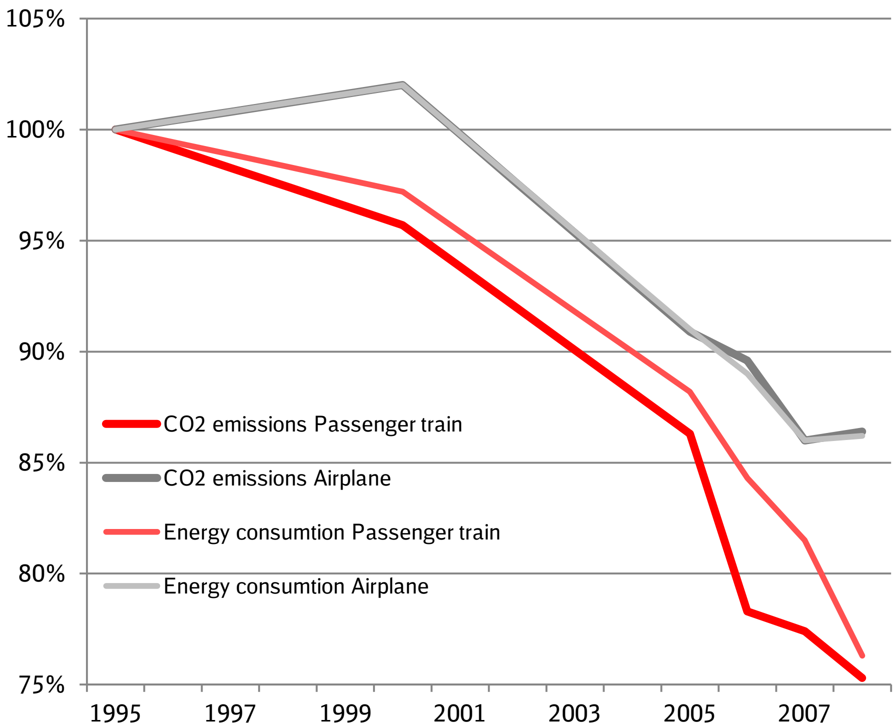
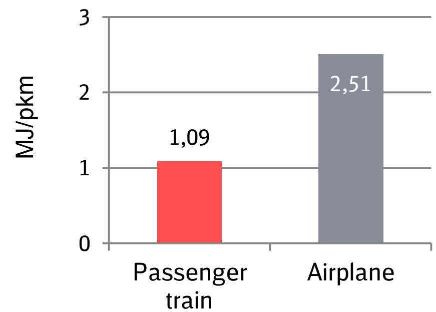
## Expanding environmental advantage of rail traffic

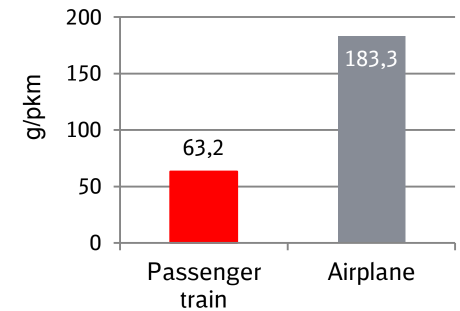
### Evolution of energy consumption and CO2 emissions per passenger-kilometer in Germany




Source: CE Delft, Infras, Fraunhofer ISI 2011; External Costs of Transport in Europe, updated study for 2008

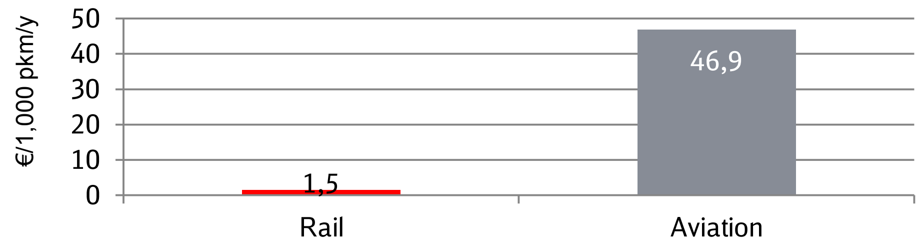
### Specific of energy consumption and $CO_2$ emissions for 2008
[in 2008 for EU-27]




Source: Allianz pro Schiene „Die verkehrsträgerübergreifende Datenbank Umwelt und Verkehr zur Nutzung der Förderer“ von 2010

### Ø external cost for Climate change in Passenger Transport
[in 2008 for EU-27]




Source: CE Delft, Infras, Fraunhofer ISI 2011; External Costs of Transport in Europe, updated study for 2008

# Comparison of environmental advantages between air and rail – methodic approach for determining the $CO_2$ emissions

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## Approach for environmental investigation

**Route selection acc. substitution rate**

↓

**Determination of airplane emissions**

↓

**Determination of rail emissions**

↓

**Comparision of emissions**

- **Step 1:** Selection of investigated corridors; For each region, the corridor with the most efficient substitution rate is to select;
- **Step 2:** Determination of average $CO_2$ emissions for airplanes on investigated corridors;
  - Enter necessary parameters of the corridor and considered airplanes into the emission calculator: Atmosfair*;
  - Determine the $CO_2$ emission per passenger (in kg) on the selected routes for available airplanes;
  - Convert to passenger-kilometre (pkm) by dividing emissions per passenger by flight distance
- **Step 3:** Determination of average $CO_2$ emissions for trains on investigated corridors; Where possible to use one of the emission calculators, otherwise using average figures
- **Step 4:** Evaluation of the determined values for airplanes and trains ($CO_2$ emissions in g/pkm)

* https://www.atmosfair.de/emissionsrechner/rechner/

# To investigate selected corridors, emission calculators were used to determine the $CO_2$ emissions for rail and air traffic

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## Considered Corridors and Emission calculators

- **Investigated Corridors**

| Region | Europe | Japan | India | China | USA |
|---|---|---|---|---|---|
| Corridor | West | Central North | West-South | South-East | East coast |
| Route | Madrid – London | Sapporo - Fukuoka | Mumbai - Bangalore | Hong Kong - Shanghai | Ottawa - Washington |

- **Tools for determination of $CO_2$ and other GHG emission as well as other environmental impacts**
  - Carbon footprint tools help costumers choosing the most environmental friendly way of transport (mostly road / rail / air)
  - Rail: for Europe, there are numerous emission calculators; in other regions not, average values were determined there
  - Air: there are emission calculators for flights all over the world

  - Used emission calculators:
    - Ecopassenger → Determination of GHG emissions for rail, road and air traffic in Europe
    - Ecocomparateur → Determination of GHG emissions for rail, road and air traffic in Europe
    - DB UmweltMobilCheck → Determination of GHG emissions for rail, road and air traffic in Europe
    - Atmosfair → Determination of GHG emissions for flights worldwide

→ Comparisons clearly show that the **rail traffic is a particular environmental friendly way to travel**

# Despite the greater distance, still trains have significant less $CO_2$ emissions on selected routes compared with direct air traffic

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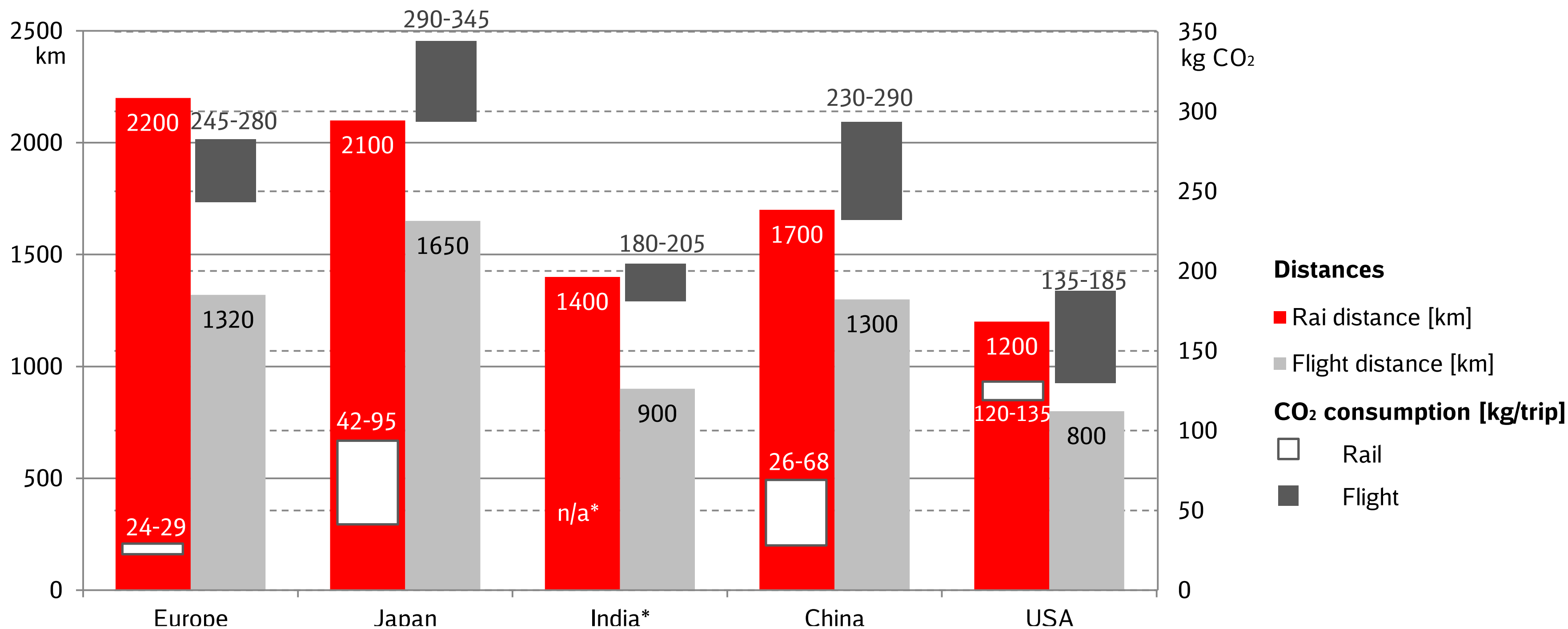
## $CO_2$ emissions – comparison of air and rail traffic

### Average $CO_2$ emission in kilogram per trip per person with current rolling stock




| $CO_2$ emission in g per pkm | | Europe Rail | Europe Air | Japan Rail | Japan Air | India* Rail | India* Air | China Rail | China Air | USA Rail | USA Air |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | min. | 11 | 185 | 20 | 175 | n/a | 200 | 15 | 175 | 101 | 170 |
| | max. | 13 | 215 | 45 | 210 | | 225 | 40 | 220 | 115 | 230 |

* India cannot be confirmed since the basis for the emissions per trip with only 5,5g CO2 per pkm is inconceivable

# Carbon footprint is for train traffic up to 15 times less compared with air traffic

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## Sustainability

- Better technologies have made the train an increasingly attractive alternative, and especially a “green” one
- Aviation and road transport, will highly depend on fossil fuels for many years, while rail transport is already using renewable energies and rising
- Carbon intensity of rail traffic can even be further reduced by increasing the share of renewable energies
- Train traffic is still more environmentally friendly even when considering the construction of the tracks and rolling stock in a full life cycle perspective

| | High speed rail (LGV (Med) | Difference | Airplane (Europe flights) |
|---|---|---|---|
| Construction of track / airport | 4.3 g $CO_2$ / pkm | 15 : 1 | 0.3 g $CO_2$ / pkm |
| Rolling stock / airplane | 1.0 g $CO_2$ / pkm | ´2 : 1 | 0.5 g $CO_2$ / pkm |
| Operation (incl. upstream emissions) | 5.7 g $CO_2$ / pkm | 1 : 28 | 163.2 g $CO_2$ / pkm |
| **Grand sum** | **11.0 g $CO_2$ / pkm** | **1 : 15** | **164.0 g $CO_2$ / pkm** |

*Acc. UIC study about Carbon Footprint of High Speed Rail chapters 3.1.1 Carbon footprint of high Speed rail transport as well as 3.1.3 Carbon footprint of air ransport 4.2 Carbon Footprint of Air traffic*

- The total **Carbon footprint** in that study **is for train traffic up to 15 times less compared with air traffic**

Note: The comparison above cannot be considered as generally valid, since the emission levels can vary widely depending on the study, kind of trains, region, time and measurement method, however all studies clearly show the environmental advantage of rail traffic .

# There are lot of potentials to improve environmental friendliness for both air and rail traffic, still rail will keep his big lead

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## Potential of energy savings until 2025

**Air traffic – 40 %** through:

- New generation of jet engines shall reduce GHG emissions by 10-15 % until 2020 and up to 40 % are expected from 2025-2030 (Source: ICCAIA)
- Reducing the detour factor and the waiting loops through utilization of ICT
- Aircraft ground handling by bottom-side power systems and alternative drive concepts

→ **Total emissions produced by air traffic will further increase** due to more expected flights in the future

**Rail traffic – 50 %** through:

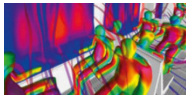
- Extensive programs to $CO_2$-neutral or exclusively by renewable energy in close future; already started by several railway companies
- Next generation trains, which can create energy savings of up to 50 % compared with today's ICE3 trains (Source: German Aerospace Center)

→ **Total emissions produced by rail traffic will decrease** due to the already started switch to renewable energies and expected extension of green energy

# Trendsetting train technology with high environmental advantage, however it is not state-of-the-art that can be reached until 2025

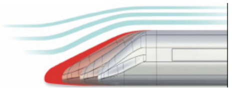
Environment

- Very high efficiency and very high performance
- Leading-edge technologies and advanced aerodynamics to reduce energy consumption
- Potentials for energy savings according to BOMBARDIER's eco[4] program up to:
  - 30 % **MITRAC Energy Saver** – stores energy released a vehicle brakes and reuse it during acceleration or operation
  - 26 % **ThermoEfficient Climatisation System** - low energy interior climate system (variable fresh air rate system / pre-heat or pre-cool fresh air by reusing up to 80 per cent of the energy)

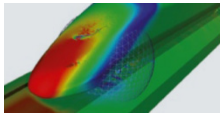


  - 25 % **FLEXX Eco Bogie** - significant reductions in energy consumption and noise emissions

  - 20 % **EnerGplan Simulation Tool** – graphical simulation tool to determine the optimal mode of operation
  - 20 % **EnerGstor Wayside Energy Storage** - stores potentially wasted braking energy and recycles it back into the system
  - 15 % **EBI Drive 50 Driver Assistance** System - smart software tool assisting train drivers (velocity and acceleration)
  - 12 % **AeroEfficient Optimized Train Shaping** - to improving the aerodynamic performance



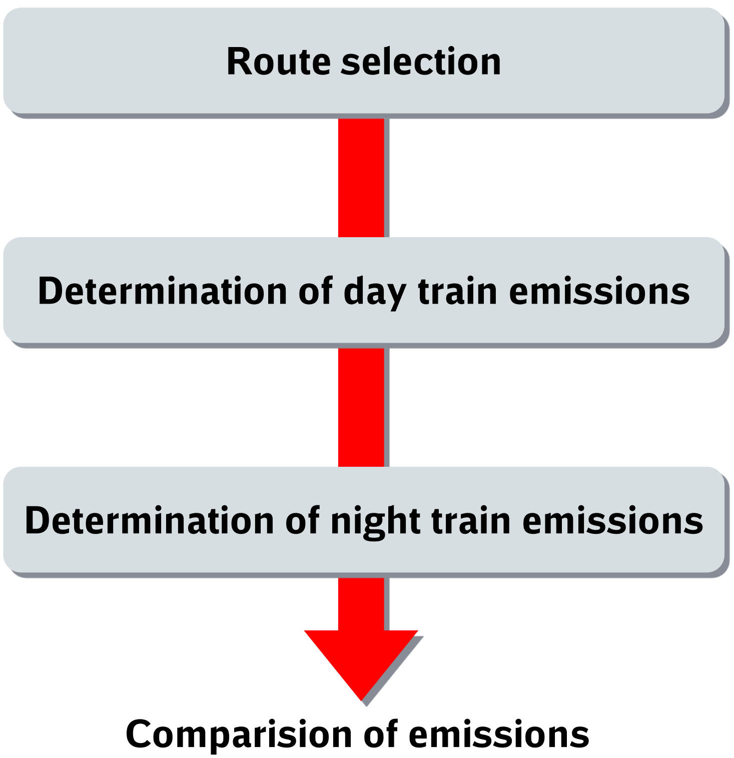
  - 10 % **Energy Management Control System** – affordable fleet energy management solution
  - 50 % Noise reduction by **EcoSilent Optimised Sound Design** - optimised wheel and bogie designs as well as cooling system



Source: BOMBARDIER EcoActive Technologies "ECO4 Technologies – Leading the way in total train performance"

# Environmental advantage of day trains in comparison to night trains, investigated on existing routes in Germany and France






- **Step 1:** Selection of investigated routes;
  Following routes are selected for Europe
  Germany: route Berlin - Munich
  France: route Paris – Toulouse
- **Step 2:** Determination of average $CO_2$ emissions for day trains on investigated routes;
  - Determine on basis of the **DB UmweltMobilCheck** $CO_2$ emission in g per pkm on selected routes;
  - Evaluation of six (6) trains on the route between 06:00am – 23:00pm
- **Step 3:** Determination of average $CO_2$ emissions for night trains on investigated routes;
  - Determine on basis of the **DB UmweltMobilCheck** $CO_2$ emission in g per pkm on selected routes;
  - Evaluation of two to three (2-3) trains on the route between 21:00pm – 07:00am
- **Step 4:** Validation of the model data and evaluation of the determined values for day and night trains ($CO_2$ emissions in g/pkm)

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# Compared with day trains, current night trains have a lower environmental advantage, still it is significant higher than air traffic

Environment

## $CO_2$ emissions – comparison of day and night trains

Following day and night trains, operating on the selected routes in France and Germany are considered in the investigation:

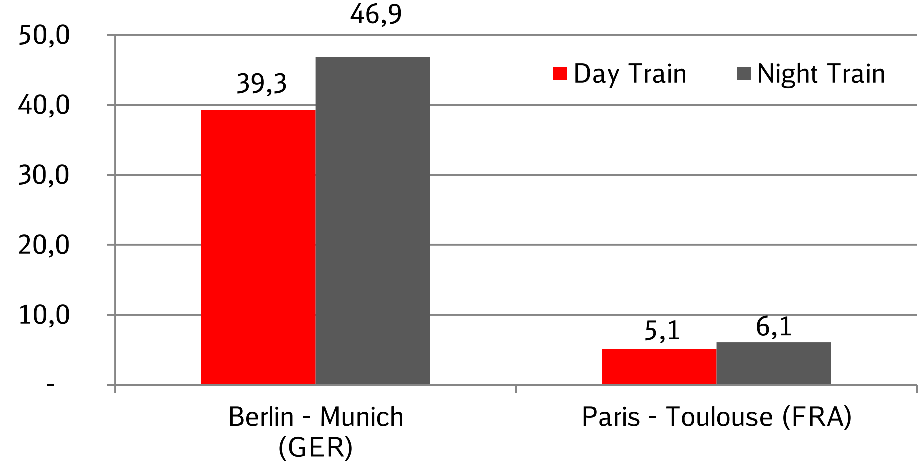
- ICE vs. CNL for the route Berlin – Munich (GER), and
- TGV vs. Intercité vs. Intercité de nuit for the route Paris-Toulouse (FRA)

→ Findings: Environmental disadvantage of night trains

**Night trains has around 20 % higher $CO_2$ emission compared with day trains.**

- Attempt to explain the environmental disadvantage of night trains:
  - lower PAX number per meter of wagon
  - significantly reduced PAX capacity in sleepers
  - more dead load per PAX due to more fixtures, more equipment (shower water, etc.)

**$CO_2$ emissions of day and night trains** [g per pkm]




Source: DB UmweltMobilCheck

Although, there are environmental disadvantages of night trains compared with day trains:

- **Night trains are an efficient** and effective solution to mitigate the impact of transportation on the environment and climate **and make it an essential part of sustainable mobility systems**
- Night trains running on HSR lines are driven with 100 % electric power which makes it capable to shift from fossil fuels to **renewable energy supply without any separate investment in the propulsion units or infrastructure**

# List of figures

# List of abbreviations

| | |
|---|---|
| ASK | Available Seat-Mile |
| ASM | Available Seat-Kilometre |
| CASM | Cost per Available Seat-Mile |
| CNL | CityNightLine |
| CNT | Conventional Night Train |
| CSR | Corporate Social Responsibility |
| DBI | DB International |
| DLR | Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Center) |
| EN | EuroNight |
| GHG | Greenhouse Gas |
| HS | High Speed |
| HSL | High Speed Line |
| HSR | High Speed Rail |
| HST | High Speed Train |
| HT | Half-train |
| IATA | International Air Transport Association |
| IC | InterCity |
| ICAO | International Civil Aviation Organisation |

| | |
|---|---|
| ICE | InterCityExpress |
| LCC | Low-Cost Carrier resp. Life Cycle Costs |
| MU | Multiple Unit |
| NT | Night Train |
| O&D | Origin and Destination |
| OPEX | Operating Expense |
| PAX | Abbreviation for Passenger(s) |
| PDL | Passenger Dedicated Line |
| pkm | Passenger-kilometre |
| PLF | Passenger Load Factor |
| RFI | Request For Information |
| SWOT | Strengths, Weaknesses, Opportunities, Threats |
| TC | Total Costs |
| TGV | Train à Grande Vitesse |
| UIC | Union Internationale de Chemins de fer / International Union of Railways |
| VAT | Value Added Tax |
| VFR | Visiting Friends and Relatives |
| VLDNT | Very Long Distance Night Train |