Time Reduction Potential through a Continental-Scale Schedule Optimisation of Long-Distance International Passenger Rail Corridors in Europe

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Abbreviations

AVE	Alta Velocidad Española (Spanish high-speed train)
BAV	Bundesamt für Verkehr (Switzerland)
BMDV	Bundesministerium für Verkehr und Digitale Infrastruktur (Germany)
ČD	České dráhy (Czech Railways)
CR	China State Railway Group Co., Ltd.
DB	Deutsche Bahn AG (German national railway company)
EC	EuroCity train
EN	EuroNight train
EU	European Union
FEVE	Ferrocariles de Vía Estrecha (Spanish Narrow-guage Railway division of RENFE)
HSR	High-Speed Rail
IC	InterCity train
ICE	InterCity Express (German high-speed train)
JR	JRグループ (Japan Railways Group)
LGV	Ligne à Grande Vitesse (French high-speed line)
MÁV	Magyar Államvasutak (Hungarian State Railways)
NS	Nederlandse Spoorwegen (Dutch Railways)
NUTS	Nomenclature of Territorial Units for Statistics (used by Eurostat and EU)
ÖBB	Österreichische Bundesbahnen (Austrian Federal Railways)
PKP	Polskie Koleje PańStwowe (Polish State Railways)
RENFE	Red Nacional de los Ferrocarriles Españoles (Spanish National Railway Network)
RJ	RailJet (Austrian train)
RJX	RailJet Express (Austrian train)
RZD	Российские железные дороги (Russian Railways)
SBB	Schweizerische Bundesbahnen (Swiss Federal Railways)
SFS	Schnellfahrstrecke (German high-speed line)
SNCB	Société nationale des chemins de fer belges (Belgian national railway company)
SNCF	Société nationale des chemins de fer français (French national railway company)
TEN-T	Trans-European Transport Network
TGV	Train à Grande Vitesse (French high-speed train)
UIC	Union internationale des chemins de fer (International Union of Railways)
USA	United States of America
WB	WestBahn (Private Austrian intercity train operator)
ŽS	Железнице Србије (Serbian Railways)

Bachelor thesis in Geospatial Engineering

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Abstract

The advent of high-speed rail has, along with the elimination of most border controls, resulted in the acceleration of long-distance European railway journeys, yet long-distance trips are still subject to long transfers and inefficiently timed trains. This thesis aims to identify how much potential travel-time reduction could be attained by minimising this inefficiency, and to compare the result to the projected travel-time reduction scheduled to accompany the construction of future high-speed rail infrastructure projects. This was made possible by the creation of a large novel database containing over thirty thousand European railway stations' minimal currently timetabled connection times, combined in one comprehensive Dijkstra-algorithm based shortest-paths Python model. Ten representative corridors were chosen for a detailed analysis, comprised of an individual corridor table overview as well as sample timetables for three scenarios per corridor. Isochronic visualisations based on a model of the continent's current as well as future passenger rail connections were generated to illustrate the scale of the potential time savings at play, and showcase the spatial distribution of rail reachability. Finally, both quantitative and qualitative conclusions highlighting the importance of greater network efficiency on a trans-European scale were drawn, then used as a basis from which to propose concrete policy changes aiming to increase international collaboration toward the shared goal of higher average speeds. These included goal suggestions to adopt, and key metrics useful in measuring progress toward making improved use of the underutilised potential of the European passenger rail network, ultimately seeking to substantially reduce travel times across the long-distance European passenger rail network.

Keywords

Long distance travel; High Speed Rail; Timetable Efficiency; European Rail Network

Data availability

Data will be made available upon request.

Preferred Citation

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1. Introduction

1.1. Increasing demand for long-distance rail travel in Europe

The past few decades have seen a steady trend toward the dismantling of barriers standing in the way of a long-distance interconnectedness of the European continent, which in combination with the nascent social phenomena of flygskam (flight-shame) and tågskryt (train-bragging) has led to an increased demand for feasible as well as traditionally infeasible long-distance rail journeys (Curtale et al., 2023) (Gourdon, 2023). Travelling from Western Europe to Istanbul or Helsinki and back is for the most part no longer plagued by visa formalities, countless currency exchanges and tedious border crossing ordeals, which historically limited its attractiveness to only amongst the most intrepid, politically privileged and patient of travellers. The increasing ease with which transcontinental journeys can nowadays be undertaken has coincided with the advent of social media quickly democratising possible itineraries (Mohamad et al., 2022), and in so doing, motivating countless potential long-distance holidayers to undergo their own cross-European trip. The wide-scale implementation of simpler online ticketing, increased competition from new train operators preventing artificially high prices (Beria, 2023) (Beria, 2019) as well as the introduction of cheaper advance fares along many routes have also decreased the barrier to entry for many a prospective traveller, and have been linked to heightened demand (Anciaes, 2019). Interrail, established with the intention of enabling easy long-distance travel in Europe across multiple operators, now sell over 600 thousand passes per year, representing a tripling in demand over the past two decades (Interrail, 2022). The widely-reported trend of young people being more likely to spend additional disposable income on travel experiences than in previous decades is one that may also be contributing to increased rail demand, though further studies are needed. The shift in demand from younger holidaymakers away from the traditional one-location “sun, sea and sand holidays” toward more longer-term multi-city trips (Daly, 2013), is yet another factor contributing to long-distance high-speed rail journeys’ continued rise in popularity (Yin et al., 2015). The renewed momentum of night trains effectively filling in long-distance gaps in tourists’ itineraries is one subject in particular in which much optimism has been found in recent years (Lena Donat et al., 2021), due in no small part to the resounding impact the recently reinvigorated night train network has had in Central Europe and elsewhere on consumer preferences vis-à-vis plane travel (Kantelaar et al., 2022).

1.2. Barriers to long-distance rail travel in Europe

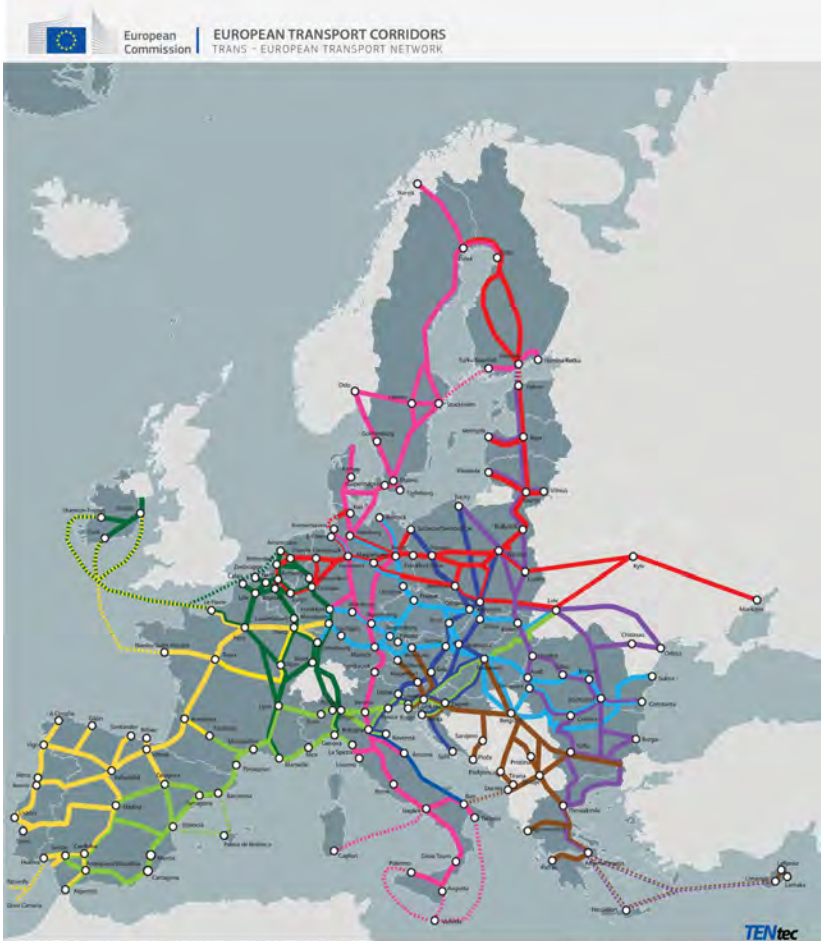
Long-distance routes remain subject to meaningful obstacles from a passenger perspective, particularly when no direct train is available. It is often impossible to buy a continuous through-ticket to a station on the other side of Europe — in fact, this is an area in which the situation has gradually worsened in recent years, with increasing isolationism on the part of certain national rail companies being made ever more apparent (Ehrbar, 2023). One impact of Russian isolationism in particular, following the COVID-19 pandemic, their 2022 invasion of Ukraine and the associated sanctions has been the cessation of prior frequent sharing of updated information about many post-Soviet European as well as Asian countries' rail services by RZD to Central European timetable data servers, eliminating a large swath of rail information from being as easily accessible to European consumers as in prior years. Previously possible direct rail tickets issued over multiple trains from Bratislava to Vladivostok or Oostende to Istanbul now remain distinctly relegated to eras passed, with no short or medium-term reintroduction of these through-tickets planned. Ultra long-distance direct cross-continental trains have also gradually been disappearing (Seidenglanz, 2021). A widespread improvement in continental through-ticketing is therefore sorely needed, which would necessitate the active collaboration of the relevant national railway companies.

A continent-wide fair connection protection to be able to board the next available train in the event of a missed connection has been very slow in arriving, despite being in the public interest. In 2023, a new European Union rule for rail passenger protection began applying after coming into force two years prior (European Union, 2021), yet it only represents a step toward ensuring fair treatment of passengers in the eventuality of a disrupted connection, and still doesn't protect passengers in a number of common instances. Beyond this, it is not uncommon for a long intra-European connection to be so poorly timed that only one through connection per day is possible. On longer corridors, an extended stop is often required along the route to await the soonest departure along the next segment of the trip, often turning the city in question into an overnight stop and in so doing, adding crucial friction to the choice to commit to travelling by train over flying. International station pairings' rail connections range from frequent, high-capacity connections (Vrána et al., 2023) to small weekly trains or indeed may no longer be served by regularly scheduled passenger service at all (European Commission, 2018). However, perhaps the most pertinent question to ask when considering a rail corridor is whether or not it benefits from high-speed rail (HSR). Due to being among the most expensive measures for speeding up international rail connections, the construction and integration of high-speed rail lines into continentally significant corridors merits a closer look.

1.3. High-speed rail in Europe

Certain parts of Western Europe in particular can be commended for their successfully completed high-speed rail projects (Vrána et al., 2023), most notably Spain, France and Italy. However, many current European high-speed rail plans lack firm timescales and budgets. Others have been scaled back, postponed indefinitely or cancelled (Government of the United Kingdom, 2023). This said, numerous lines currently under planning or construction stand to radically reduce travel times across much of the continent, and the European Union has committed to tripling high-speed rail traffic by 2050 as part of the Green Deal (European Commission, 2020), for which master plans have been proposed to aid in their implementation (Community of European Railway and Infrastructure Companies, 2023). Most relevant to the European Union are the projects which follow the so-called Trans-European Transport Network (TEN-T) Core Network corridors (Figure 1), allocated the highest international priority.

Figure 1 TEN-T Core Network Corridors Schematic Map



Source: European Commission (2023)

It would, however, be somewhat wasted potential to introduce a new high speed rail line without ensuring it is well integrated into the existing railway timetable around it. The headline time savings made possible by these new infrastructure projects can only be experienced by passengers if they are also able to catch an earlier onward connection after leaving the high-speed train, provided their final destination is not the high-speed rail station itself. The same applies in reverse to their starting location. Within many cities, frequent buses, trams and/or local trains make this a non-issue — however, it is when connecting to other mainlines and regional rail lines across the entire wider network where more considered care must be taken toward ensuring the presence of sensible onward connections. In other words, one would do well to strive to reduce passengers' total travel-time along corridors of multiple trains by considering station transfer time in concert with the time spent on the trains themselves, and not merely by relying on decreasing travel-time through speed increases alone.

This problem is exacerbated where highly infrequent connections exist. Once-daily or twice-daily cross-border trains, which are not uncommon in many parts of the continent, substantially weaken the network effect inherent to such a large interconnected railway system and funnel all long-distance passengers wishing to travel on a specific corridor onto the same itinerary. Ensuring that these long-distance, cross-border trajectories are well integrated with one another should therefore be considered a priority, so as to decrease the inefficiency of the network as a whole, which can only be as strong as its weakest link.

1.4. Contribution of this thesis

The primary objective of this thesis is to assign concrete numerical values to the average timetable inefficiency within long-distance European rail corridors, and in so doing, address an identified gap in wider scientific literature, in which no similar analysis was found. To this end, the effects of a comprehensive Europe-wide reduction in transfer times from a hypothetical schedule optimisation will be compared and contrasted to the expected time reduction impact of upcoming high-speed rail projects. The expected results are intended to be able to be used as a basis for justifying practical proposals on how best to implement ambitious, yet realistic time reductions across the European continent, and to bring awareness to the underreported value of increasing the network effect of European passenger railways by capitalising on the currently unused potential inherent to the currently inefficient schedules.

2. Literature Review

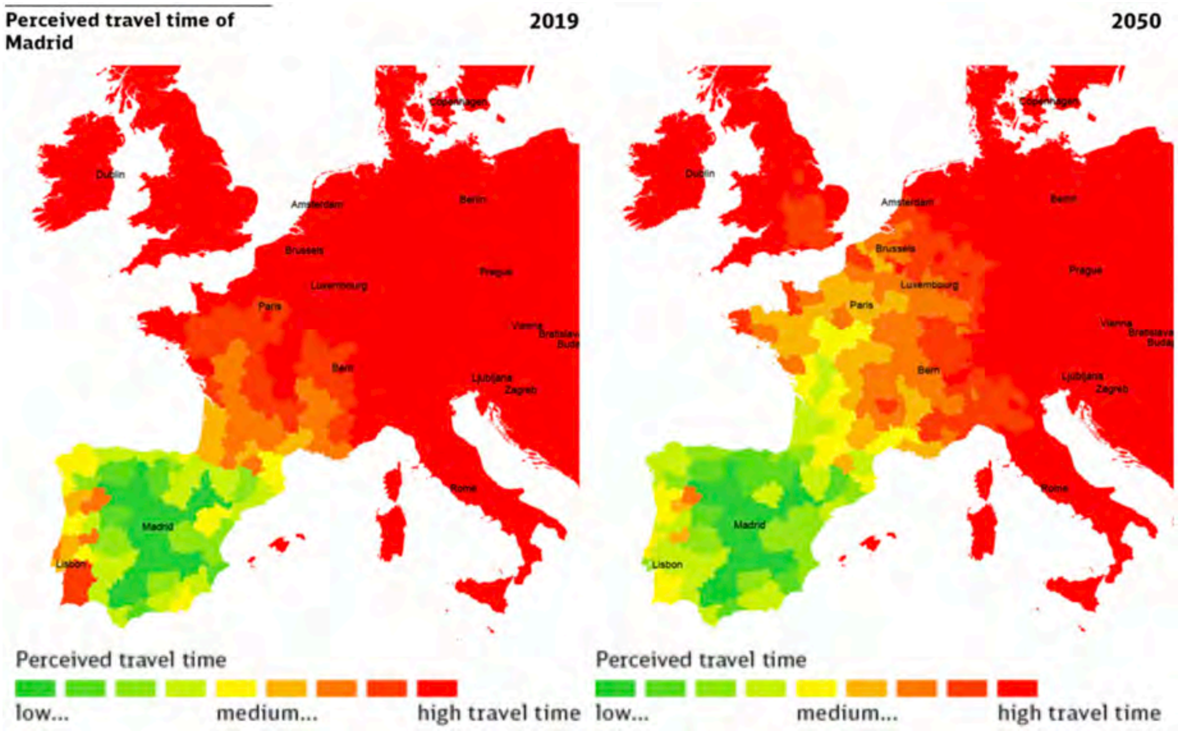
The subject of high-speed rail and travel time savings in a European context is one much investigated. A collaboration spearheaded by Deutsche Bahn (DB) along with ČD, NS, ÖBB, PKP, RENFE, SBB, SNCB, SNCF and Trenitalia delved into the future change in perceived travel time as a result of the introduction of new high-speed rail services (PTV Group, 2019). An increase in future high-speed rail projects is argued for, beyond what is currently planned. Their proposed so-called "Metropolitan Network" as per Figure 2 is particularly focused on providing new 300 km/h lines to areas of Europe currently underserved by high speed rail.

Figure 2 Vision 2050: European Metropolitan Network

Source: (PTV Group, 2019)

Perceived travel time maps were generated to support this point, though this thesis aims to produce more detailed isochrone maps than the NUTS-statistical-region-based ones present in this collaboration of railway operators, such as in Figure 3.

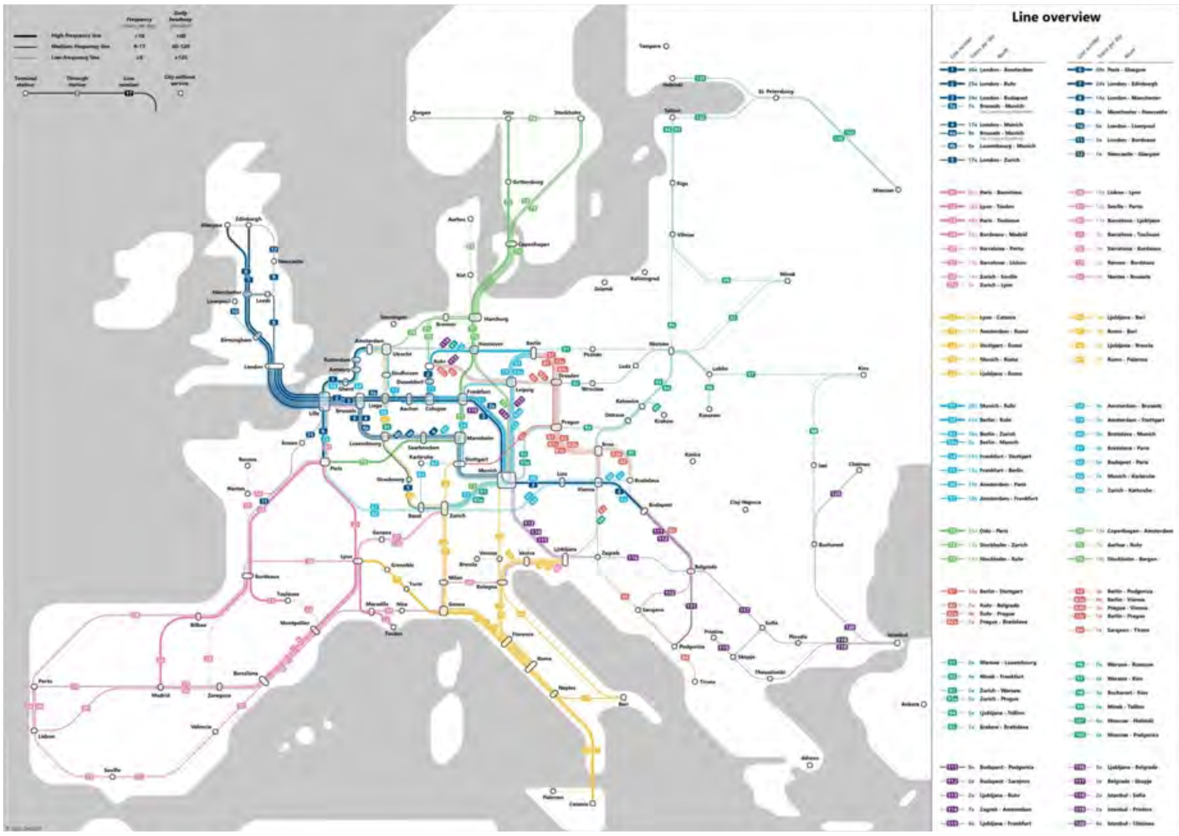
Figure 3 Change in perceived travel time by 2050 from Madrid



Source: (PTV Group, 2019)

Research on high-speed rail in Europe is typically focused on shorter distances under 1000km (BAV, 2021) (Deutschel, 2022), as the prevalence of very-long-distance international trains appear to be going out of fashion, replaced instead by multiple higher-frequency medium-distance services along their former routes (Seidenglanz, 2021). However, longer corridors stand to potentially gain the most in absolute numbers from time-reducing projects along them, making them worthy of a closer look. Attempts have been made to propose continental high-speed network plans such as in Figure 4, strengthening network integration through the lengthening of existing lines past their current termini to better interlink with one another (Grolle et al., 2024). This has the potential to increase efficiency for long-distance travellers, who would need to change trains less often. According to prevailing research, passengers are strongly averse to additional transfers, a reduction of which can therefore noticeably decrease their perceived travel time (Wardman et al., 2001), serving as a pull factor toward rail as the chosen mode for a particular journey. A recent proposal for a similar reactivation of longer-distance daily direct trains, under the moniker of “TransEuropExpress 2.0” (BMDV, 2020) has been described as a “great idea, but with implementation unknown” (Back On Track EU, 2021), outlining the political difficulty of cross-border railway coordination.

Figure 4 Proposed European high-speed rail network plan



Source: Grolle et al. (2024)

As of yet, any similar comprehensive and coordinated plans for European HSR networks remain hypothetical, having never been realised and not currently being openly targeted by the individual national railway companies. The difficulty in cross-border railway coordination has been extensively researched, following which Europe's network has faced criticism for being an "ineffective patchwork of isolated national high-speed lines, with subpar connections between one another" (European Court of Auditors, 2018). To unlock the full benefits of HSR, it is not enough to merely construct the required infrastructure; one must also ensure that high-quality service is present on the newly constructed line. One often-criticised example is that of the Barcelona (Spain) — Perpignan (France) high-speed rail line, first opened in 2013 and part of the wider high-priority Mediterranean Corridor (European Commission, 2023). Despite this, international connections along the line have never been particularly frequent. Originally, SNCF and RENFE collaborated by introducing shared AVE trains following the withdrawal of cross-border night train services, though SNCF unilaterally terminated this 9-year cooperation in 2022 (Haydock, 2022), worsening the situation to such an extent that only two fast trains per direction per day connected Barcelona to France for over half a year. These have since been joined by 2 further AVE trains operated by RENFE in competition with SNCF, making for 4 trains per day and direction (SBB Timetable, 2024). However, the first train in the direction of Barcelona doesn’t arrive until the afternoon, ensuring that travel to the western parts of Iberia necessitate an overnight stop when starting the day north of Barcelona. It is clear that this high-speed rail line has not provided the benefit it could with improved scheduling, and it is conceivable that many trips that would otherwise have been done by rail are being pushed toward alternate modes of transport. This line is not just inefficient in terms of schedules, but also in terms of speed: Despite only seeing scant few departures per day and thus little in the way of conflicting traffic, the original headline time of 50 minutes (Masson, 2009) has never been reached in regular passenger service. Instead, the 182.9 km long route (Signal, 2024) is covered in no faster than 1 hour 20 minutes (SBB Timetable, 2024). The originally planned average speed along this route would have been 219 km/h, around 100 km/h slower than CR’s average speeds from Beijing (China) to Nanjing (China) (318 km/h), and around 50 km/h slower than Ouigo services from Lyon St-Exupéry (France) to Aix-en-Provence (France) (271 km/h) but still on par with average high-speed rail times from Rome (Italy) to Milan (Italy), as can be observed in Table 1. However, the real average speed on launch, which has gone unchanged from the introduction of high-speed trains a decade ago to the present day, is only 137 km/h. This is 40% slower compared to what was originally planned and widely expected in the lead-up to the launch of services (European Commission, 2012), despite the line consisting of lengthy segments having been built to 250 km/h, 290 km/h, and 350 km/h standards at great additional expense and being operated by trainsets capable of reaching 300 km/h. The average speed of 137 km/h, incidentally not too far ahead of the average speed of 129 km/h attained between Los Angeles (USA) and Long Beach (USA) in 1905 (Middleton, 1968), is in fact low enough that this prominent example of an international high-speed rail line appears never to have technically qualified as having had any high-speed service at all, at least, under one definition (Demiridis, 2012), which limits the label “high-speed” to only be applicable when the average running speed of the corridor exceeds 150 km/h, as well as top speeds surpassing 200 km/h. Considering that France and Spain are both otherwise often lauded for their individually successful high-speed rail networks, it is unfortunate that these deficiencies can be observed in the highly symbolic high-speed link connecting both countries. Drawing from this example, this thesis shall be careful to use current average speeds as opposed to the hypothetical top speeds permitted by the infrastructure when evaluating the unused potential, to produce as realistically attainable results as possible, achievable through the consideration of currently timetabled as opposed to hypothetical times.

Table 1 Fastest timetabled average high-speed line speeds between global station pairs

Train	From	To	Distance km	Time min	Speed km/h
250-350 km/h					
1. China (350 km/h)					
G17/G39	Beijing Nan	Nanjing Nan	1021·9	193	317·7
G8/G19/G7/G3/G11/G4	Nanjing Nan	Jinan Xi[1]	616·0	117	315·9
G22	Nanjing Nan	Bejing Nan	1021·9	196	312·8
G1	Jinan Xi	Nanjing	616·0	120	308·0
2. Italy (300 km/h)					
Italo 9955	Milano Rogoredo	Reggio Emilia AV	145·3	32	272·4
Several Italo	Roma Tiburtina	Milano Rogoredo	560·3	158	212·8
Several Frecciarossa	Roma Tiburtina	Milano Rogoredo	560·3	160	210·1
Italo 9907	Roma Termini	Napoli Centrale	222·4	66	202·2
3. France (320 km/h)					
TGV 5479/5441/5422	Champagne-Ardenne TGV	Lorraine TGV[1]	167·6	37	271·8
Ouigo 7851	Lyon St-Exupéry	Aix-en-Provence	289·4	64	271·3
TGV 8505/8500	Paris Montparnasse	Bordeaux St-Jean[1]	537·0	128	251·7
TGV 9561	Paris Est	Strasbourg	439·6	105	251·2
4. Japan (320 km/h)					
Several trains	Omiya	Sendai[1]	294·1	66	267·4
Several trains	Morioka	Sendai[1]	171·1	39	263·2
N52	Kokura	Hiroshima	192·0	44	261·8
N1	Shin Yokohama	Nagoya	316·5	76	249·9
5. Spain (310 km/h)					
AVE 3062	Zaragoza Delicias	Guadalajara-Yebes	242·3	56	259·6
Several trains	Madrid Atocha	Barcelona Sants[1]	621·0	150	248·4
AVE 5149/5340	Requena/Utiel	Cuenca F'do Zóbel[1]	132·4	33	240·6
AVE 5141	Valencia Joaquin Sorolla	Madrid Atocha	391·0	98	239·4
6. Taiwan (300 km/h)					
Several trains	Zuoying	Taichung	179·5	42	256·4
Several trains	Taichung	Banqiao	152·6	38	240·9
200-249 km/h					
7. Germany (300 km/h)					
ICE 772/10	Frankfurt Flughafen	Siegburg/Bonn	143·3	36	238·8
ICE 715/214/1223	Siegburg/Bonn	Montabaur[1]	63·1	18	210·3
Several trains	Halle	Erfurt[1]	92·8	27	206·1
ICE 827	Nürnberg	Ingolstadt	90·1	27	200·2
8. Morocco (300 km/h)					
All trains	Kénitra	Tanger[1]	193·9	50	232·7
9. South Korea (305 km/h)					
KTX 503	Gwangmyeong	Chonan Asan	74·0	20	222·0
Several SRT	Gwangju	Iksan	92·7	27	206·0
Several KTX	Dongdaegu	Daejeon	133·3	40	200·0
Several SRT	Dongdaegu	Daejeon	133·3	40	200·0

Source: Railway Gazette International (2019)

A number of studies have investigated the societal benefits of HSR construction (e.g. Barrón et al., 2009), which are described as being are principally produced by the induced generation of new trips as well as by travel-time savings (Coto-Millán et al., 2007). Some studies have also attempted to determine what travel time reduction can be expected from newly-built HSR in various specific locations. The results range from 34% (Liu et al., 2021), 50% (Bazin et al., 2006), 60% (Gutiérrez, 2001) to as high as 73% between Prague (Czechia) and Wrocław (Poland), representing a reduction of five and a half hours to only one and a half hours (Pinkava, 2018). These percentages well encapsulate the value of high-speed rail, while the large variability highlights how dependent these projects are on the existing local situation to achieve the high time reductions in percentage terms. In other words, it is precisely in the areas with the worst current connections that brand new high-speed rail lines stand to improve the travel time situation by the most. Places that already benefit from a well-developed, efficient train network would presumably find it harder to justify the construction of new, faster lines, as reflected in the lack of true high-speed rail between most Swiss cities. The most prominent counterexample is that of JR’s Chūō ultra-high-speed maglev railway line between Tokyo and Osaka, currently being constructed to relieve the strain on the existing parallel high-speed Tōkaidō Shinkansen line which has reached capacity (Japan Railways Group, 2024). The benefits of this new maglev line, however, do not as clearly outweigh the costs as was initially hoped (Tanaka, 2023). In any case, such an example which surpasses the capabilities of conventional high-speed rail infrastructure is not planned for implementation on the European continent in the coming decades, and can therefore be discounted for the purposes of this thesis.

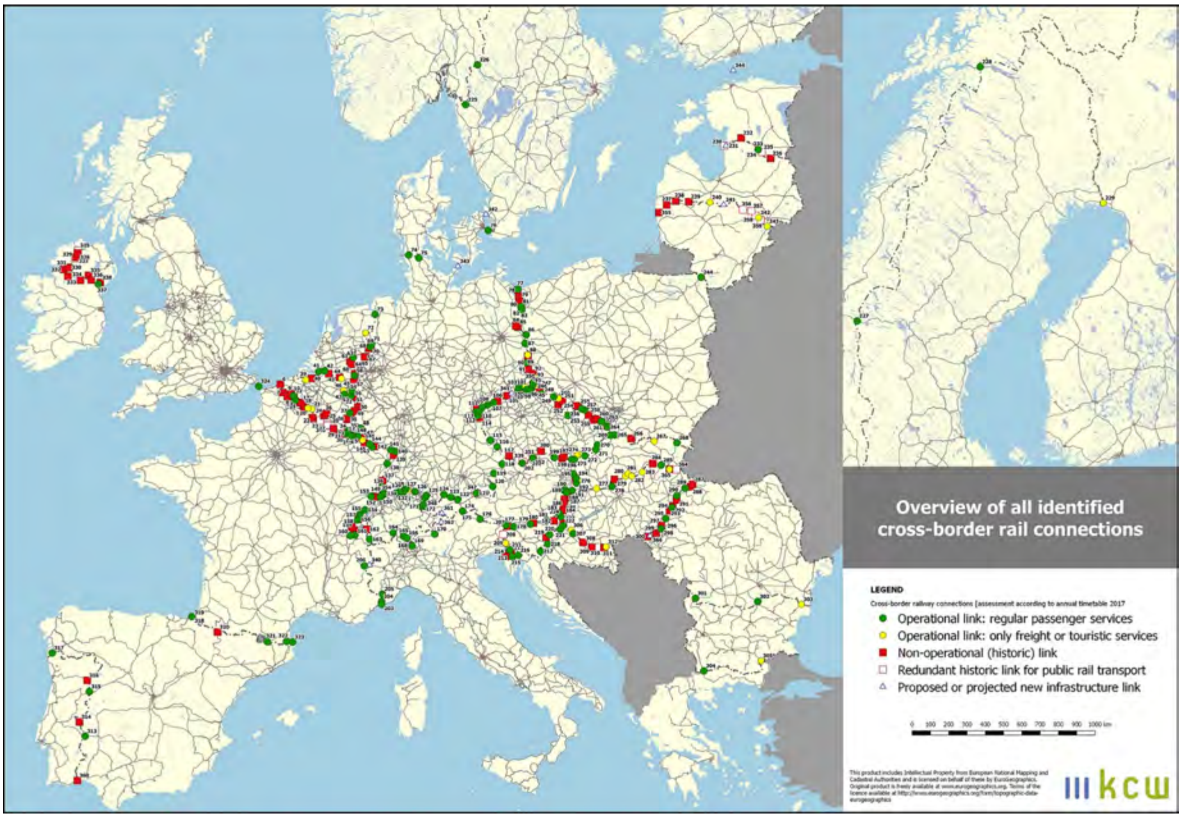
One important question naturally arises: Is it possible to impactfully reduce travel time by any other measure than by building a brand new high-speed rail line? Regarding the aforementioned 5 hours 30 minute example between Prague and Wrocław, this time includes 38 minutes of waiting for the next train on the platforms of intermediate stations. Additionally, the three trains between the two termini will make 43 stops totalling a cumulative minimum of 42 minutes of dwell time, i.e. time spent idling (České Dráhy, 2024). This is without considering the dwell times of the 17 intermediate stations scheduled for departure during the same minute as arrival. A hypothetical non-stop train today, stopping only at Prague and Wrocław as a future high-speed train might, could therefore conservatively take 4 hours 10 minutes. This is a decrease of 25%, before accounting for the 43 times the trains fully decelerate and accelerate for the intermediate stops, which could also be removed to attain even lower travel times.

In this example, it is clear that the potential 25% decrease in travel time achievable by a timetable optimisation is still noticeably inferior to the 73% decrease possible by constructing high-speed rail. The compatibility of this hypothetical service with the existing slower service patterns along the route is also not guaranteed. However, shifting around train departure and arrival times within the technical specifications and abilities of currently existing rolling stock would be both substantially cheaper and faster to implement when compared to building new infrastructure. This strategy of prioritising international timetable optimisation could be used on corridors on which the construction of high-speed rail is today politically inconceivable due to insufficient cost-benefit ratios, ensuring that these areas are able to profit in some way from decreased travel times. It must be noted, however, that even some projects which at one point did not pass or only narrowly passed a cost-benefit analysis (de Rus, 1997) (European Parliament, 2014) ended up showing success in retrospect, so it remains paramount that great care be taken to consider the total possible impact of high-speed rail construction when deciding whether or not to proceed with the project in question.

Conventional night trains have seen a European resurgence in recent years after an intermediate period of decay, due in no small part to increased environmentally conscious travel behaviour becoming ever more common among Europeans (Curtale et al., 2023) (Kantelaar et al., 2022). Arguments could be made in favour of the next step up from conventional night trains — namely brand new high-speed sleeper services. Globally, these are currently only operated by CR in Mainland China as D-trains between such major cities as Beijing, Shanghai, Guangzhou and Xi'An (China Railway, 2024). Corridors reaching a length of 2000-3500 km are no longer served by direct trains in Europe after the suspension of RZD's direct weekly Moscow-Berlin-Paris and Moscow-Vienna-Nice trains in 2020, and the gradual decline in reach of the Orient Express connecting Western Europe to Turkey during the 20th century. Conventional night trains today cover approximately 1200 km per 12-hour period (DB Mobility Networks Logistics, 2014), around half the length possible through the use of higher-speed "Very Long Distance Night Trains" (DB Mobility Networks Logistics, 2013).

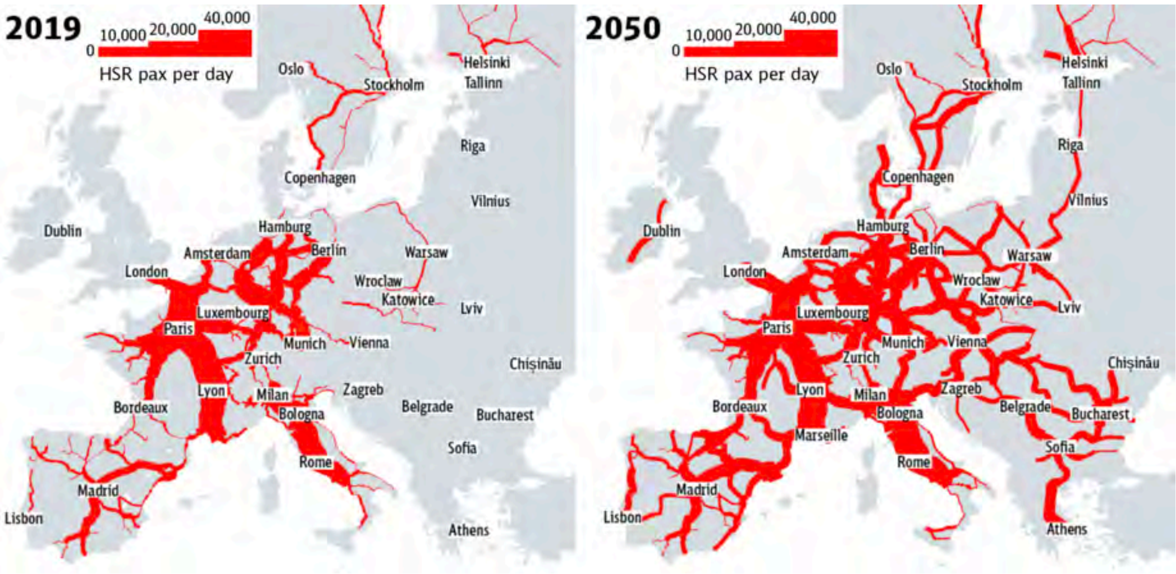
Known to many residents of border areas as well as to the scientific community at large, cross-border rail services are severely lacking throughout large parts of Europe (European Commission, 2018) as seen in Figure 5. While border crossings no longer serve to impede passengers as much as before the implementation of the Schengen Agreement, despite continuing to inconvenience much of South East Europe (Miltiadou et al., 2017), their effects can still be felt in the way many national networks evolved independently of one another in the previous century, often leading to bottlenecks at the points they come in contact with one another. This is true both for transporting passengers as well as freight (Shan et al., 2024). These regional frontiers have been described as crucial systemic barriers (Medeiros et al., 2021), which constitute roadblocks in the way toward unraveling the full potential of closer European territorial integration. One such example is that of the Baltic states, where during a recent multi-year period there was no train connecting Lithuania to Latvia or Poland at all. While it is nowadays once again possible to travel by rail from Tallinn to Warsaw, the current timetable does little to make rail an attractive option, as shall be detailed in Section 3.

Figure 5	Overview of European cross-border rail connections



Source: European Commission (2018)

Figure 6	Past vs expected HSR passenger volumes by 2050

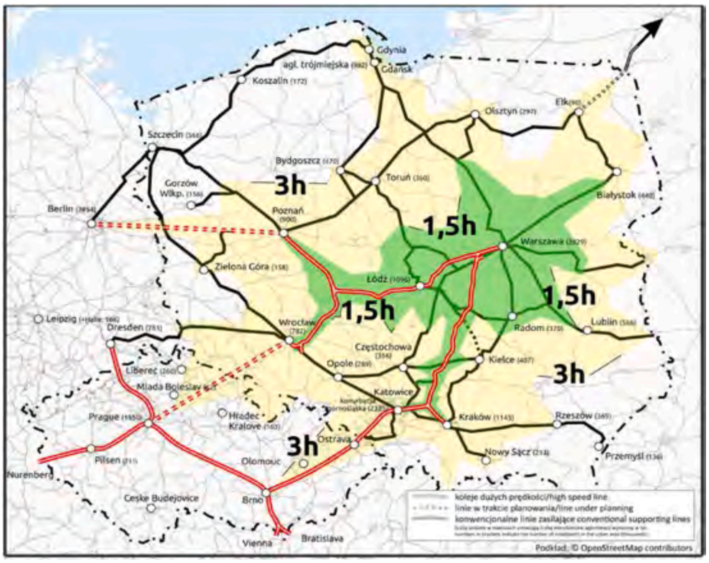


Source: PTV Group (2019)

The overwhelming majority of research done on potential travel time reduction has been found to pertain to the construction of high-speed rail. The predicted HSR passenger volume increase by 2050 as seen in Figure 6 is certainly large enough to justify the quantity of research toward this travel time reduction strategy. To reach this ambitious target number of future passengers, multiple daily HSR trains are assumed to be required by 2050 along all red-highlighted routes, with the highest amount of passengers concentrated in the central portions, and the highest improvement in travel time to be found in areas currently lacking fast trains.

However, beyond just the traditional travel time reduction strategy of the construction of high-speed rail, the analytical portion of this thesis will be focused on comparing current timetables with potentially optimised timetables and timetables that take future infrastructure improvements into account, specifically along cross-continental rail corridors chosen to have a high degree of pan-European relevance. To this end, a variety of robust sources for future high-speed rail travel times will be considered, cross-referenced and compared to the currently available project status. Of these, the Trans-European Railway High-Speed Master Plan Study (United Nations Economic Commission for Europe, 2022) is particularly useful and provides an nearly exhaustive overview of current and future high-speed rail projects on the continent, containing a compendium of many figures such as Figure 7 showcasing individual countries' plans (here: Poland's) of future reachability improvements, to be used as a basis for a collection of future travel time links.

Figure 7 Future travel time from Warsaw with a future Polish HSR network



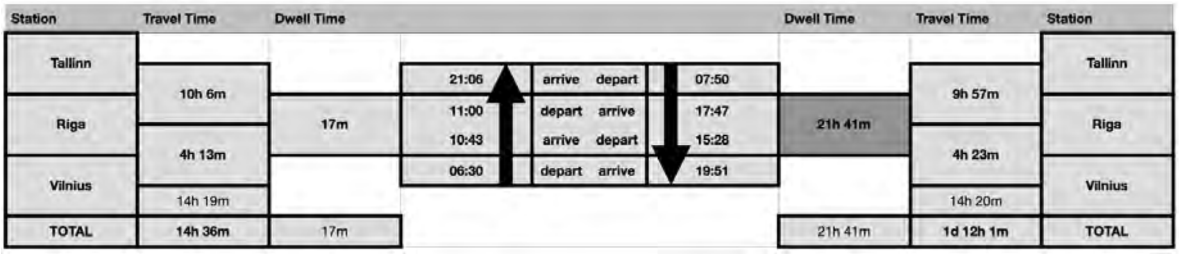
Source: Rady Ministrów (Uchwała Nr 276, 2008)

3. Problem description

3.1.1. Example timetable inefficiency

In Europe today there are many corridors along which train travel is particularly inefficiently timetabled. An strong example of this is when travelling along the current Baltic corridor from Tallinn (Estonia) via Riga (Latvia) to Vilnius (Lithuania). Currently, this corridor only sees one existing rail connection every 24 hours (Elron, 2024) (Pasažieru Vilciens, 2024) (Lietuvos Geležinkeliai, 2024), namely the one displayed in Table 2:

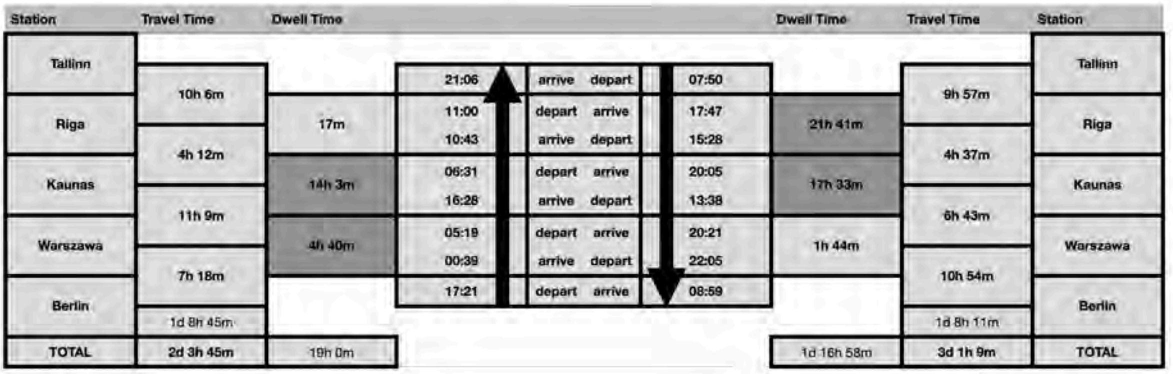
Table 2 Current Vilnius — Tallinn — Vilnius timetable



Station	Travel Time	Dwell Time						Dwell Time	Travel Time	Station
Tallinn			21:06	↑	arrive	depart	↓	07:50			Tallinn
	10h 6m								9h 57m	
Riga		17m	11:00		depart	arrive		17:47	21h 41m		Riga
			10:43		arrive	depart		15:28			
	4h 13m								4h 23m	
Vilnius	14h 19m		06:30		depart	arrive		19:51		14h 20m	Vilnius
TOTAL	14h 36m	17m						21h 41m	1d 12h 1m	TOTAL

From this timetable, it can be gleaned that both northbound and southbound passengers will spend nearly an identical amount of time on a moving train — 14 hours 19 minutes and 14 hours 20 minutes respectively. However, while northbound passengers benefit from only a 17-minute change of train in Riga, southbound passengers must wait 21 hours and 41 minutes before they can expect their onward train to depart. Despite spending roughly the same amount of time on the trains themselves, southbound travel therefore takes 2.47x as long as northbound travel. Needless to say, this is not a timetable that can be considered attractive for travel between Estonia and Lithuania, and will likely cause passengers to turn their consideration to direct bus or plane connections instead. The passengers that are inclined to travel southbound by train are thus forced into an overnight layover, something which has been observed by local media as leading to an uptick in overnight hotel stays in Riga since the launching of this newest timetable (Zalāne, 2024). Indeed, at least half of all rail passengers travelling on the Vilnius-Riga train currently plan to stay in a hotel in either city. This is doubtlessly beneficial to local tourism and specifically to the providers of accommodation but it is ultimately not conducive to increasing the modal share of rail for longer trips in the region, beyond just these two capital cities.

Table 3 Current Berlin — Tallinn — Berlin timetable



Station	Travel Time	Dwell Time					Dwell Time	Travel Time	Station
Tallinn			21:06	arrive	depart	07:50			Tallinn
	10h 6m							9h 57m	
Riga		17m	11:00 10:43	depart arrive	arrive depart	17:47 15:28	21h 41m		Riga
	4h 12m							4h 37m	
Kaunas		14h 3m	06:31 16:28	depart arrive	arrive depart	20:05 13:38	17h 33m		Kaunas
	11h 9m							6h 43m	
Warszawa		4h 40m	05:19 00:39	depart arrive	arrive depart	20:21 22:05	1h 44m		Warszawa
	7h 18m							10h 54m	
Berlin			17:21	depart	arrive	08:59			Berlin
	1d 8h 45m							1d 8h 11m	
TOTAL	2d 3h 45m	19h 0m					1d 16h 58m	3d 1h 9m	TOTAL

Assuming one were to want to travel between Estonia and Western Europe by train, the arrival in Lithuania would not be the end of the timetable inefficiency. As can be seen in the next timetable, the next obstacle along the fastest route would be the daily Lithuania — Poland train, which is not aligned with the daily Latvia — Lithuania train and therefore requires an overnight wait of 17 hours 33 minutes in Kaunas. After arriving in Warsaw (Poland), there are multiple onward daily trains, and therefore only a smaller, but still substantial wait of 1 hour 44 minutes must be taken into account before continuing on towards Berlin (Germany) and the rest of Western Europe.

Travelling in the other direction from Berlin to Tallinn, one encounters a 4 hour 40 minute overnight change in Warsaw and a 14 hour 3 minute change in Kaunas on either side of the once-daily Poland-Lithuania train, which leaves Poland too early to permit same-day transfers for almost all origin cities in Central Europe aside from Warsaw and Krakow. This means that the fastest Estonia-bound Berlin-Tallinn train route has exactly 19 hours of dwell time spent waiting for a connection in the shown cities, whereas its Germany-bound counterpart is approximately 22 hours less efficient, with a total dwell time of 1 day 16 hours 58 minutes. Combined with the very similar time spent on a moving train in both instances (1 day 8 hours 45 minutes vs 1 day 8 hours 11 minutes), the total travel time between the termini of this line adds up to 3 days 1 hour 9 minutes southbound, but approximately a whole day faster northbound at 2 days 3 hours 45 minutes.

This example goes to show that whilst time spent moving is an important, much-studied element worth considering when studying long-distance train travel in Europe, inefficient connections along the corridor one wishes to travel on can turn a somewhat feasible train trip into an infeasible one. A well-coordinated strategy of neighbouring countries with the goal of dwell time reduction along their shared railway corridors would have clearly been a worthwhile investment in this particular case. Unjustifiably long dwell times at stations should therefore be deliberately minimised so as to increase the attractiveness of rail for long-distance passengers, and eliminate the potential for unnecessary weak spots to appear in the passenger rail network of Europe — as touched upon in the introduction, such a network is only as strong as its weakest link.

3.1.2. Research questions

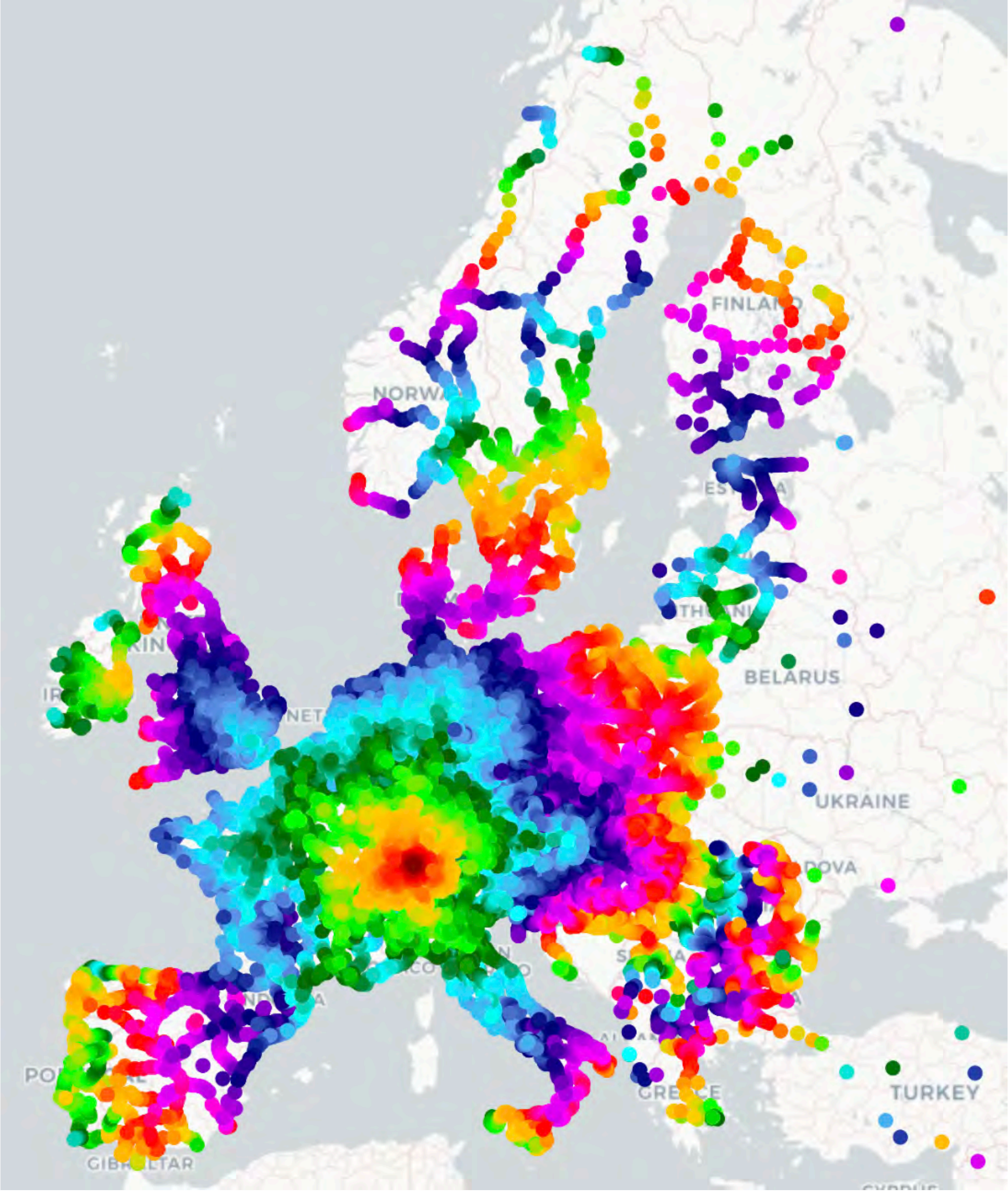
In order to more effectively argue in favour of this point, more data is required. The degree to which long dwell times are impacting long-distance is therefore what much of the rest of this thesis aims to pursue. To this end, the following research questions emerge: What concrete average time reduction would a continent-wide timetable optimisation have on long-distance inter-European travel? How does this contrast to the expected average time reduction from the implementation of ongoing high-speed rail projects? Additionally, provided a randomly chosen origin, what would the impact of a pan-European timetable optimisation have on the reachability of the continent? An expectation is for the reachability difference to increasingly improve post-optimisation compared to the current situation the further one gets from the origin, as the longer a transcontinental route is, the less likely it would appear to be for the constituent parts of the corridor to have been timetabled with contiguous end-to-end travel in mind.

Fundamentally, this thesis aims to compare and contrast the improvement of a continent-spanning timetable optimisation approach to that of a point-to-point time reduction approach through ongoing high-speed rail infrastructure projects. In taking this two-pronged approach to the question of how best to reduce long-distance travel time in Europe, the intent is not to take away from the potential of valuable new high-speed rail lines to reduce travel time, nor to undermine their importance, but instead to highlight how they may be implemented in a conscious and coordinated manner with dwell time reductions in order to achieve the greatest possible time reduction effects across Europe.

4. Methods

4.1. Weighted graph based on Dijkstra’s algorithm

Figure 8 Stations included in the model



Basemap: Carto Positron (2024)

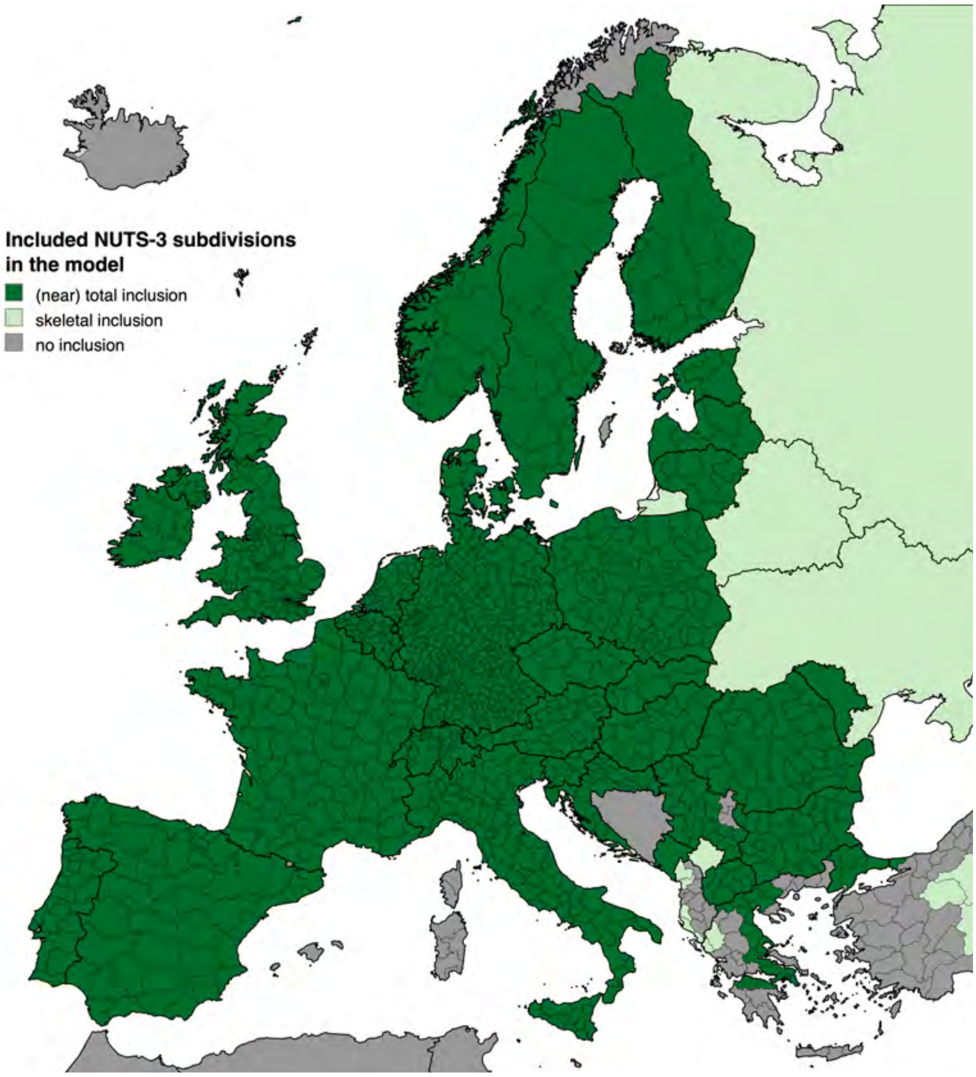
At the core of this analysis lies a large mathematical model of Europe's railways, created in Python from a weighted graph based upon Dijkstra's algorithm. This required many thousands of nodes, representing the overwhelming majority of the individual stations of Europe (as visible in Figure 8), and a higher number of links, which represent the shortest currently existing timetabled time between these stations. It is the link database and the ensuing analyses made possible from its transformation into a weighted graph which represent the largest contribution of this thesis to the scientific literature, as no prior public attempts to explore this research area have been identified. This thesis aims to rectify the current unavailability of this type of data by creating a Europe-wide model of the current state of railway links in 2024. Dijkstra's algorithm permits the efficient chaining together of links to compute the fastest hypothetical time in which any two desired stations may be connected, once dwell time at the stations along the way is taken into account. Similarly, the Bellman-Ford algorithm was used in the process of setting up the model, returning identical results to the Dijkstra algorithm. An advantage of both these shortest path graphs is that the origin node/station can be changed at will, making this model a powerful origin-independent tool for comprehensive long-distance analyses. Through various implementations of kriging interpolation, the model can be used to plot different isochrone maps, which shall be further detailed in Section 5.

4.1.1. Nodes

Models are, as a rule, created after assuming certain reductions in complexity of the system they are attempting to portray (Stachowiak, 1973). This case is no exception, however, it was determined that it would be beneficial to include as many stations as possible in the model to ensure that potential faster alternate routes not go undiscovered, as well as to enhance the planned isochronic visualisations' level of detail and accuracy. To this end, the node database is comprised of 31616 nodes, representing every single mainline station and almost all branch line stations in Austria, Belgium, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, the Netherlands, North Macedonia, Moldova, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, the United Kingdom, as well as most stations in Greece, Montenegro and Serbia. The corresponding NUTS-3 statistical regions can be seen in dark green in Figure 9, where light green shows the areas that lend a supplementary, skeletal function to the network, namely Albania, Belarus, Kosovo, Russia, Turkey and Ukraine. Bosnia and Herzegovina and Mediterranean islands excepting Sicily were left out of the model, as well as regions without trains (Finnmark, Iceland, etc.), and are displayed in grey.

A variety of publicly available datasets (DB, 2024) (ÖBB, 2024) (SBB, 2024) (FEVE, 2024) (Trainline, 2024) were used for the compilation of all the stations along with their coordinates, to which the ISO 3166-1 country and ISO 3166-2 subdivision codes were added. For the thousands of stations not covered in these datasets, manual coordinate retrieval was undertaken (Apple Maps, 2024) (Google Maps, 2024), which was also regularly needed for dataset error correction. The names of the stations were compared to the names kept by the Swiss Federal Railways (SBB, 2024) and Deutsche Bahn (DB, 2024), which in a few thousand cases were added to a separate column to streamline the later web-scraping task. The names for the stations often varied by dataset due to differing local naming conventions, so attention was paid to ensure no two stations were labelled with the same name.

Figure 9 Geographical completeness of the model



Basemap: Mapchart (2024)

4.1.2. Current Links

Alongside nodes, the other half of a mathematical weighted graph are links, which in this model represent the shortest travel time currently timetabled between neighbouring stations. The graph contains 34168 such links, meaning that every station connects to an average of 2.16 other stations. The vast majority of these links are train nodes, but where necessary, ferries and buses were also included as well as some short pedestrian links between stations. Where known, the track-kilometre distance of each link was included for increased accuracy when later calculating average speeds. These values for each link were sourced by web-scraping the SBB timetable website (SBB Timetable, 2024), to automatically return the fastest current connection linking any two supplied stations after comparing multiple dates throughout the year, as well as on different days of the week so as to consider potential weekday-weekend timetable differences. Idle time was added to the web-scraping program between the hundreds of thousands of individual requests to minimise the burden on the SBB and thereby adhere to existing ethical principles (Kriesel, 2019) (Singstat, 2024), bringing the total continuous runtime to nearly two weeks. In thousands of cases, this web-scraping program was not able to be used to find out the minimal travel times, as the SBB does not have access to any data from the entirety of multiple European countries, and it lacks a number of branch lines in Italy, Spain and others, particularly those not operated by the main operator of the relevant country. These links were added manually, referring in most cases to publicly available printed timetables, and occasionally to the online planners of the appropriate operators. In a few cases, the web-scraping tool failed to execute within included territory, often due to character limitations (such as over one hundred stations throughout mostly Ireland and the UK containing the character “&”) but also due to cases affected by construction work. In these instances, further manual verification was undertaken to include the individual base times as per the train service provider.

In order to accurately display potential timings along branch lines, times along a set corridor between major stops were proportionally adjusted to correspond to the movement of the fastest currently timetabled connection. This did not impact the timings generated between any major stations, yet served to include all intermediate stations between two major stations as part of the route, increasing accuracy in terms of cumulative distance along the corridors, as well as smoothening out the isochronic visualisations. In every instance of quadruple-track railway corridors, these were treated as two separate lines and the parallel local stations were not given the same proportional generalisation as the express track, so as to retain a high degree of faithfulness to the local track geometry and later provide realistic routing suggestions.

4.1.3. Future Links

In order to be able to analyse the cumulative impact of ongoing high-speed rail projects in Europe, their minimal travel times were included in a separate dataset. This could then be added to or removed from the mathematical graph as needed in order to compare travel times with or without future infrastructure. The target date of 2050 was selected for all “future times”, as 2050 is the year by which most ongoing projects are set to have been completed. Additionally, the planned end date of construction as well as individual sources for the future timings were added to the dataset. The future link dataset compiles 171 connections, most of which were found and verified using various press releases and planning documents, often in conjunction with translating software (deepL, 2024). Their impact on the model can be directly interpreted from the isochronic visualisations included in the appendix of this thesis.

4.1.4. Example graph insight

As the Dijkstra-derived model portrays an idealised timetable with dwell time removed, it is possible to visually plot the shortest paths and in so doing, confirm the shortest potential routing. In the vast majority of cases, the temporally-optimal hypothetical routing corresponds to what long-distance operators today choose to run their services along, but in some unique cases, this is not the case. A telling such example is to be found in Figure 10, along the so-called TEN-T Magistrale / Main Line for Europe corridor, specifically on this portion of the Munich (Germany) — Vienna (Austria) line, between Munich and Wels (Austria):

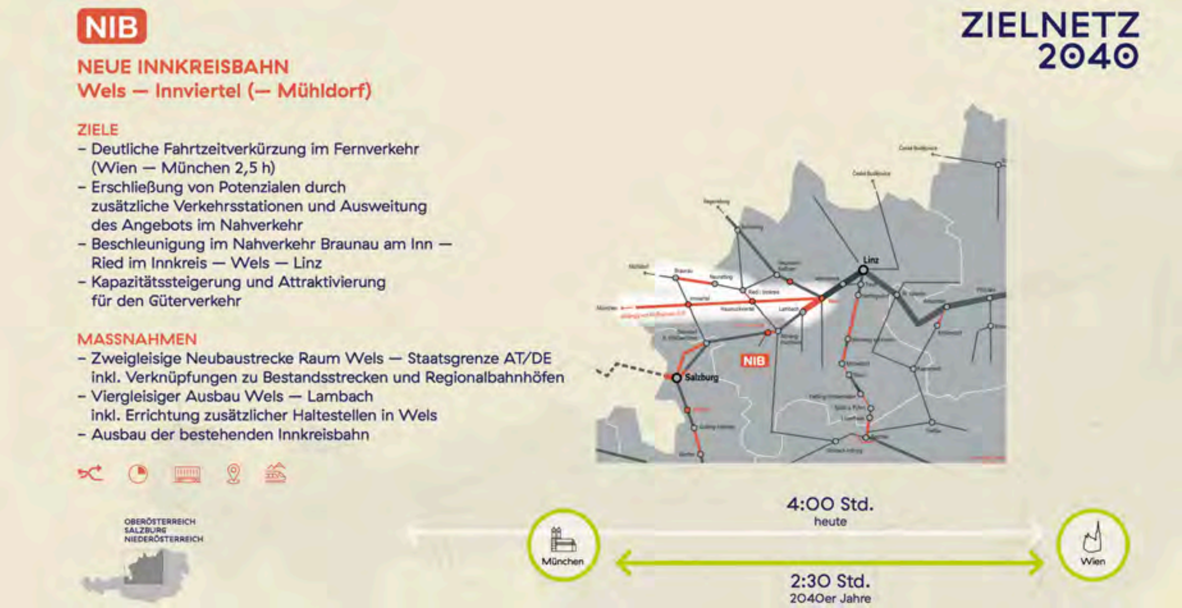
Figure 10 Dijkstra-modelled paths between Munich (left) and Wels (right)

Basemap: OpenStreetMap (2024)

Currently, fast non-stop trains (EC, EN IC, ICE, RJ, RJX, WB) travel partially or completely via the southern route from Munich to Salzburg in order to travel eastward. The northern route via Mühldorf am Inn is today only used by less frequent regional trains, on account of it being unelectrified and still extensively single-tracked. If one were to travel along this northern route today, it would take over one hour longer than the southern route via Salzburg. However, if one were to sum up all the individual travel times between the stations along the northern route, removing all dwell time, one could reach Wels in less time than the southern route currently takes. This shows the unused potential of this northern routing, which if it could be double-tracked and electrified, would represent a viable alternate route for direct Munich-Vienna trains.

The Austrian Federal Railways (ÖBB) appear to have arrived at a similar conclusion about the unused potential of the northern route, as they have recently declared their intent to ready a high-speed line (the so-called "Neue Innkreisbahn") along precisely this corridor by 2040 (ÖBB Infra, 2024), made possible by existing plans to soon electrify the remaining German portion of the line (DB InfraGO AG, 2024). It stands to reason that if this corridor is even today theoretically slightly faster (though indeed not practically due to its aforementioned physical limitations) than the southern route, then the construction of a new high-speed rail line along the Austrian portion of it will serve to firmly establish it as the new routing of the Magistrale for Europe, instead of the current path via Salzburg.

Figure 11 Zielnetz 2040 showcasing the Neue Innkreisbahn's northern routing



NIB

NEUE INNKREISBAHN
Wels — Innviertel (— Mühldorf)

ZIELE
- Deutliche Fahrtzeitverkürzung im Fernverkehr (Wien — München 2,5 h)
- Erschließung von Potenzialen durch zusätzliche Verkehrsstationen und Ausweitung des Angebots im Nahverkehr
- Beschleunigung im Nahverkehr Braunau am Inn — Ried im Innkreis — Wels — Linz
- Kapazitätssteigerung und Attraktivierung für den Güterverkehr

MASSNAHMEN
- Zweigleisige Neubaustrecke Raum Wels — Staatsgrenze AT/DE inkl. Verknüpfungen zu Bestandsstrecken und Regionalbahnhöfen
- Viergleisiger Ausbau Wels — Lambach inkl. Errichtung zusätzlicher Haltestellen in Wels
- Ausbau der bestehenden Innkreisbahn

Source: ÖBB Infra (2024)

4.2. Corridors

4.2.1. Corridor selection

The European Commission’s TEN-T Core Network Corridors Schematic map displayed in Figure 1 was used as a basis from which to select similar corridors to analyse in greater detail. For the sake of simplicity, corridors without branch lines were preferred. Additionally, care was taken to ensure that the chosen corridors each represented various aspects of typical long-distance travel in Europe, and to ensure that ample geographic variability as well as variety relating to average current travel speed was present. These selection criteria resulted in the ten corridors as listed in Table 4 and as mapped in Figure 12. The intermediate stations were selected from the major cities and important railway junctions along the route at which (almost) all long-distance services currently stop. In total, the ten selected corridors pass through 30 countries, a large majority of those considered in the model. There is a wide variety of services along these, with some comprising of substantially more high-speed rail than others. There is also a meaningful variety in terms of frequency along these corridors, ranging from once to nine times per day (SBB Timetable, 2024).

Table 4 Overview of the corridors selected for further analysis

Corridor	Terminus	Intermediate stations	Terminus
Corridor 1	Narvik	Boden, Umeå, Gävle, Stockholm, Malmö, Københavnm Hamburg, Hannover, Würzburg, Nürnburg, München, Innsbruck, Verona, Bologna, Firenze, Roma, Napoli, Salerno, Villa San Giovanni, Messina, Palermo	Trapani
Corridor 2	Rostock	Berlin, Dresden, Ústí nad Labem, Praha, Brno, Břeclav, Bratislava, Budapest, Arad, Timișoara, Craiova, Sofia, Thessaloniki, Athens	Patras
Corridor 3	Paris	Strasbourg, Stuttgart, Ulm, Augsburg, München, Linz, Wien, Budapest, Novi Sad, Belgrade, Niš, Sofia, Plovdiv, Dimitrovgrad, Svilengrad, Edirne	İstanbul
Corridor 4	Cádiz	Sevilla, Córdoba, Madrid, Zaragoza, Lleida, Tarragona, Barcelona, Perpignan, Montpellier, Lyon, Torino, Milano, Verona, Venezia, Trieste, Ljubljana, Zagreb, Budapest, Debrecen, Záhony	Chop
Corridor 5	Luleå	Haparanda, Tornio, Oulu, Tampere, Helsinki, Tallinn, Riga, Panevėžys, Kaunas, Białystok, Warszawa, Łódź, Poznań, Frankfurt (Oder), Berlin, Hannover, Bielefeld, Hamm, Köln, Aachen, Liège, Brussel, Gent, Brugge	Oostende
Corridor 6	Groningen	Lelystad, Amsterdam, Rotterdam, Brussel, Lille, London, Birmingham, Crewe, Carlisle, Edinburgh, Stirling, Perth, Inverness	Thurso
Corridor 7	Amsterdam	Utrecht, Düsseldorf, Köln, Frankfurt, Mannheim, Karlsruhe, Basel, Zürich, Lugano, Milano, Genova	Ventimiglia
Corridor 8	Ventimiglia	Nice, Marseille, Lyon, Mulhouse, Strasbourg, Metz, Luxembourg, Brussel	Amsterdam
Corridor 9	Paris	Bordeaux, Hendaye, San Sebastián, Vitoria-Gasteiz, Burgos, Valladolid, Madrid, Badajoz	Lisboa
Corridor 10	Lecce	Bari, Ancona, Bologna, Padova, Venezia, Udine, Klagenfurt, Graz, Wien, Ostrava, Katowice, Łódź, Warszawa, Gdańsk	Gdynia

Figure 12 Map of the corridors selected for further analysis

It is of note that the continued and future high passenger demand for rail transport along these routes can be demonstrated either in the current presence of multiple daily trains along their route, or, where this is not a given, in their estimated future passenger volume per day as determined in a collaboration of major European passenger railway operators in Figure 6. The expected HSR passenger per day values as indicated in the legend of Figure 6 imply that sufficient demand to justify traditional as well as high-speed night-train services would exist along the corridors of Figure 12, considering most are long enough to surpass a day's travel time. While this is not actively planned by the national railway companies of Europe, Corridors 1, 2, 3, 5 and 10 would appear to best fit the requirements for the introduction of longer night train services, be they high-speed or conventional multi-day services.

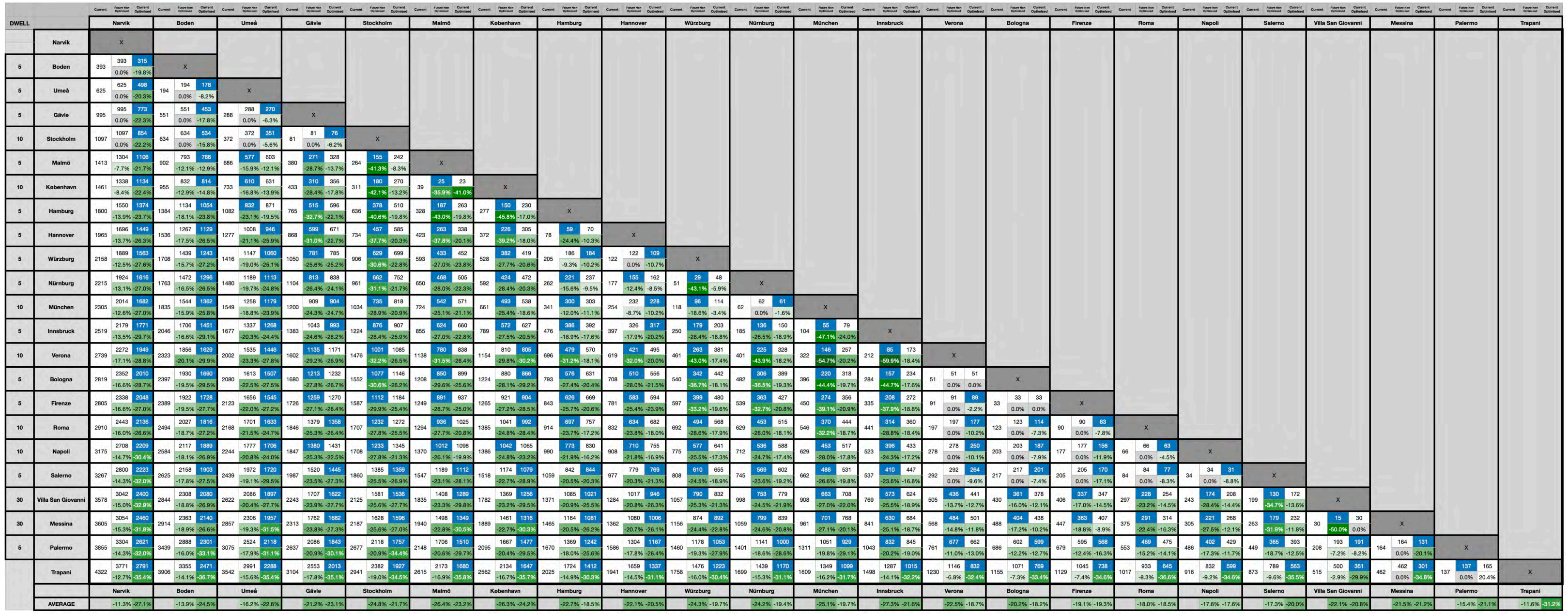
4.2.2. Corridor tables

Once the corridors had been selected, the next step was to generate tables comparing the currently scheduled times with two distinct approaches of time reduction. The following explanation of how to read these tables relate to the example of Corridor 1 (Narvik — Trapani) showcased in Table 5:

The stations along the corridor are listed once vertically on the left, and once horizontally at the top. At each tabled junction between any two stations along the corridor, three separate time values expressed as a total number of minutes can be found. The first is the minimal number of minutes the journey takes today, according to existing timetables (SBB Timetable, 2024). The second is the estimated future, non-optimised travel time by 2050, calculated by subtracting the publicly announced travel time improvements as collated in the future link database outlined in Section 4.1.3 from the current-day, non-optimised timetable. The third is the number of minutes that is calculated to be realistically attainable after an optimisation of the current timetable, which comprises the calculated value of time spent moving inside the train via the discussed Dijkstra algorithm in addition to minute values relating to station dwell time as indicated on the leftmost side of the tables.

The smallest of these three minute values (current time, future non-optimised time, potential current optimised time) is highlighted in blue for increased readability, and their variation from the current value is indicated as a percentage coloured in increasingly dark shades of green. Finally, all time improvement percentages for every possible station pairing along the corridor are averaged into a single value per station, displayed in green on the bottom row. It is immediately noticeable from the positioning of the blue cells that some stations would benefit more from future infrastructure projects than others, which would benefit more from a timetable optimisation relating to travel along this specific corridor. This step was then repeated for each of the ten corridors, which can be found in their entirety in the appendix.

Table 5 Corridor 1: Comparison of current, future and potential travel times



		Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL		Narvik			Boden			Umeå			Gävle		
	Narvik	X											
5	Boden	393	393 0.0%	315 -19.8%	X								
5	Umeå	625	625 0.0%	498 -20.3%	194	194 0.0%	178 -8.2%	X					
5	Gävle	995	995 0.0%	773 -22.3%	551	551 0.0%	453 -17.8%	288	288 0.0%	270 -6.3%	X		
10	Stockholm	1097	1097 0.0%	854 -22.2%	634	634 0.0%	534 -15.8%	372	372 0.0%	351 -5.6%	81	81 0.0%	76 -6.2%
5	Malmö	1413	1304 -7.7%	1106 -21.7%	902	793 -12.1%	786 -12.9%	686	577 -15.9%	603 -12.1%	380	271 -28.7%	328 -13.7%
10	København	1461	1338 -8.4%	1134 -22.4%	955	832 -12.9%	814 -14.8%	733	610 -16.8%	631 -13.9%	433	310 -28.4%	356 -17.8%
5	Hamburg	1800	1550 -13.9%	1374 -23.7%	1384	1134 -18.1%	1054 -23.8%	1082	832 -23.1%	871 -19.5%	765	515 -32.7%	596 -22.1%
5	Hannover	1965	1696 -13.7%	1449 -26.3%	1536	1267 -17.5%	1129 -26.5%	1277	1008 -21.1%	946 -25.9%	868	599 -31.0%	671 -22.7%
5	Würzburg	2158	1889 -12.5%	1563 -27.6%	1708	1439 -15.7%	1243 -27.2%	1416	1147 -19.0%	1060 -25.1%	1050	781 -25.6%	785 -25.2%
5	Nürnburg	2215	1924 -13.1%	1616 -27.0%	1763	1472 -16.5%	1296 -26.5%	1480	1189 -19.7%	1113 -24.8%	1104	813 -26.4%	838 -24.1%
10	München	2305	2014 -12.6%	1682 -27.0%	1835	1544 -15.9%	1362 -25.8%	1549	1258 -18.8%	1179 -23.9%	1200	909 -24.3%	904 -24.7%
5	Innsbruck	2519	2179 -13.5%	1771 -29.7%	2046	1706 -16.6%	1451 -29.1%	1677	1337 -20.3%	1268 -24.4%	1383	1043 -24.6%	993 -28.2%
10	Verona	2739	2272 -17.1%	1949 -28.8%	2323	1856 -20.1%	1629 -29.9%	2002	1535 -23.3%	1446 -27.8%	1602	1135 -29.2%	1171 -26.9%
5	Bologna	2819	2352 -16.6%	2010 -28.7%	2397	1930 -19.5%	1690 -29.5%	2080	1613 -22.5%	1507 -27.5%	1680	1213 -27.8%	1232 -26.7%
5	Firenze	2805	2338 -16.6%	2048 -27.0%	2389	1922 -19.5%	1728 -27.7%	2123	1656 -22.0%	1545 -27.2%	1726	1259 -27.1%	1270 -26.4%
10	Roma	2910	2443 -16.0%	2136 -26.6%	2494	2027 -18.7%	1816 -27.2%	2168	1701 -21.5%	1633 -24.7%	1846	1379 -25.3%	1358 -26.4%
10	Napoli	3175	2708 -14.7%	2209 -30.4%	2584	2117 -18.1%	1889 -26.9%	2244	1777 -20.8%	1706 -24.0%	1847	1380 -25.3%	1431 -22.5%
5	Salerno	3267	2800 -14.3%	2223 -32.0%	2625	2158 -17.8%	1903 -27.5%	2439	1972 -19.1%	1720 -29.5%	1987	1520 -23.5%	1445 -27.3%
30	Villa San Giovanni	3578	3042 -15.0%	2400 -32.9%	2844	2308 -18.8%	2080 -26.9%	2622	2086 -20.4%	1897 -27.7%	2243	1707 -23.9%	1622 -27.7%
30	Messina	3605	3054 -15.3%	2460 -31.8%	2914	2363 -18.9%	2140 -26.6%	2857	2306 -19.3%	1957 -31.5%	2313	1762 -23.8%	1682 -27.3%
5	Palermo	3855	3304 -14.3%	2621 -32.0%	3439	2888 -16.0%	2301 -33.1%	3075	2524 -17.9%	2118 -31.1%	2637	2086 -20.9%	1843 -30.1%
	Trapani	4322	3771 -12.7%	2791 -35.4%	3906	3355 -14.1%	2471 -36.7%	3542	2991 -15.6%	2288 -35.4%	3104	2553 -17.8%	2013 -35.1%
		Narvik			Boden			Umeå			Gävle		
	AVERAGE		-11.3%	-27.1%		-13.9%	-24.5%		-16.2%	-22.6%		-21.2%	-23.1%

		Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL		Stockholm			Malmö			København			Hamburg		
10	Stockholm	X											
5	Malmö	264	155 -41.3%	242 -8.3%	X								
10	København	311	180 -42.1%	270 -13.2%	39	25 -35.9%	23 -41.0%	X					
5	Hamburg	636	378 -40.6%	510 -19.8%	328	187 -43.0%	263 -19.8%	277	150 -45.8%	230 -17.0%	X		
5	Hannover	734	457 -37.7%	585 -20.3%	423	263 -37.8%	338 -20.1%	372	226 -39.2%	305 -18.0%	78	59 -24.4%	70 -10.3%
5	Würzburg	906	629 -30.6%	699 -22.8%	593	433 -27.0%	452 -23.8%	528	382 -27.7%	419 -20.6%	205	186 -9.3%	184 -10.2%
5	Nürnburg	961	662 -31.1%	752 -21.7%	650	468 -28.0%	505 -22.3%	592	424 -28.4%	472 -20.3%	262	221 -15.6%	237 -9.5%
10	München	1034	735 -28.9%	818 -20.9%	724	542 -25.1%	571 -21.1%	661	493 -25.4%	538 -18.6%	341	300 -12.0%	303 -11.1%
5	Innsbruck	1224	876 -28.4%	907 -25.9%	855	624 -27.0%	660 -22.8%	789	572 -27.5%	627 -20.5%	476	386 -18.9%	392 -17.6%
10	Verona	1476	1001 -32.2%	1085 -26.5%	1138	780 -31.5%	838 -26.4%	1154	810 -29.8%	805 -30.2%	696	479 -31.2%	570 -18.1%
5	Bologna	1552	1077 -30.6%	1146 -26.2%	1208	850 -29.6%	899 -25.6%	1224	880 -28.1%	866 -29.2%	793	576 -27.4%	631 -20.4%
5	Firenze	1587	1112 -29.9%	1184 -25.4%	1249	891 -28.7%	937 -25.0%	1265	921 -27.2%	904 -28.5%	843	626 -25.7%	669 -20.6%
10	Roma	1707	1232 -27.8%	1272 -25.5%	1294	936 -27.7%	1025 -20.8%	1385	1041 -24.8%	992 -28.4%	914	697 -23.7%	757 -17.2%
10	Napoli	1708	1233 -27.8%	1345 -21.3%	1370	1012 -26.1%	1098 -19.9%	1386	1042 -24.8%	1065 -23.2%	990	773 -21.9%	830 -16.2%
5	Salerno	1860	1385 -25.5%	1359 -26.9%	1547	1189 -23.1%	1112 -28.1%	1518	1174 -22.7%	1079 -28.9%	1059	842 -20.5%	844 -20.3%
30	Villa San Giovanni	2125	1581 -25.6%	1536 -27.7%	1835	1408 -23.3%	1289 -29.8%	1782	1369 -23.2%	1256 -29.5%	1371	1085 -20.9%	1021 -25.5%
30	Messina	2187	1628 -25.6%	1596 -27.0%	1940	1498 -22.8%	1349 -30.5%	1889	1461 -22.7%	1316 -30.3%	1465	1164 -20.5%	1081 -26.2%
5	Palermo	2677	2118 -20.9%	1757 -34.4%	2148	1706 -20.6%	1510 -29.7%	2095	1667 -20.4%	1477 -29.5%	1670	1369 -18.0%	1242 -25.6%
	Trapani	2941	2382 -19.0%	1927 -34.5%	2615	2173 -16.9%	1680 -35.8%	2562	2134 -16.7%	1647 -35.7%	2025	1724 -14.9%	1412 -30.3%
		Stockholm			Malmö			København			Hamburg		
	AVERAGE		-24.8%	-21.7%		-26.4%	-23.2%		-26.3%	-24.2%		-22.7%	-18.5%

		Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL		Hannover			Würzburg			Nürnburg			München		
5	Hannover	X											
5	Würzburg	122	122 0.0%	109 -10.7%	X								
5	Nürnburg	177	155 -12.4%	162 -8.5%	51	29 -43.1%	48 -5.9%	X					
10	München	254	232 -8.7%	228 -10.2%	118	96 -18.6%	114 -3.4%	62	62 0.0%	61 -1.6%	X		
5	Innsbruck	397	326 -17.9%	317 -20.2%	250	179 -28.4%	203 -18.8%	185	136 -26.5%	150 -18.9%	104	55 -47.1%	79 -24.0%
10	Verona	619	421 -32.0%	495 -20.0%	461	263 -43.0%	381 -17.4%	401	225 -43.9%	328 -18.2%	322	146 -54.7%	257 -20.2%
5	Bologna	708	510 -28.0%	556 -21.5%	540	342 -36.7%	442 -18.1%	482	306 -36.5%	389 -19.3%	396	220 -44.4%	318 -19.7%
5	Firenze	781	583 -25.4%	594 -23.9%	597	399 -33.2%	480 -19.6%	539	363 -32.7%	427 -20.8%	450	274 -39.1%	356 -20.9%
10	Roma	832	634 -23.8%	682 -18.0%	692	494 -28.6%	568 -17.9%	629	453 -28.0%	515 -18.1%	546	370 -32.2%	444 -18.7%
10	Napoli	908	710 -21.8%	755 -16.9%	775	577 -25.5%	641 -17.3%	712	536 -24.7%	588 -17.4%	629	453 -28.0%	517 -17.8%
5	Salerno	977	779 -20.3%	769 -21.3%	808	610 -24.5%	655 -18.9%	745	569 -23.6%	602 -19.2%	662	486 -26.6%	531 -19.8%
30	Villa San Giovanni	1284	1017 -20.8%	946 -26.3%	1057	790 -25.3%	832 -21.3%	998	753 -24.5%	779 -21.9%	908	663 -27.0%	708 -22.0%
30	Messina	1362	1080 -20.7%	1006 -26.1%	1156	874 -24.4%	892 -22.8%	1059	799 -24.6%	839 -20.8%	961	701 -27.1%	768 -20.1%
5	Palermo	1586	1304 -17.8%	1167 -26.4%	1460	1178 -19.3%	1053 -27.9%	1401	1141 -18.6%	1000 -28.6%	1311	1051 -19.8%	929 -29.1%
	Trapani	1941	1659 -14.5%	1337 -31.1%	1758	1476 -16.0%	1223 -30.4%	1699	1439 -15.3%	1170 -31.1%	1609	1349 -16.2%	1099 -31.7%
		Hannover			Würzburg			Nürnburg			München		
	AVERAGE		-22.1%	-20.5%		-24.3%	-19.7%		-24.2%	-19.4%		-25.1%	-19.7%

		Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL		Innsbruck			Verona			Bologna			Firenze		
5	Innsbruck	X											
10	Verona	212	85 -59.9%	173 -18.4%	X								
5	Bologna	284	157 -44.7%	234 -17.6%	51	51 0.0%	51 0.0%	X					
5	Firenze	335	208 -37.9%	272 -18.8%	91	91 0.0%	89 -2.2%	33	33 0.0%	33 0.0%	X		
10	Roma	441	314 -28.8%	360 -18.4%	197	197 0.0%	177 -10.2%	123	123 0.0%	114 -7.3%	90	90 0.0%	83 -7.8%
10	Napoli	523	396 -24.3%	433 -17.2%	278	278 0.0%	250 -10.1%	203	203 0.0%	187 -7.9%	177	177 0.0%	156 -11.9%
5	Salerno	537	410 -23.6%	447 -16.8%	292	292 0.0%	264 -9.6%	217	217 0.0%	201 -7.4%	205	205 0.0%	170 -17.1%
30	Villa San Giovanni	769	573 -25.5%	624 -18.9%	505	436 -13.7%	441 -12.7%	430	361 -16.0%	378 -12.1%	406	337 -17.0%	347 -14.5%
30	Messina	841	630 -25.1%	684 -18.7%	568	484 -14.8%	501 -11.8%	488	404 -17.2%	438 -10.2%	447	363 -18.8%	407 -8.9%
5	Palermo	1043	832 -20.2%	845 -19.0%	761	677 -11.0%	662 -13.0%	686	602 -12.2%	599 -12.7%	679	595 -12.4%	568 -16.3%
	Trapani	1498	1287 -14.1%	1015 -32.2%	1230	1146 -6.8%	832 -32.4%	1155	1071 -7.3%	769 -33.4%	1129	1045 -7.4%	738 -34.6%
		Innsbruck			Verona			Bologna			Firenze		
	AVERAGE		-27.3%	-21.6%		-22.5%	-18.7%		-20.2%	-18.2%		-19.1%	-19.3%

		Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL		Roma			Napoli			Salerno			Villa San Giovanni		
10	Roma	X											
10	Napoli	66	66 0.0%	63 -4.5%	X								
5	Salerno	84	84 0.0%	77 -8.3%	34	34 0.0%	31 -8.8%	X					
30	Villa San Giovanni	297	228 -23.2%	254 -14.5%	243	174 -28.4%	208 -14.4%	199	130 -34.7%	172 -13.6%	X		
30	Messina	375	291 -22.4%	314 -16.3%	305	221 -27.5%	268 -12.1%	263	179 -31.9%	232 -11.8%	30	15 -50.0%	30 0.0%
5	Palermo	553	469 -15.2%	475 -14.1%	486	402 -17.3%	429 -11.7%	449	365 -18.7%	393 -12.5%	208	193 -7.2%	191 -8.2%
	Trapani	1017	933 -8.3%	645 -36.6%	916	832 -9.2%	599 -34.6%	873	789 -9.6%	563 -35.5%	515	500 -2.9%	361 -29.9%
		Roma			Napoli			Salerno			Villa San Giovanni		
	AVERAGE		-18.0%	-18.5%		-17.6%	-17.6%		-17.3%	-20.0%		-22.1%	-20.8%

		Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL		Messina			Palermo			Trapani		
30	Messina	X								
5	Palermo	164	164 0.0%	131 -20.1%	X					
	Trapani	462	462 0.0%	301 -34.8%	137	137 0.0%	165 20.4%	X		
		Messina			Palermo			Trapani		
	AVERAGE		-21.5%	-21.2%		-15.4%	-21.1%		-11.6%	-31.2%

4.3. Sample timetables

4.3.1. Current timetables

The next step involved not only comparing the separate strategies of adding future infrastructure and a potential timetable optimisation, but rather analysing both effects in unison. To this end, three sample timetables per corridor have been created — one showcasing the status quo, the next the potential current situation after an optimisation, and the last one additionally considering the impact of future rail projects. To start with, the current-day fastest timetable along each corridor was collected bidirectionally and set up as in the example of Corridor 3:

Table 6 Corridor 3: Current Timetable

Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
Paris				3050 km				Paris
			10:38	arrive depart	10:52			
	1h 46m						1h 46m	
Strasbourg		5m	08:52 08:47	depart arrive arrive depart	12:38 12:42	4m		Strasbourg
	2h 48m						1h 22m	
Stuttgart		51m	05:59 05:08	depart arrive arrive depart	14:04 14:51	47m		Stuttgart
	58m						43m	
Ulm		2m	04:10 04:08	depart arrive arrive depart	15:34 15:36	2m		Ulm
	39m						41m	
Augsburg		2m	03:29 03:27	depart arrive arrive depart	16:17 16:19	2m		Augsburg
	35m						30m	
München		6m	02:52 02:46	depart arrive arrive depart	16:49 17:30	41m		München
	3h 16m						2h 45m	
Linz		2m	23:30 23:28	depart arrive arrive depart	20:15 20:17	2m		Linz
	1h 33m						1h 15m	
Wien		35m	21:55 21:20	depart arrive arrive depart	21:32 21:40	8m		Wien
	2h 40m						2h 42m	
Budapest		31m	18:40 18:09	depart arrive arrive depart	00:22 05:50	5h 28m		Budapest
	9h 14m						13h 6m	
Novi Sad		10m	08:55 08:45	depart arrive arrive depart	18:56 19:00	4m		Novi Sad
	36m						36m	
Belgrade		54m	08:09 07:15	depart arrive arrive depart	19:36 21:30	1h 54m		Belgrade
	3h 15m						4h 19m	
Niš		10h 0m	04:00 18:00	depart arrive arrive depart	01:49 04:40	2h 51m		Niš
	3h 0m						4h 10m	
Sofia		1h 10m	16:00 14:50	depart arrive arrive depart	09:50 10:30	40m		Sofia
	2h 59m						2h 37m	
Plovdiv		4m	11:51 11:47	depart arrive arrive depart	13:07 13:12	5m		Plovdiv
	58m						58m	
Dimitrovgrad		1h 34m	10:49 09:15	depart arrive arrive depart	14:10 16:08	1h 58m		Dimitrovgrad
	55m						54m	
Svilengrad		5h 39m	08:20 02:41	depart arrive arrive depart	17:02 01:25	8h 23m		Svilengrad
	1h 49m						1h 18m	
Edirne		22m	00:52 00:30	depart arrive arrive depart	02:43 02:48	5m		Edirne
	4h 30m						3h 46m	
Istanbul		47.9 km/h	20:00	depart arrive	06:34	45.7 km/h		Istanbul
	1d 17h 31m						1d 19h 28m	
TOTAL	2d 15h 38m	22h 7m				23h 14m	2d 18h 42m	TOTAL

In creating this timetable, the stations which are currently associated with the most dwell time can be easily identified, and a greater understanding of exactly which specific segments are least conducive to efficient travel along this corridor can be achieved. This methodology therefore allows for a reliable identification of problematic weak-spots along the corridors. In cases where no trains are currently available (in Table 6 only between Niš and Sofia), existing bus connections were used instead. Over the entirety of Corridor 3 between Paris and Istanbul, a cumulative dwell time inefficiency of almost one whole day has been measured, which when considered as a proportion of the time spent moving in trains (namely, approximately one and three-quarter days) makes clear that over a third of the total travel time from end to end is currently lost to inefficient transfers.

4.3.2. Optimised current timetables

To reduce this inefficiency as far as reasonably possible, specific dwell times of 5 minutes or 10 minutes are set in this next step, depending on the simplicity of the track geometry. Terminal stations are assumed to have longer stops than through stations, as turnaround time must be considered. At certain stations, border procedures are taken into account and a much longer dwell time is assumed. These dwell times are combined with the shortest potential current-day travel time as calculated with the Dijkstra algorithm explained in Section 4.1. to create a sample timetable for what could be achieved today by adjusting train departure times along this corridor to connect with one another. The resulting Table 7 is therefore a dramatically faster timetable which does not necessitate the construction of any additional, costly high-speed infrastructure. As can be read from the bottom row, these conservative optimisation measures alone would result in an end-to-end time reduction of over 40% as opposed to the current timetable along this corridor, and the cumulative total dwell time lost while en route can be reduced to just over three hours along the entire route.

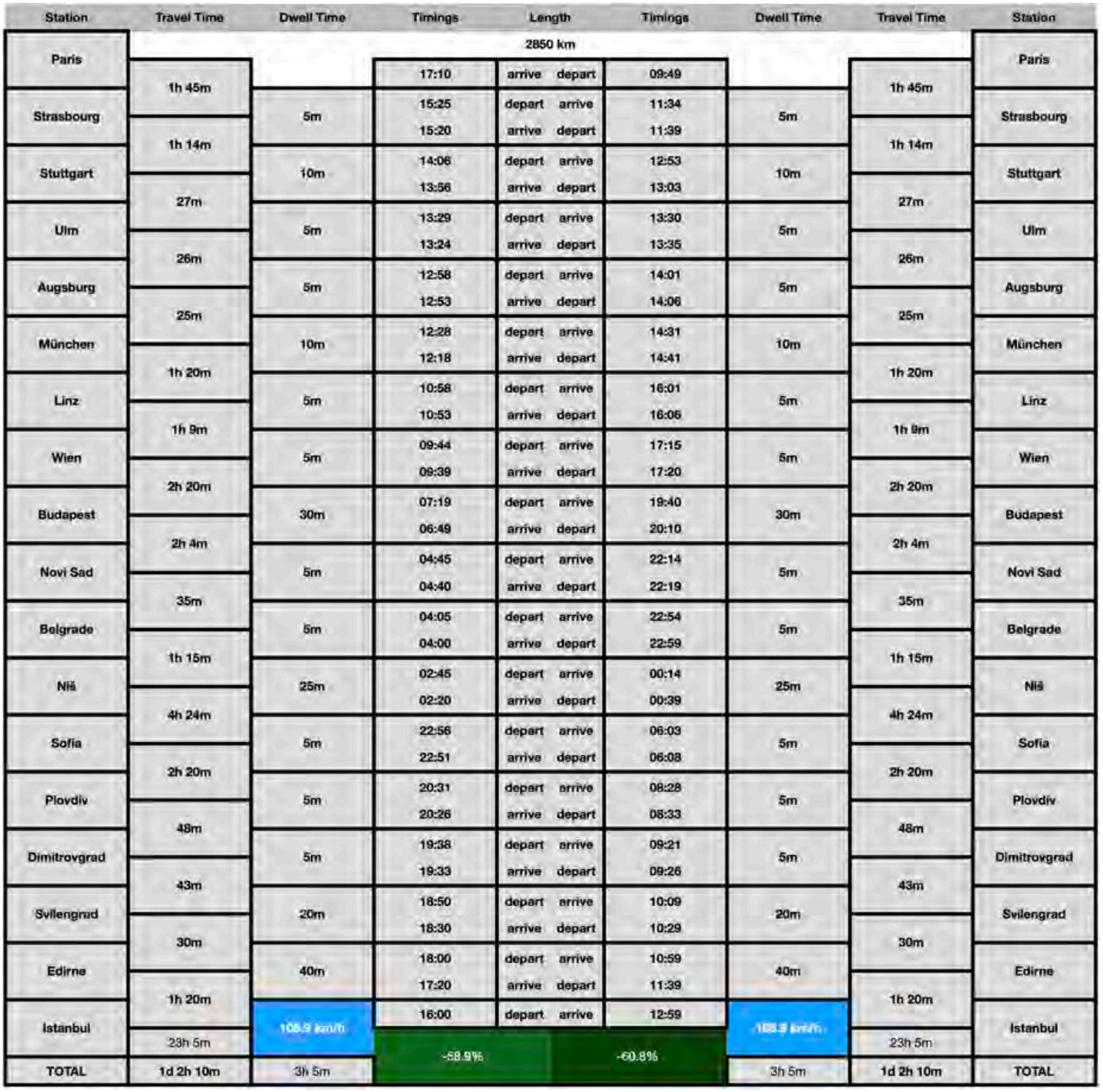
Table 7 Corridor 3: Optimised Timetable

Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				3050 km				
Paris			17:01	arrive depart	10:19			Paris
	1h 45m						1h 45m	
Strasbourg		5m	15:16 15:11	depart arrive arrive depart	12:04 12:09	5m		Strasbourg
	1h 14m						1h 14m	
Stuttgart		10m	13:57 13:47	depart arrive arrive depart	13:23 13:33	10m		Stuttgart
	41m						41m	
Ulm		5m	13:06 13:01	depart arrive arrive depart	14:14 14:19	5m		Ulm
	38m						38m	
Augsburg		5m	12:23 12:18	depart arrive arrive depart	14:57 15:02	5m		Augsburg
	25m						25m	
München		10m	11:53 11:43	depart arrive arrive depart	15:27 15:37	10m		München
	2h 26m						2h 26m	
Linz		5m	09:17 09:12	depart arrive arrive depart	18:03 18:08	5m		Linz
	1h 9m						1h 9m	
Wien		5m	08:03 07:58	depart arrive arrive depart	19:17 19:22	5m		Wien
	2h 22m						2h 22m	
Budapest		30m	05:36 05:06	depart arrive arrive depart	21:44 22:14	30m		Budapest
	6h 14m						6h 14m	
Novi Sad		5m	22:52 22:47	depart arrive arrive depart	04:28 04:33	5m		Novi Sad
	35m						35m	
Belgrade		5m	22:12 22:07	depart arrive arrive depart	05:08 05:13	5m		Belgrade
	4h 10m						4h 10m	
Niš		25m	17:57 17:32	depart arrive arrive depart	09:23 09:48	25m		Niš
	4h 24m						4h 24m	
Sofia		5m	14:08 14:03	depart arrive arrive depart	15:12 15:17	5m		Sofia
	2h 20m						2h 20m	
Plovdiv		5m	11:43 11:38	depart arrive arrive depart	17:37 17:42	5m		Plovdiv
	48m						48m	
Dimitrovgrad		5m	10:50 10:45	depart arrive arrive depart	18:30 18:35	5m		Dimitrovgrad
	43m						43m	
Svilengrad		20m	10:02 09:42	depart arrive arrive depart	19:18 19:38	20m		Svilengrad
	34m						34m	
Edirne		40m	09:08 08:28	depart arrive arrive depart	20:12 20:52	40m		Edirne
	3h 38m						3h 38m	
Istanbul		82.0 km/h	04:50	depart arrive	00:30	82.0 km/h		Istanbul
	1d 10h 6m		-41.6%		-44.3%		1d 10h 6m	
TOTAL	1d 13h 11m	3h 5m				3h 5m	1d 13h 11m	TOTAL

4.3.3. Optimised future timetables

In a final step, the influence of high-speed rail infrastructure set for completion before 2050 is taken into account. This is done by modifying the appropriate travel times while retaining the previously determined dwell times as determined for Table 7, resulting in Table 8:

Table 8 Corridor 3: Optimised Future Timetable



Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				2850 km				
Paris			17:10	arrive depart	09:49			Paris
	1h 45m						1h 45m	
Strasbourg		5m	15:25 15:20	depart arrive arrive depart	11:34 11:39	5m		Strasbourg
	1h 14m						1h 14m	
Stuttgart		10m	14:06 13:56	depart arrive arrive depart	12:53 13:03	10m		Stuttgart
	27m						27m	
Ulm		5m	13:29 13:24	depart arrive arrive depart	13:30 13:35	5m		Ulm
	26m						26m	
Augsburg		5m	12:58 12:53	depart arrive arrive depart	14:01 14:06	5m		Augsburg
	25m						25m	
München		10m	12:28 12:18	depart arrive arrive depart	14:31 14:41	10m		München
	1h 20m						1h 20m	
Linz		5m	10:58 10:53	depart arrive arrive depart	16:01 16:06	5m		Linz
	1h 9m						1h 9m	
Wien		5m	09:44 09:39	depart arrive arrive depart	17:15 17:20	5m		Wien
	2h 20m						2h 20m	
Budapest		30m	07:19 06:49	depart arrive arrive depart	19:40 20:10	30m		Budapest
	2h 4m						2h 4m	
Novi Sad		5m	04:45 04:40	depart arrive arrive depart	22:14 22:19	5m		Novi Sad
	35m						35m	
Belgrade		5m	04:05 04:00	depart arrive arrive depart	22:54 22:59	5m		Belgrade
	1h 15m						1h 15m	
Niš		25m	02:45 02:20	depart arrive arrive depart	00:14 00:39	25m		Niš
	4h 24m						4h 24m	
Sofia		5m	22:56 22:51	depart arrive arrive depart	06:03 06:08	5m		Sofia
	2h 20m						2h 20m	
Plovdiv		5m	20:31 20:26	depart arrive arrive depart	08:28 08:33	5m		Plovdiv
	48m						48m	
Dimitrovgrad		5m	19:38 19:33	depart arrive arrive depart	09:21 09:26	5m		Dimitrovgrad
	43m						43m	
Svilengrad		20m	18:50 18:30	depart arrive arrive depart	10:09 10:29	20m		Svilengrad
	30m						30m	
Edirne		40m	18:00 17:20	depart arrive arrive depart	10:59 11:39	40m		Edirne
	1h 20m						1h 20m	
Istanbul		108.9 km/h	16:00	depart arrive	12:59	108.9 km/h		Istanbul
	23h 5m		-58.9%		-60.8%		23h 5m	
TOTAL	1d 2h 10m	3h 5m				3h 5m	1d 2h 10m	TOTAL

Yet another large improvement in end-to-end travel time can be observed, with the difference to Table 8 being entirely due to the effects of new, faster infrastructure. Depending on whether the westbound or eastbound route is considered, an improvement of just under or just over 60% appears possible, which represents well over a day and a half's travel time saved when compared to the current-day timetable. After repeating this process for the 10 corridors, the 30 sample timetables along with the previously prepared corresponding 10 station tables are thus well suited for further analysis as per Section 5.3. The completed tables can be found in the appendix for reference.

5. Results & Analysis

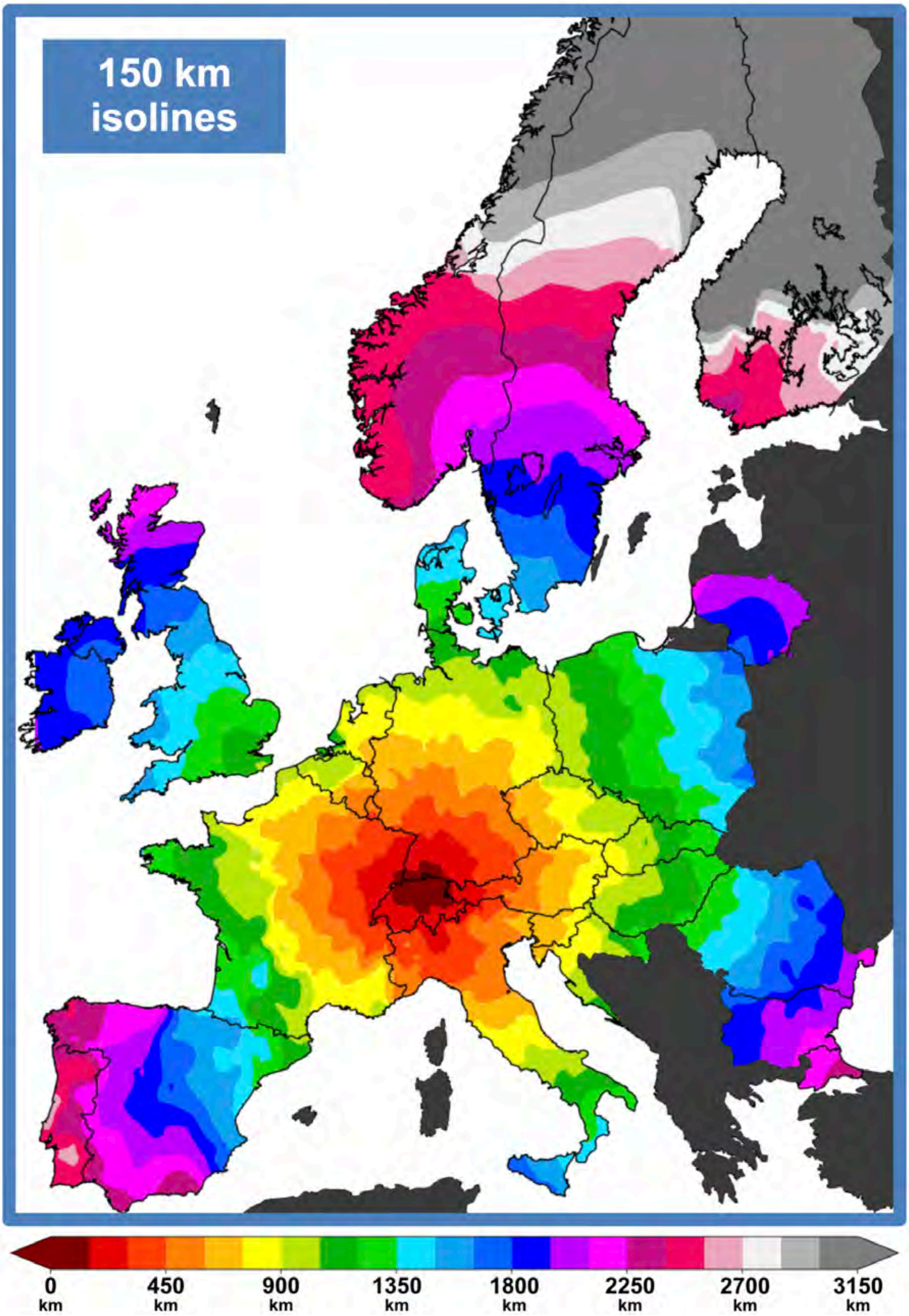
5.1. Results of the isochronic visualisations

For the duration of Section 5.1., Zurich (Switzerland) has been chosen as the example city with which to showcase the resulting isochronic visualisations of the mathematical weighted graph previously mentioned. This is due in large part to Zurich being centrally located within Europe, and at the crossroads between various north/south and east/west corridors to the neighbouring countries and beyond, making for an ideal showcase of the different effects discussed in this section. In the appendix, four isochrone maps for a selection of 46 further major European cities are provided.

5.1.1. Distance map

In order to be able to generate speed maps, the distances to each individual station in Europe must first be known. The map in Figure 13 shows how many cumulative kilometres are covered on transit when travelling along the fastest route between Zurich Main Station (Zürich HB) and the nearest railway station for all valid areas of the map. It was created by using kriging interpolation (also known as Gaussian process regression) following the routing determined by Dijkstra's algorithm as introduced in 4.1. and using kilometre values as determined whilst creating the database of European links (Signal, 2024). When an exact track-kilometre value is not known, the geodesic value is taken instead. The distorting effects of different countries' track geometry influence the resulting map in various ways: While Italy's distance progression is quite uniform, France's is much less regular due to trips to the southwest of the country necessitating a long detour through Paris first. The area where the fastest route switches from a more direct path to a routing via Paris shows itself as a sudden increase in distance, quickly progressing through the 150 kilometre isolines. The same phenomenon is visible within the territory of Spain, another country with a particularly radial high-speed network based on Madrid. Paying attention to Belgium, the area in which a routing via the French high speed rail network (passing through the outskirts of Paris and Lille) is preferred over the more direct (but slower) routing via Luxembourg shows up as a very narrow 750-900 kilometre yellow band. These examples demonstrate that often, the route which is longer in terms of distance can be shorter in terms of time when high-speed rail is involved.

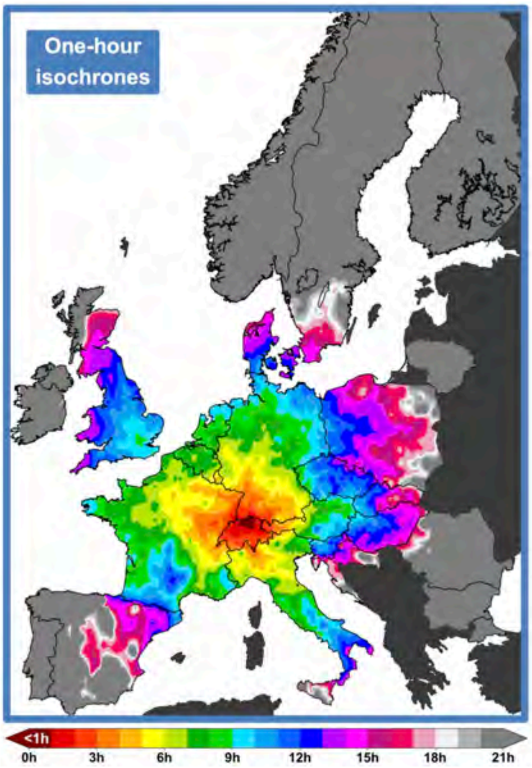
Figure 13 Europe's current cumulative public transport route length from Zurich [km]

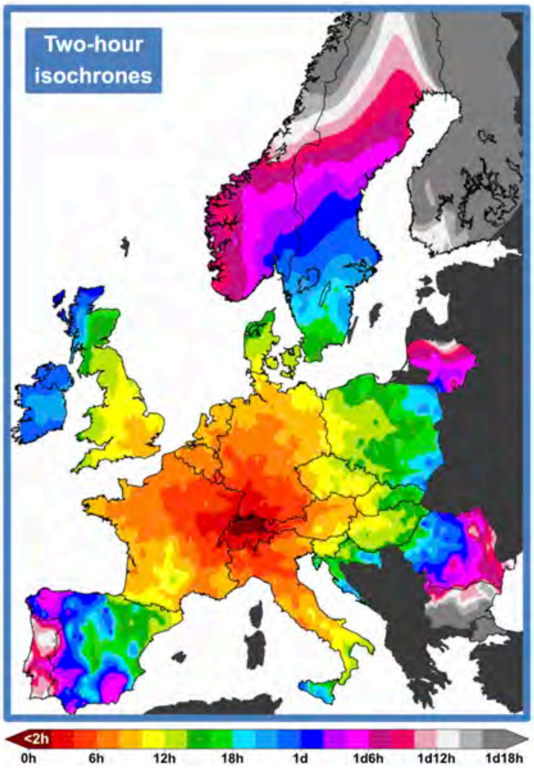


5.1.2. Current Isochrones

Figure 14 Europe’s current reachability from Zurich [1h isochrones]

Figure 15 Europe’s current reachability from Zurich [2h isochrones]





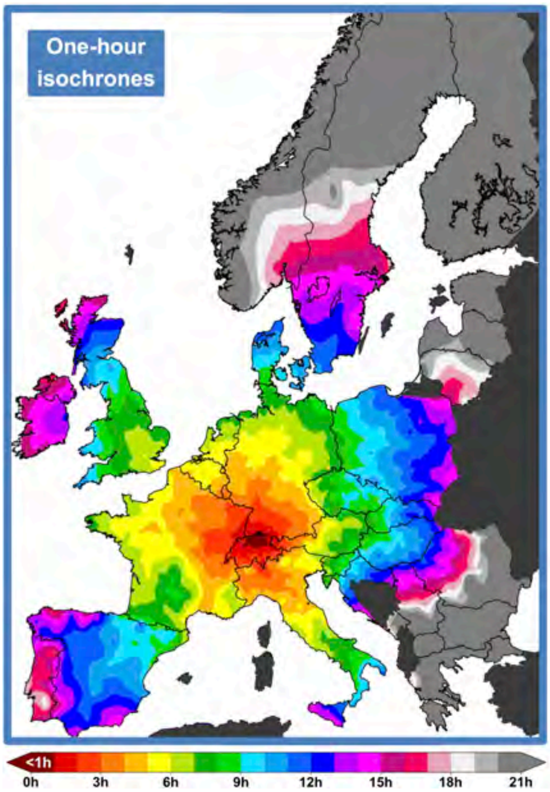
In Figures 14 and 15, the current reachability of Europe from the perspective of Zurich is displayed. The positive influence of higher speed lines on reachability can be distinguished, along with the negative influence of slower branch lines. Certain “islands” appear when relative areas in all cardinal directions can all be reached either faster or slower than the island in question. In proximal areas to the point of origin, the isochrones are more regular, and these islands are less common and smaller. Conversely, the further away from the origin one reaches, and in particular after approximately 12 hours’ travel time has elapsed, these holes become more prominent in size and amplitude. This is due to lengthy overnight stops becoming necessary for certain areas, due to the lack of trains running through certain hours of the day leading to a forced pause along the route.

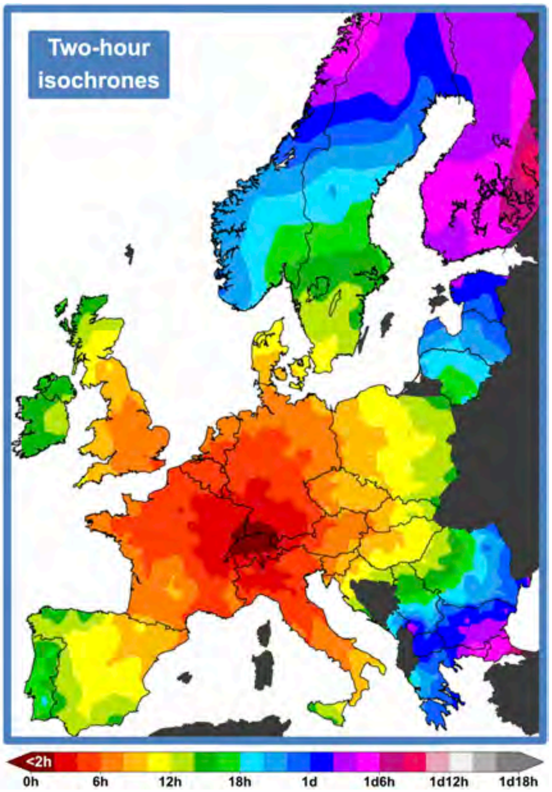
There are however indeed a number of far-flung areas which can be reached very efficiently compared to these holes, such as parts of Scotland, the south of Italy or Warsaw, which can today be reached with minimal extended stops. Some areas such as Western Iberia, Bulgaria, and most noticeably Finland require up to two overnight stops, and therefore take markedly longer to reach when compared to other places of a comparable distance.

5.1.3. Potential Isochrones

Figure 16 Europe’s current potential reachability achievable by a timetable optimisation from Zurich [1h isochrones]

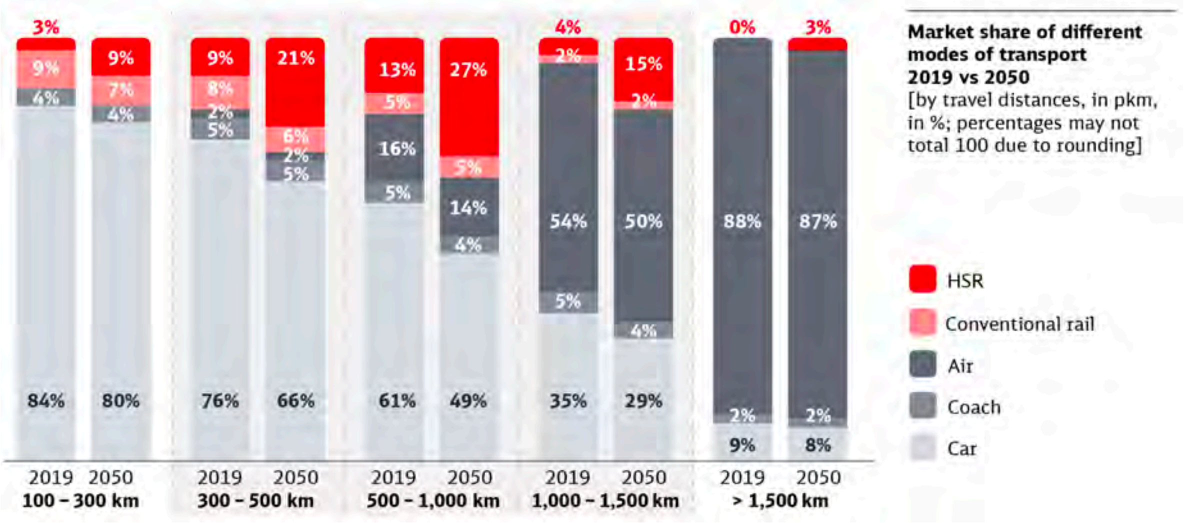
Figure 17 Europe’s current potential reachability achievable by a timetable optimisation from Zurich [2h isochrones]





Figures 16 and 17 show the currently underutilised potential reachability of Europe from Zurich, i.e. what the continent’s reachability would look like if all railways were to be optimised to one another to minimise transfer times. It is important to note that this does *not* assume that all of Europe’s railways are optimised for Zurich’s needs, as this would be entirely unrealistic. Instead, it assumes that the European mainlines are optimised to one another, as well as to their branch lines — and that Zurich is merely a node in this continental network. Comparing these figures to Figures 14 and 15, one can immediately notice the near elimination of the aforementioned “holes”, and that the isochrones appear to expand out from the point of origin in a much more regular fashion. In particular, places further away appear to benefit from a larger total time reduction, which is in line with the expectations accompanying the research questions. The increase of the individual isochrone rings to cover additional cities shows which locations stand to benefit from an increased rail competitiveness over plane journeys as they relate to Zurich. It has been observed that high-speed rail journeys remain highly competitive up to 4 hours journey time (Leboeuf, 2016). It can be assumed that rail journeys even slightly longer than this still enjoy a degree of popularity, in particular amongst those already biased against flying, be that for ecological reasons, personal preference, or because the nearest airport is inconveniently located. According to the major national passenger railway operators of Europe, the expected rail share for trips between 1000 and 1500 km is set to increase from 6% in 2019 to 17% in 2050 (PTV Group, 2019).

Figure 18 Rail market share by trip distance, 2019 vs 2050



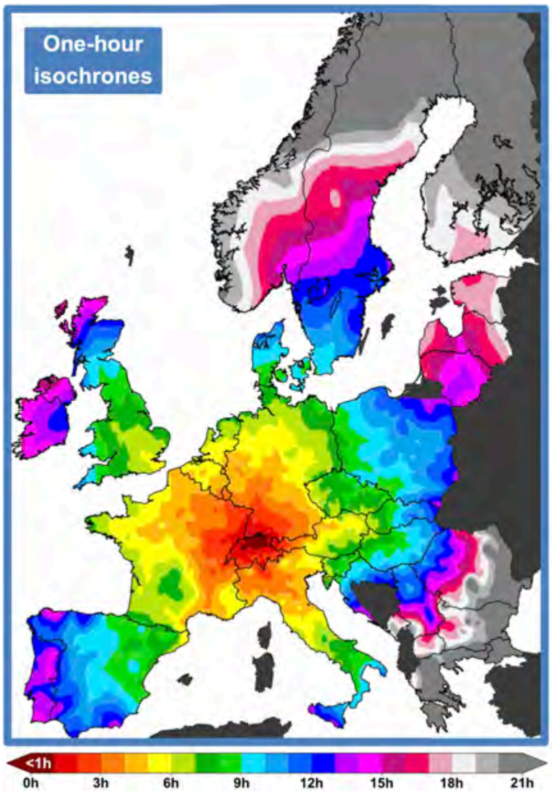
Source: PTV Group (2019)

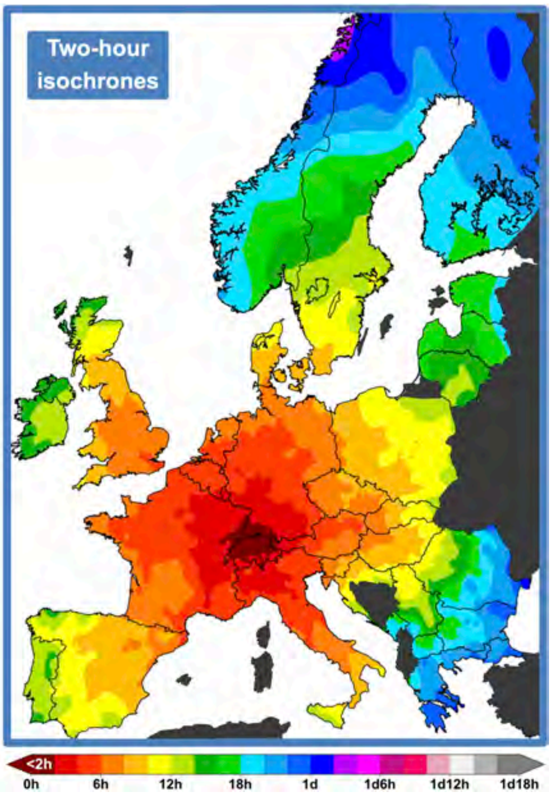
Cross-referencing the potential isochrones with extent of the light blue isoline visible in Figure 13, the resulting distance range encompasses a lot of popular holiday destinations. For trips between 500 km and 1000 km, the future expectation of 32% modal share (vs 18% in 2019) translates to increased rail demand for many cities closer to Zurich. Important cities such as Venice, Florence, Rome, Marseille, Montpellier, Lille, London, Brussels, Erfurt and many others are therefore likely to see increased rail demand at the expense of car and air demand, which stands to be improved yet further if the current rail travel times could be lowered to approach the orbit of the traditionally attractive four-hour rail-journey range (Leboeuf, 2016).

5.1.4. Future Isochrones

Figure 19 Europe’s future potential reachability due both to timetable optimisation and to the construction of new infrastructure by 2050 from Zurich [1h isochrones]

Figure 20 Europe’s future potential reachability due both to timetable optimisation and to the construction of new infrastructure by 2050 from Zurich [2h isochrones]





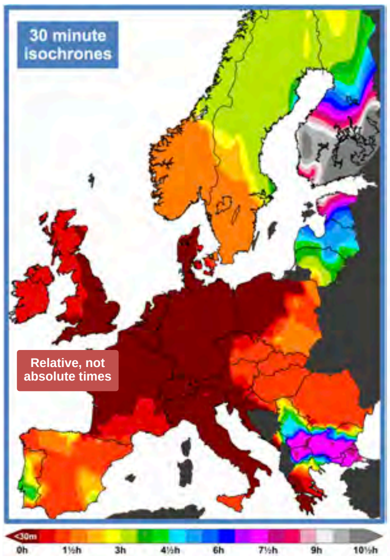
Including the influence of the new European infrastructure projects planned to be completed by 2050 in addition to the modelled potential schedule improvement, one would obtain the maps shown in Figures 19 and 20. Certain areas close to the point of origin do not appear very different, and it is in the far northeastern and southeastern extremes of the continent where the biggest improvements are to be seen. This is due in large part to the important Rail Baltica project (Governments of Latvia, Estonia and Lithuania, 2017), stretching from Poland across the Baltic states, and connecting to a future Polish high-speed rail network (Pomykała, 2023). Serbia’s ŽS is also on track to provide a far swifter cross-Balkan route than the current-day timings through the construction of a continuous high-speed rail corridor linking up to Budapest (Hungary) in a joint venture with CR and MÁV (MÁV, 2021) and continuing south as far as Niš and beyond, as part of the so-called Pan-European Corridor X.

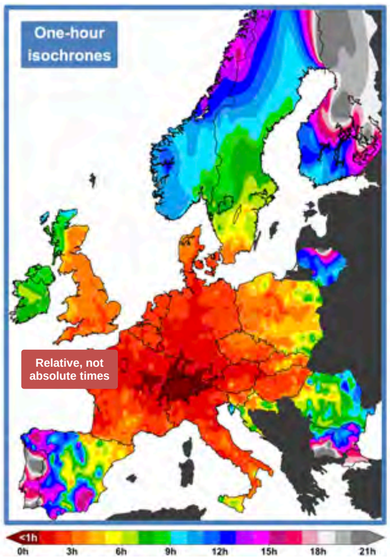
5.1.5. Isochrone comparison

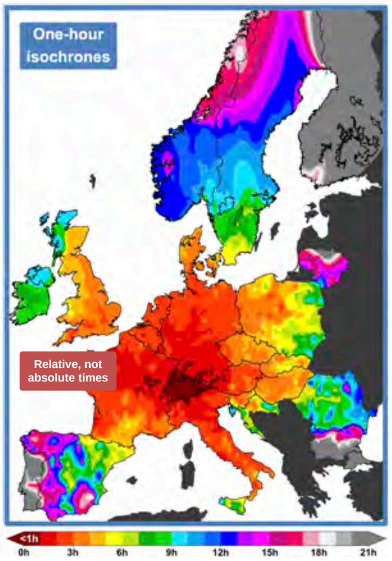
Figure 21 Isolated time-reduction effect of high-speed rail construction from Zurich [30m isochrones]

Figure 22 Isolated time-reduction effect of schedule optimisation from Zurich [1h isochrones]

Figure 23 Combined time-reduction effect of schedule optimisation and high-speed rail construction from Zurich [1h isochrones]







To make better sense of the previously shown isochrone maps, these three comparative maps extract the effects of both time reduction strategies: high speed rail construction and timetable optimisation, showing potential improvement measured in relative time versus the current timetable, and not absolute travel times. This means that smaller coloured areas correspond to a greater speeding-up effect of the strategy in question. From Figure 21, we can see that that all high-speed rail construction by 2050 will not result in time savings from Zurich of greater than half an hour for a large area in its immediate vicinity. The greatest effect of HSR construction will instead be found in the far geographical extremities of Europe, after accumulating many new high speed lines along the way.

However, it can be assumed that nearby countries are much more common destinations when considering average Swiss demand (BAV, 2021), so it is worth noting that 2, 3 or even 4 hours could be saved today when travelling to these neighbouring countries after an optimisation as per Figure 22. Figure 22, which compares the current state of rail travel with a hypothetical continent-wide optimal timetable, reveals that a large proportion of the European continent is today reachable from Zurich with under four hours of dwell time inefficiency. However, once this observed four-hour threshold is crossed, the inefficiency tends to increase rapidly and devolve into complicated eddies and holes, with sharp cutoffs appearing, and to a much greater extent than the effects of the addition of high-speed rail alone.

Nearby Zurich, large travel-time reductions can only be achieved with a reduction of inefficiency of the current schedules, as the current high-speed rail plans slated for completion prior to 2050 would not suffice by themselves. There are however certain cities on the outskirts of Europe, where the inverse is true, as can be observed in the appendix of this thesis.

A key takeaway from these visualisations is that, from Zurich, 4x to 8x more travel time could be saved from a continental schedule optimisation than the savings possible from the construction of all currently planned high-speed rail projects when it comes to neighbouring countries. This observation remains true when looking at the entire continent, and even increases past 10x in areas. This lays bare the true potential of a schedule optimisation, and highlights the scale of the Europe-spanning efficiency increase it could cause. Combining both time reduction strategies in Figure 23, the time savings are made even more noticeable. It seems clear that the kind of dramatic time savings needed to reduce travel times enough to notably increase the competitiveness of rail on a continental scale seem to only be achievable not just through the building of new high-speed rail alone, but also through the concurrent synchronisation of services to one another to cut down on superfluous wait time.

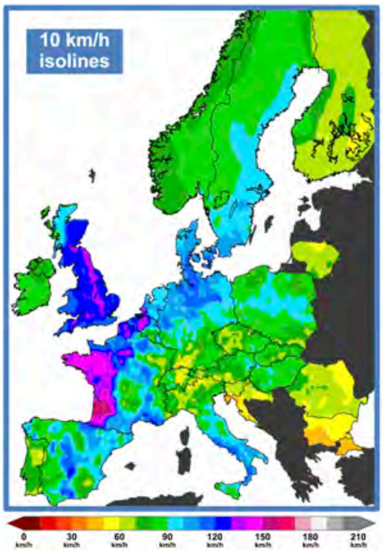
5.1.6. Speed maps

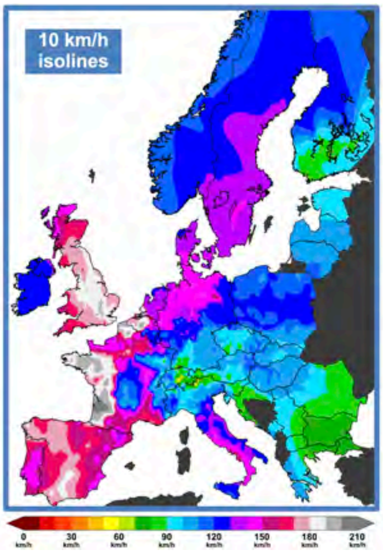
Speed maps can be generated by dividing the distance map shown in Figure 13 by the desired isochrone map. In Figure 24, the current average speed required to reach European railway stations by public transport from Zurich is shown. Western France, Western Belgium and Great Britain can all today be reached at average speeds exceeding 120 km/h, in some cases even 150 km/h. These are impressive average speeds for such extended, multi-train distances and can be chalked down to the success of the French “LGV” high-speed lines at enabling long distances to be traversed at very high average speeds with minimal stops. The German high-speed network is more of a patchwork of “SFS” high-speed rail lines connected by long segments of lower mainline speeds, and punctuated by more frequent stops than in France (Vrána et al., 2023), which leads to a visibly lower average speed on the map. While Spain and Italy have particularly long corridors of 300 km/h max speed rail lines, they are, from a trip originating in Zurich, preceded by extended transfer times in Barcelona and Milan, which somewhat counteract the benefit of these high speeds and leaves them reachable with an average speed closer to Germany than France or the UK. Additionally, Spain is affected by the comparatively low average speed of 137 km/h on the up to 300km/h track between Perpignan and Barcelona as outlined in Section 2, from which Table 1 may be considered a useful point of reference to use to better understand the average speeds in these visualisations. On the other side of the spectrum, some parts of Croatia, Bulgaria and nearby areas of Switzerland and Germany can only be reached today at 40 km/h on average, but for very different reasons. With Croatia and Bulgaria, this can be explained by highly inefficient timetables pulling down the average speed, whereas closer to the origin point, these speeds are most likely due to the fact that the routings to reach these branch lines simply do not spend enough time on the fast cross-continental mainlines to counterbalance the negative influence on average speed from the slower branch lines.

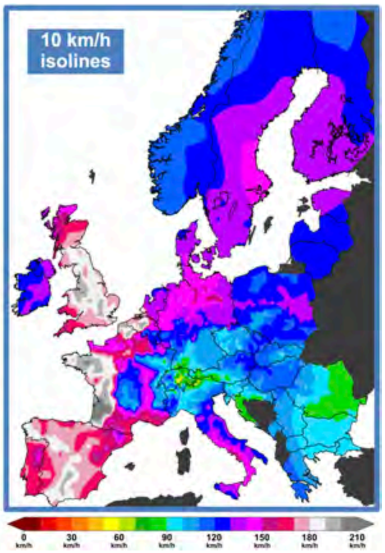
Figure 24 Europe’s current average public transport travel speed from Zurich [km/h]

Figure 25 Europe’s current potential average public transport travel speed after a timetable optimisation from Zurich [km/h]

Figure 26 Europe’s future potential average public transport travel speed after both a timetable optimisation and the completion of new infrastructure by 2050 from Zurich [km/h]



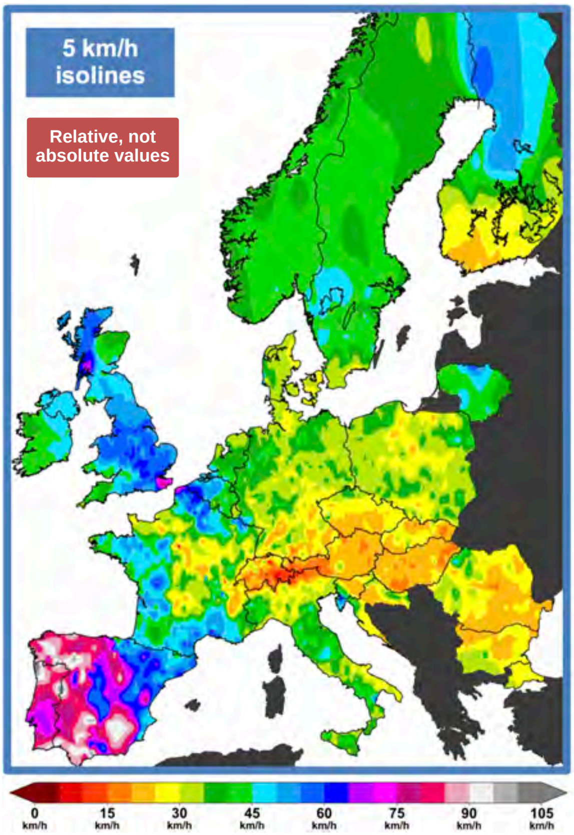


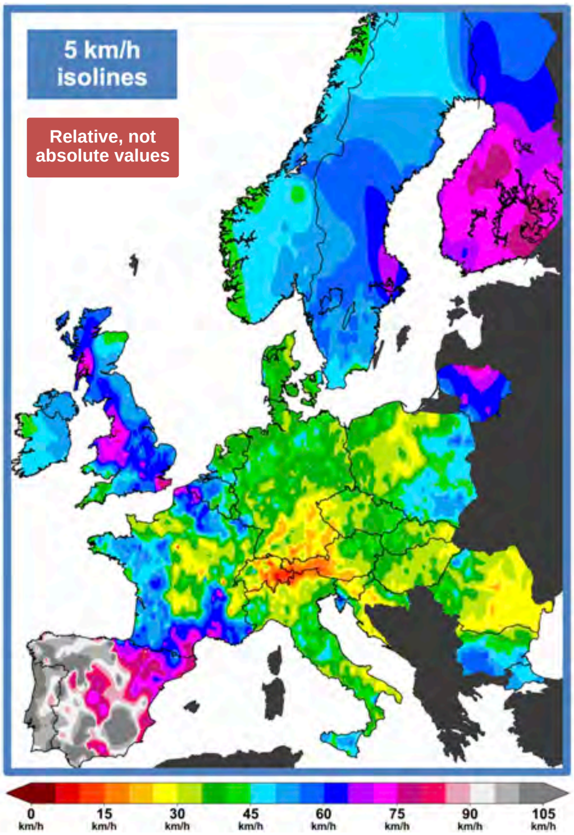


Stepping up to Figure 25, a large increase in speed can be observed. This map shows what is potentially achievable today after a widespread timetable optimisation. With this improvement, average speeds required to reach most parts of Western Europe would increase to 140 km/h or higher, and some areas would be able to approach or even surpass a 200 km/h average speed. After optimising all connections, Bulgaria could today be reached at an average of 70 km/h, a 75% improvement over the current 40 km/h. Additionally, once future high-speed rail projects are brought online as displayed in Figure 26, even many areas of Poland, Estonia and Finland could be reached at an average speed of 130 km/h, and southern as well as western Spain would see average speeds of over 180 km/h. The lowest average speeds for long-distance destinations anywhere on the continent would not fall under 80 km/h, representing a doubling of current-day minimum speeds.

Figure 27 Isolated average speed-increase effect of schedule optimisation from Zurich [km/h]

Figure 28 Combined average speed-increase effect of schedule optimisation and high-speed rail construction in Europe [km/h]

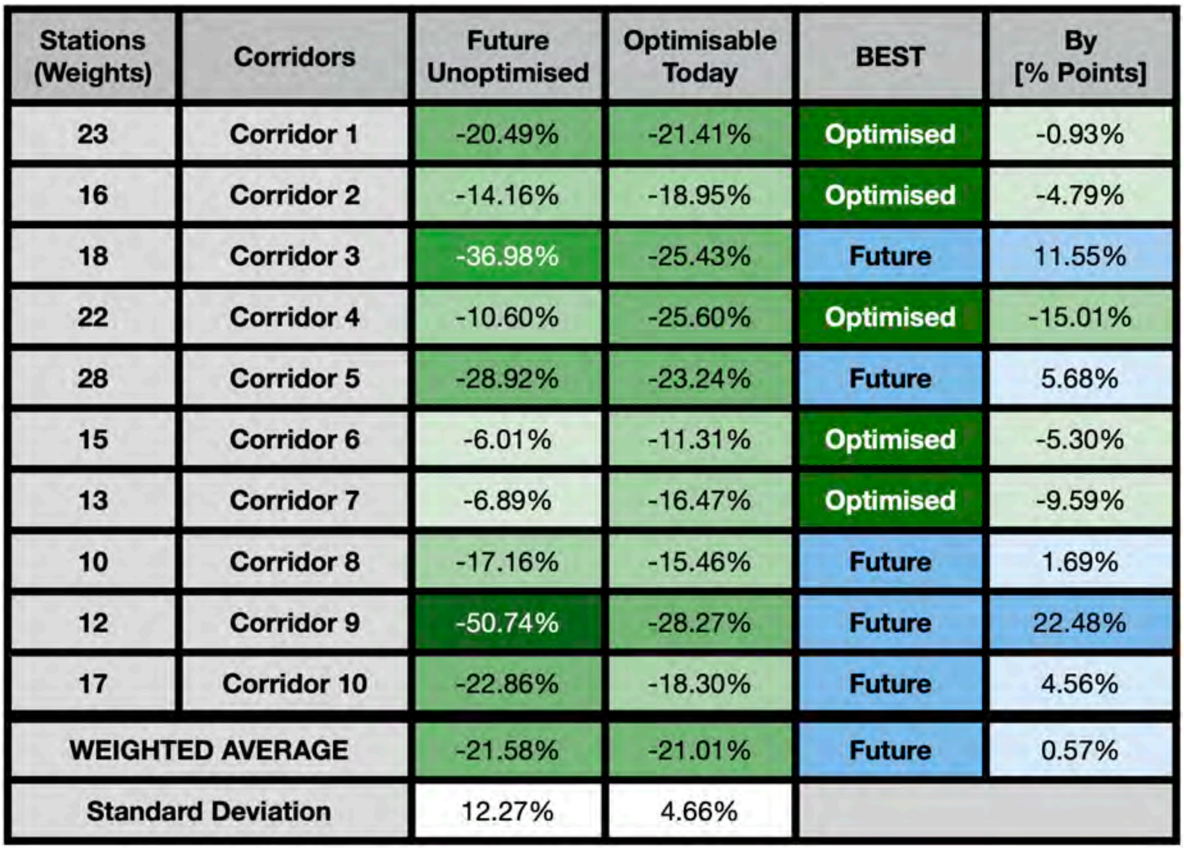




In Figure 27, the effect of a timetable optimisation is shown on average travel speeds. Adding the influence of future high-speed rail lines in Figure 28 results in a map of the highest potential speed increase by 2050, if both accelerative measures are taken concurrently. Of note is the fact that the difference between the current average speed and the potential average speed to reach almost the entirety of Iberia is currently particularly high, as one could benefit from average post-optimisation speed increases of 90 km/h even today, and increases of 100 km/h to yet more cities in the future. The influence of Rail Baltica can be made out in Finland, as well as that of HS2 in western England and northern Wales. Currently, Figure 27 shows that countries such as Austria and Hungary are already rather efficiently connected to Zurich, as their average speed could only be increased today by no more than 20-25 km/h compared to much larger values found at equal distances in all other cardinal directions.

5.2. Analysis of the corridor tables

Table 9 Average potential travel time improvement between corridor stations



Stations (Weights)	Corridors	Future Unoptimised	Optimisable Today	BEST	By [% Points]
23	Corridor 1	-20.49%	-21.41%	Optimised	-0.93%
16	Corridor 2	-14.16%	-18.95%	Optimised	-4.79%
18	Corridor 3	-36.98%	-25.43%	Future	11.55%
22	Corridor 4	-10.60%	-25.60%	Optimised	-15.01%
28	Corridor 5	-28.92%	-23.24%	Future	5.68%
15	Corridor 6	-6.01%	-11.31%	Optimised	-5.30%
13	Corridor 7	-6.89%	-16.47%	Optimised	-9.59%
10	Corridor 8	-17.16%	-15.46%	Future	1.69%
12	Corridor 9	-50.74%	-28.27%	Future	22.48%
17	Corridor 10	-22.86%	-18.30%	Future	4.56%
WEIGHTED AVERAGE		-21.58%	-21.01%	Future	0.57%
Standard Deviation		12.27%	4.66%		

Table 9 displays the average results of each corridor analysis, as detailed in Section 4.2.2. Exactly half of these corridors stand to gain more from planned future construction, whereas half have more unrealised potential post-optimisation even today, without any new future projects, showing that both strategies are at least comparable when it comes to average time reduction.

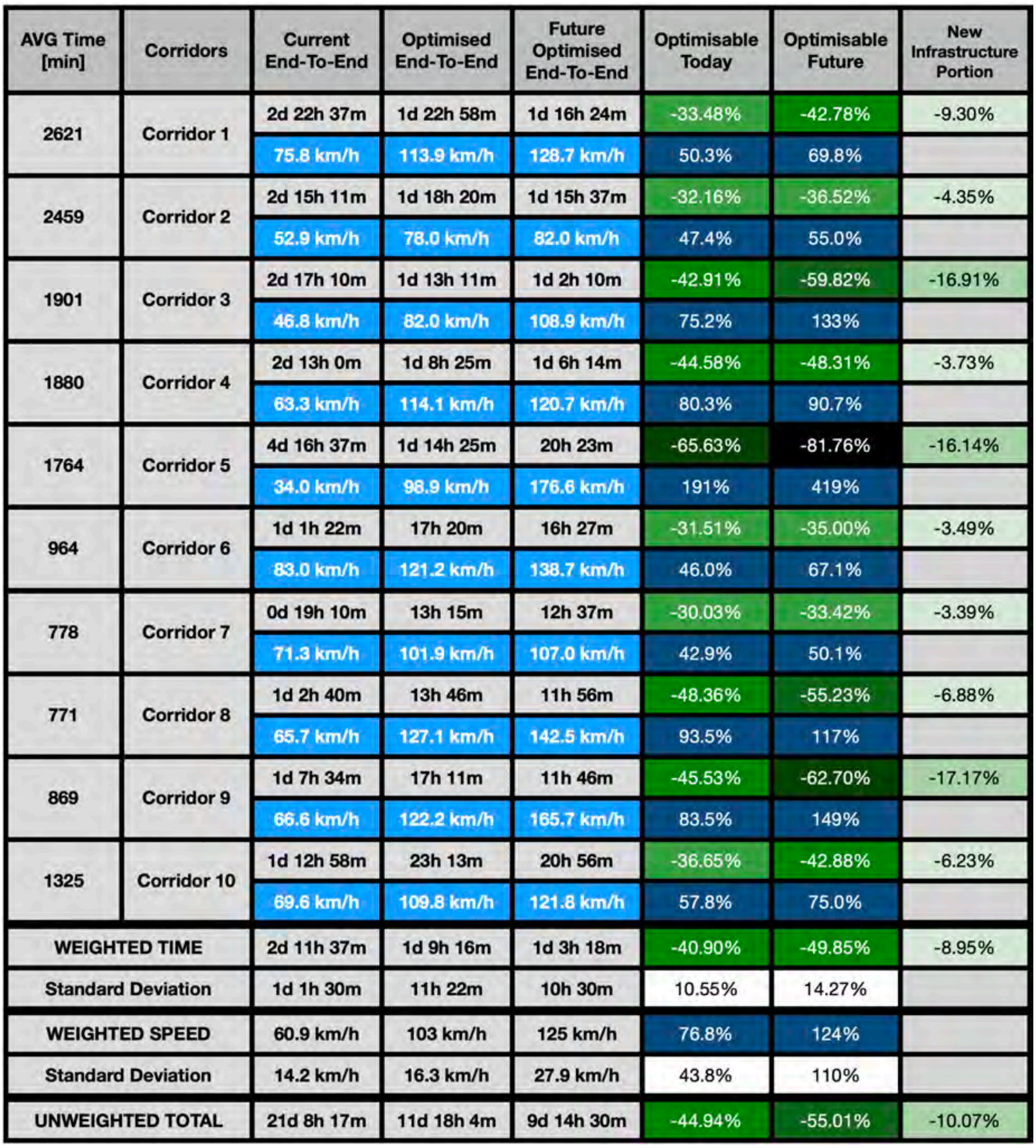
Overall, constructing the high-speed rail projects of Europe planned before 2050 for all stations along the chosen ten corridors is determined to correspond to an average weighted time reduction of 21.58% (with a standard deviation of 12.27 percentage points). This is approximately equal to the effect of optimising the schedule along these corridors, which would reduce average weighted travel times by 21.01% (with a noticeably lower standard deviation of 4.66 percentage points).

The corridors which stand to gain the most from future infrastructure projects are Corridors 9 and 3, at a 50.74% and 36.98% time reduction respectively, both of which fall outside the range of a standard deviation. These two corridors have multiple ongoing projects spread along the length of their route, many of which represent major time savings of multiple hours. Conversely, Corridors 6 and 7 have very modest future improvements planned, and would find greater time savings through the optimisation of services. The corridor for which optimisation would yield the greatest comparative results is however Corridor 4, at 15.01 more potential percentage points of time savings possible through optimisation versus the construction of new infrastructure. This is due to the corridor currently having an excessively inefficient timetable as well as only few high-speed projects being planned along its length.

5.3. Analysis of the sample timetables

The results from the thirty sample timetables generated in Section 4.3 can be found in Table 10. As opposed to Section 5.2., these sample timetables necessarily consider the entire length of the corridor at once, instead of the average of all the individual station pairings along it. Due to this, the time reduction potential will naturally be markedly greater, as it relates to the longest possible distance along the corridor, namely the end-to-end distance. In total, over three cumulative weeks' worth of current timetables were analysed for time reduction potential, which the initial optimisation step brought down to 11 days, 18 hours, and 4 minutes (-44.94%). When adding future infrastructure, a smaller, yet still meaningful reduction to 9 days, 12 hours, and 50 minutes (-55.33%) is possible. When weighted by the length of each corridor in minutes, this means that the time taken to currently traverse an average corridor is 1 day, 1 hour and 30 minutes, yet has the potential to be brought down to 11 hours 22 minutes today and to 10 hours 30 minutes by 2050. This points to average potential end-to-end time savings of 40.90% and 49.85% respectively. Similarly to Table 9, the potential time reduction from schedule optimisation today has a lower standard deviation than when future projects are added. This can be explained by optimisation having a more reliably consistent improvement effect that appears to correlate to total distance, whereas building new high-speed rail infrastructure can inherently only serve to improve the travel times for the 171 segments along which they are planned to be located, as per Section 4.1.3.

Table 10 Potential end-to-end travel time and average speed improvement for each corridor



AVG Time [min]	Corridors	Current End-To-End	Optimised End-To-End	Future Optimised End-To-End	Optimisable Today	Optimisable Future	New Infrastructure Portion
2621	Corridor 1	2d 22h 37m	1d 22h 58m	1d 16h 24m	-33.48%	-42.78%	-9.30%
		75.8 km/h	113.9 km/h	128.7 km/h	50.3%	69.8%	
2459	Corridor 2	2d 15h 11m	1d 18h 20m	1d 15h 37m	-32.16%	-36.52%	-4.35%
		52.9 km/h	78.0 km/h	82.0 km/h	47.4%	55.0%	
1901	Corridor 3	2d 17h 10m	1d 13h 11m	1d 2h 10m	-42.91%	-59.82%	-16.91%
		46.8 km/h	82.0 km/h	108.9 km/h	75.2%	133%	
1880	Corridor 4	2d 13h 0m	1d 8h 25m	1d 6h 14m	-44.58%	-48.31%	-3.73%
		63.3 km/h	114.1 km/h	120.7 km/h	80.3%	90.7%	
1764	Corridor 5	4d 16h 37m	1d 14h 25m	20h 23m	-65.63%	-81.76%	-16.14%
		34.0 km/h	98.9 km/h	176.6 km/h	191%	419%	
964	Corridor 6	1d 1h 22m	17h 20m	16h 27m	-31.51%	-35.00%	-3.49%
		83.0 km/h	121.2 km/h	138.7 km/h	46.0%	67.1%	
778	Corridor 7	0d 19h 10m	13h 15m	12h 37m	-30.03%	-33.42%	-3.39%
		71.3 km/h	101.9 km/h	107.0 km/h	42.9%	50.1%	
771	Corridor 8	1d 2h 40m	13h 46m	11h 56m	-48.36%	-55.23%	-6.88%
		65.7 km/h	127.1 km/h	142.5 km/h	93.5%	117%	
869	Corridor 9	1d 7h 34m	17h 11m	11h 46m	-45.53%	-62.70%	-17.17%
		66.6 km/h	122.2 km/h	165.7 km/h	83.5%	149%	
1325	Corridor 10	1d 12h 58m	23h 13m	20h 56m	-36.65%	-42.88%	-6.23%
		69.6 km/h	109.8 km/h	121.8 km/h	57.8%	75.0%	
WEIGHTED TIME		2d 11h 37m	1d 9h 16m	1d 3h 18m	-40.90%	-49.85%	-8.95%
Standard Deviation		1d 1h 30m	11h 22m	10h 30m	10.55%	14.27%	
WEIGHTED SPEED		60.9 km/h	103 km/h	125 km/h	76.8%	124%	
Standard Deviation		14.2 km/h	16.3 km/h	27.9 km/h	43.8%	110%	
UNWEIGHTED TOTAL		21d 8h 17m	11d 18h 4m	9d 14h 30m	-44.94%	-55.01%	-10.07%

Far and away the most inefficient corridor today is Corridor 5, which today loses over three days to dwell and transfer time whilst travelling between the termini. After Rail Baltica and related rail projects are completed, along with a comprehensive timetable optimisation, the total time to travel along this route could be reduced to only 20 hours and 23 minutes, compared to 4 days, 16 hours and 37 minutes today. Despite a deliberate difference in methodology, the same two corridors as in Section 5.2. (Corridors 9 and 3) are found to benefit the most from future infrastructure, supporting the consistency of these results.

In addition to the travel times, the average speeds for each corridor were also analysed (shown in blue in Table 10). On the whole, the current average speed along these cross-continental corridors has been determined to be only 60.9 km/h, from which a 69.1% average increase may today be obtained after reducing timetable inefficiencies. By 2050, a 105% average increase post-optimisation could be expected, representing more than a doubling of average railway speeds across Europe. In the case of Corridor 5, the completion of Rail Baltica would permit more than a quadrupling of average speeds, from 34.0 km/h to 176.6 km/h, which is by far the largest change. Even the lowest future potential improvement of 50.1% on Corridor 7 represents a major average speed increase from 71.3 km/h to 107 km/h. It can be noted that none of these corridors approach the high average speeds showcased in Table 1, which is due to the fact that all analysed cross-continental corridors rely on mainlines connecting to HSR portions, and do not follow high-speed rail lines exclusively for the length of the corridor. Additionally, these calculations were done conservatively, considering ample buffer time already integrated in the times generated by the Dijkstra algorithm as well as more than sufficient stopping times at the various intermediate stops, to ensure that the resulting headline potential time reduction and speed increases were as feasible as possible.

Outliers are Corridor 5 and Corridor 9, which in future shall contain nearly exclusively high-speed track. These two corridors would have an average speed in 2050 of 176.6 km/h and 165.7 km/h respectively, meaning that the entire length of the corridors would fit into the definition of high-speed rail according to Demiridis (2012), as they would maintain average speeds of higher than 150 km/h while having maximum speeds (well) in excess of 200 km/h. Conversely, the remaining eight continental corridors would fall short of wholly being qualified as high-speed rail, even if the most optimistic 2050-infrastructure scenario were to come to pass.

6. Conclusion

Historically, cross-European rail travel has been marred by lengthy border crossing procedures and low average travel speeds. In recent decades, many of these inefficiencies have been reduced or eliminated and passengers now benefit from faster long-distance connections. This thesis has however shown that the current state of railway infrastructure still has a double-digit percentage degree of inefficiency, which upon being reduced would increase intercontinental reachability, in particular for the longest-distance routes (for which total end-to-end traversal time may be reduced by close to 40%, as per Table 10).

The 10 corridors chosen to represent long-distance European travel which were specifically highlighted in this thesis have been shown to stand to benefit from the planned future construction of high-speed lines, leading to an average reduction in travel time of around 20%, as per Table 9. However, a similar 20% reduction in average travel time can also be obtained by ensuring that travel along these corridors is as efficient as possible, and as little time as possible is unnecessarily lost to transfer time. For this to be accomplished, the service providers of passenger rail along each corridor would need to coordinate with one another and guarantee that passenger movement along overarching trans-European corridors is given precedence when planning their individual national timetables. It is with a higher strategy focused on cohesive cross-continental travel that the underutilised potential of the European railway network could be unlocked and countless passenger-hours saved, thereby increasing the societal benefit of passenger rail travel.

In Table 11, directly calculated average improvements with associated quantitative values as outlined in the previous section have been transformed into qualitative ratings for comparison with one another, whereas informed assumptions have been added in brackets. From this, it is clear that a centrally coordinated cross-continental timetable optimisation has been demonstrated to have substantial time-saving effects on par with or surpassing high speed rail construction. This is particularly true for long-distance trips as opposed to more medium-distance average station pairings. For both, comparable time savings stand to be achieved at drastically lower costs. The area people consider accessible by rail from their hometown would expand (see Section 5.1.3.) due to less valuable minutes being lost to network inefficiencies, allowing for more city pairings to see increased rail demand at the expense of flights. As time spent transferring is generally perceived to be twice as long as time spent in-vehicle for non-business trips (Wardman et al., 2001) (Iseki et al., 2006), the headline time improvements associated with cutting down substantially on transfer times would have an even greater perceived effect on the affected passengers than would be proportional to the time saved.

Table 11 Comparison of both travel-time reduction strategies

Travel-time reduction strategy	End-To-End travel-time reduction along long-distance railway corridors	Average travel-time reduction along long-distance railway corridors	Inter-European Reachability	Monetary Cost	Necessary International Coordination
Pan-European Optimised Schedule	+ +	+	+ +	(+)	(+ + +)
Planned High Speed Rail Construction	(+)	+	+	+ + +	(+ +)
Both strategies in concert	+ + +	(+ +)	+ + +	+ + +	+ + +

High speed rail is capable of large travel-time reductions as well, but not from every starting location, as the effect is intrinsically only limited to places where construction is planned. When it comes to necessary international coordination, the strategy of timetable optimisation incurs the cost of researching and adjusting all timetables on a cross-continental scale, needing dozens of participating companies and governments to work in unison. This necessitates more multilateral cooperation than individual high-speed rail projects, each of which can be completed independently of one another. While the goal of optimising the continental schedule is simply to reorganise existing services, it would be beneficial to introduce more frequent trains in certain places, inducing expenditure on some new train units. High-speed rail construction, whilst bringing a similar increase in reachability, is conversely associated with comparatively astronomical costs. Not only are both large-turning-radius line construction and procurement of high speed trains very expensive, but elements like land acquisition, environmental damage and the often highly complex tunnelled and viaduct segments can significantly delay projects and cause them to overrun the expected budget. This is not to suggest that high-speed rail not be constructed though, as the greatest travel time reductions can only be achieved when both measures are applied in concert with one another — however, the sheer potential in this thesis' findings mean that even if the effects of a timetable optimisation were only half much as observed, it would still be worth further investigation and future studies into how best to be implemented in a manner most acceptable to all involved stakeholders.

This research effort concedes some limitations. As this thesis directly tackles the perspective of the average long-distance traveller travelling along a corridor, the time advantage of a possibly substantial infrastructure improvement for an individual short connection is somewhat diluted in this broader context. Whilst from a continental perspective, the timetable savings of new infrastructure may appear comparable to a schedule optimisation, this need not necessarily apply when one is principally considering the two immediate cities to be linked by such new infrastructure, as is often the case when deciding whether the project is worthwhile or not. In this shortest-distance case, the construction of brand new, direct rail lines is associated with the highest reduction in speed in almost all cases (as can be taken from proximate station pair timings in Table 5 and Tables 11-19), and is often only comparable to or surpassed by a schedule optimisation after the stringing together of many individual city pairs. Further research may look into the viability of introducing a few optimally-timed trains along an entire corridor per day, and how to time these so that they best integrate with existing services. It appears highly likely that, due to the fact that any chosen corridors to prioritise would cover the majority of Europe, a complete, time and resource-intensive integral rescheduling of the continent's mainlines (and branch lines to efficiently connect to these new mainlines) is necessary to achieve the improvement on travel times outlined in this thesis.

In summation, this thesis has demonstrated the underreported, yet substantial underused potential lying dormant in the European continent's railway network's structural inefficiencies, and has endeavoured to quantitatively and qualitatively describe just how beneficial it is not only for high-speed railway projects to be built, but also for the passenger service along them to be consciously aimed at taking near full advantage of the infrastructure they are afforded, and in so doing, serve to ensure an ever-closer inter-European connectedness.

7. Outlook

To have any chance of a successful and concrete implementation, a continent-spanning timetable optimisation cannot realistically be brought to life without a well-coordinated overarching program guiding all involved actors; countries and railway companies. Considering the observations outlined in Section 3, which shows a marked lack of strategic corridor planning across multiple countries even for recently introduced services, it is likely that a third party's authority over a potential new schedule is necessary to help resolve disagreements between railway companies vis-à-vis their preferred timings as neutrally as possible. The European Union as a whole is the only authority within Europe to fit this profile, as it is able to directly impact policy in member states as well as indirectly impact the transport policy of most non-member states. To this end, proponents of ensuring the future implementation of such an optimisation should start by working toward adding a clause outlining the necessity of efficient timetabling along the EU's TEN-T corridors within their documentation, serving as a clear and actionable concretisation of the European Commission's current aim to make the EU's transport network "faster and more convenient" (European Commission, December 2021).

Currently, a goal of the TEN-T railway corridors is to "allow passenger trains to travel at 160 km/h or faster by 2040" along passenger railway lines on the TEN-T core and extended core network (European Commission, 2023). In addition to this targeted maximum line speed, a target *average* speed as a dynamic proportion of maximum line speed should also be set for the entire length of each corridor, thus providing a useful metric by which to measure the success or failure of timetable optimisation attempts. Through an analysis of current timetables, this metric could be tracked yearly for each TEN-T corridor, analogous to Table 10, and made freely available so as to remain accountable to the public and allow for multi-year comparisons to be drawn, either attracting public scrutiny and pressure against timetable changes not conducive to long-distance travel, or public praise from continued schedule optimisations. This transparency by means of easily comprehensible, headline yearly figures is sorely needed, as the public can be presumed to currently have very little awareness of the scale of the European passenger rail network's long-distance inefficiency, besides anecdotal experience. As a substantial average speed increase can be achieved with relatively little effort compared to new HSR construction, therefore associated with disproportionately large time savings for an equivalent amount of monetary investment, making progress in this area would be a simple way to garner praise from the media and long-distance passengers alike, elevating the reputation of rail when faced with mode choice decisions for long-distance journeys.

Due to the fact that timetable optimisations are not as labour-intensive as the construction of infrastructure projects, it would seem entirely within reason to set as a goal a substantive increase in average line speed along these corridors after only a couple of years of coordination between the relevant passenger rail service providers. Both the high degree of international cooperation required for its implementation as well the resulting shrinkage of Europe in the mental maps of its travellers would serve as potent symbols of the fundamental European objective of creating an ever closer union (European Economic Community, 1957). The European Commission's Mobility Strategy currently aims for a fully operational Trans-European Transport Network by 2050, and supports this by having declared one particular "flagship key area for action" making possible the seamless switching between different transport modes on the TEN-T corridors (European Commission, July 2021). Now armed with the knowledge of precisely how inefficient the long-distance European corridors actually are, it is important not to overlook the importance of making transfers seamless within the *same* transport mode as well — this is just as worthy of a position as a "flagship" goal of the Mobility Strategy, as it has been demonstrated to result in a hefty reduction in long-distance travel times, comparable to what is achievable through the construction of high-speed rail.

Ultimately, the highest time-reduction effect is obtainable through a combination of both going after the "low hanging fruit" i.e. ensuring greater timetable efficiency as well as constructing the more resource-intensive, yet often similarly impactful construction of further high-speed rail projects. It is by working toward the employment of these two different, yet complimentary approaches in careful concordance with one another, and by openly tracking metrics to reliably gauge whether progress in the direction of this goal is being made that cross-continental rail travel in Europe could continue the historical trend of steadily increasing average speeds and reachability.

8. Literature

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Appendix

1. Visualisations of Potential Reachability

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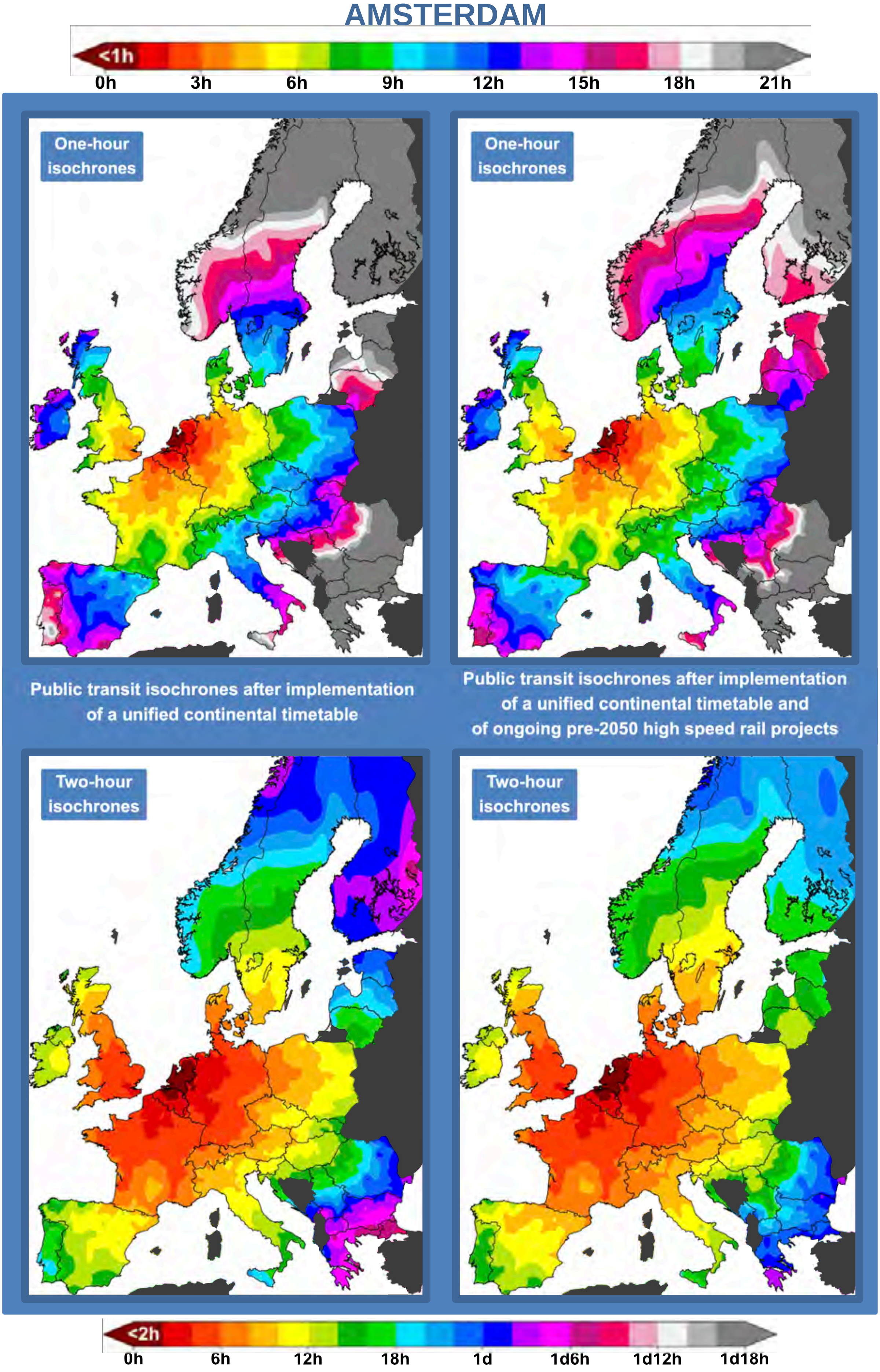

Public transit isochrones after implementation of a unified continental timetable

Public transit isochrones after implementation of a unified continental timetable and of ongoing pre-2050 high speed rail projects

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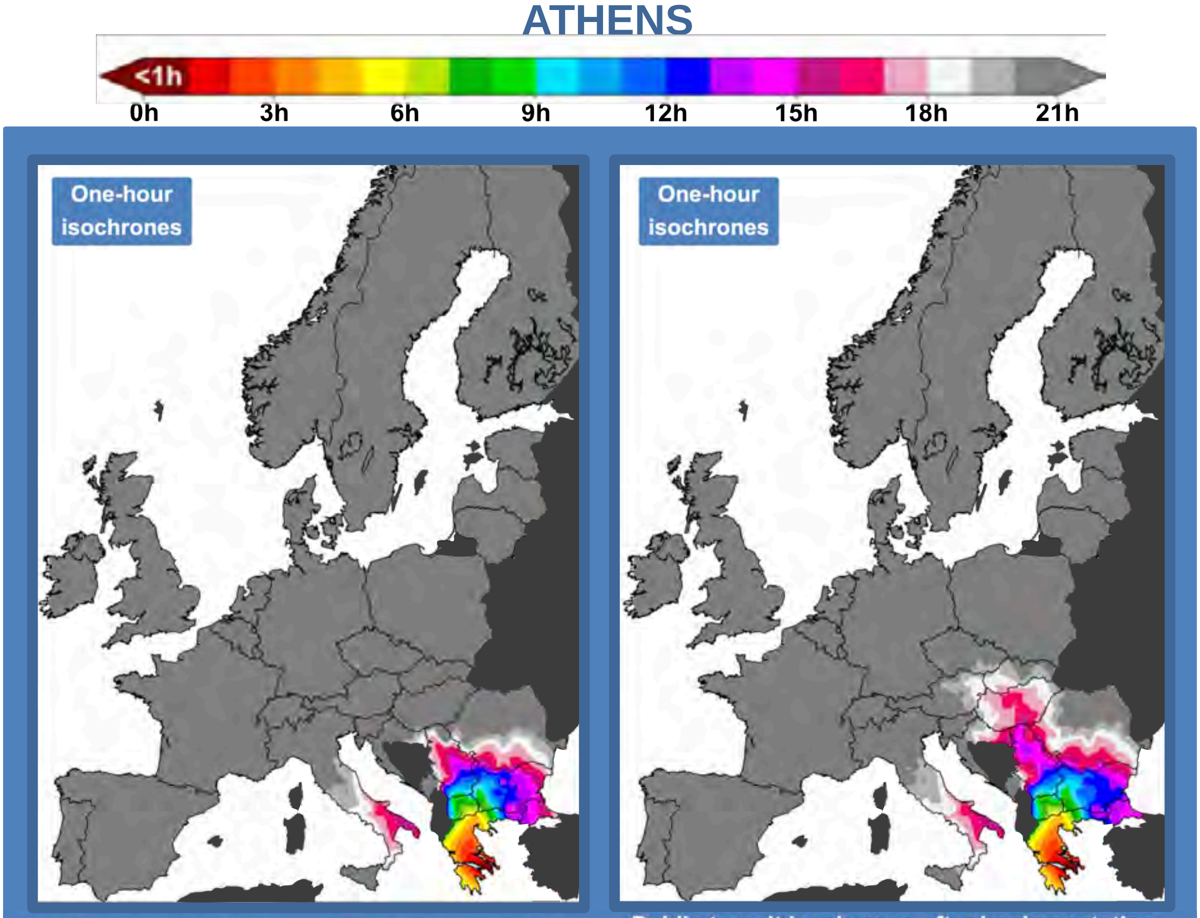

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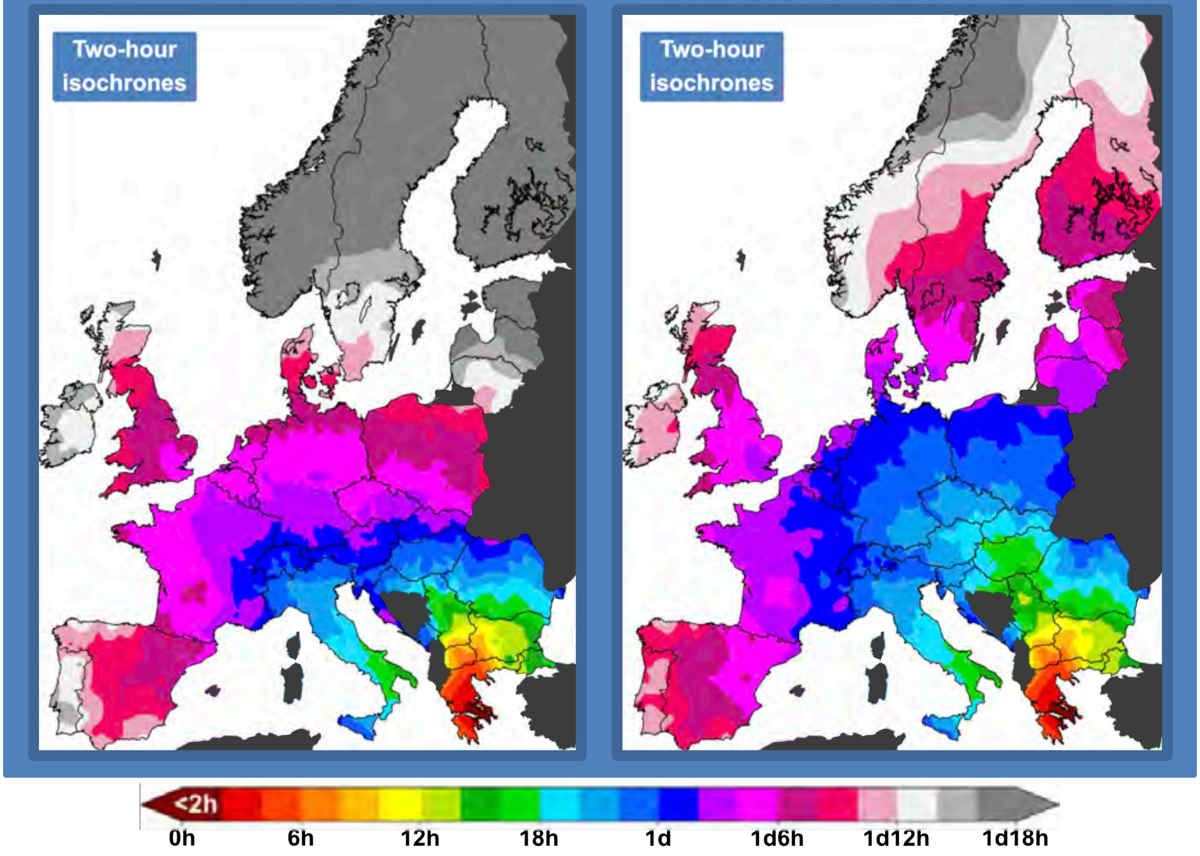

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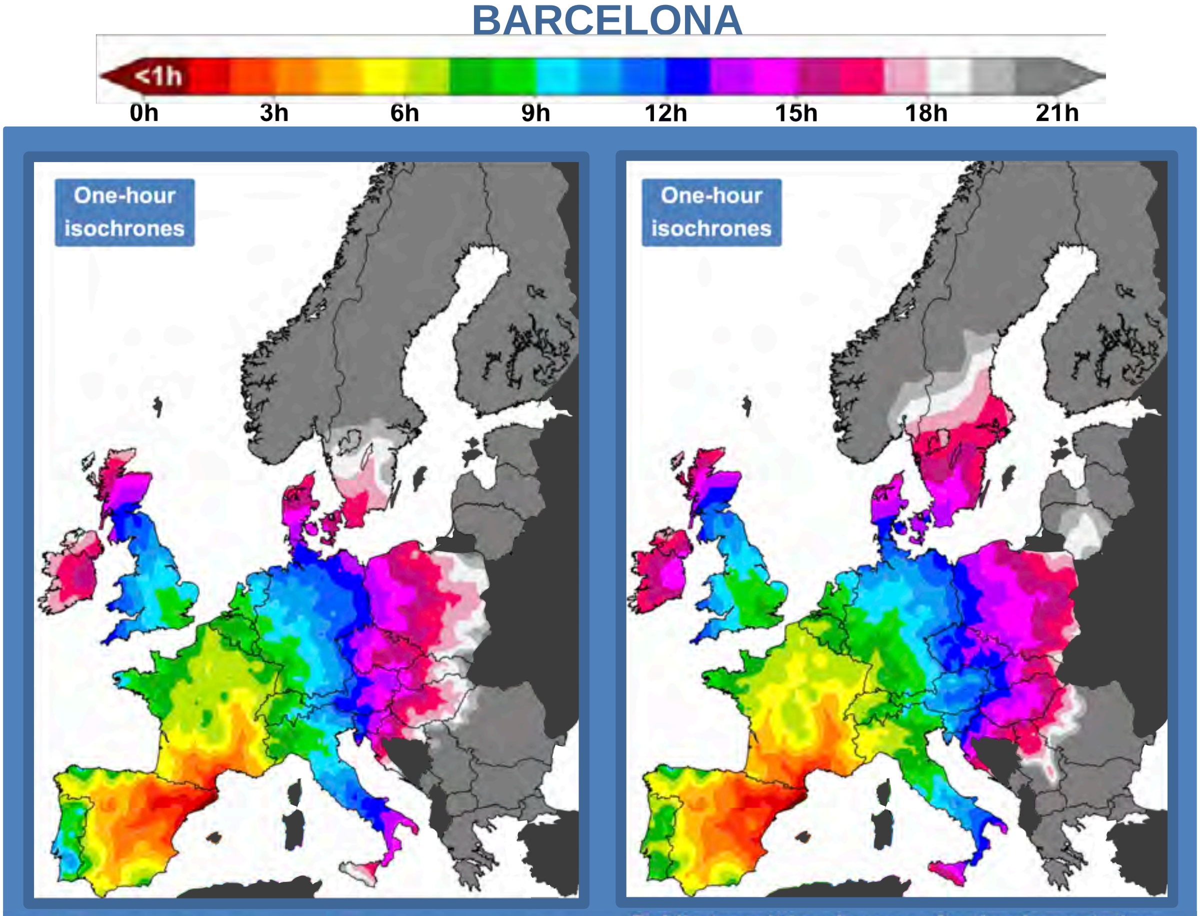

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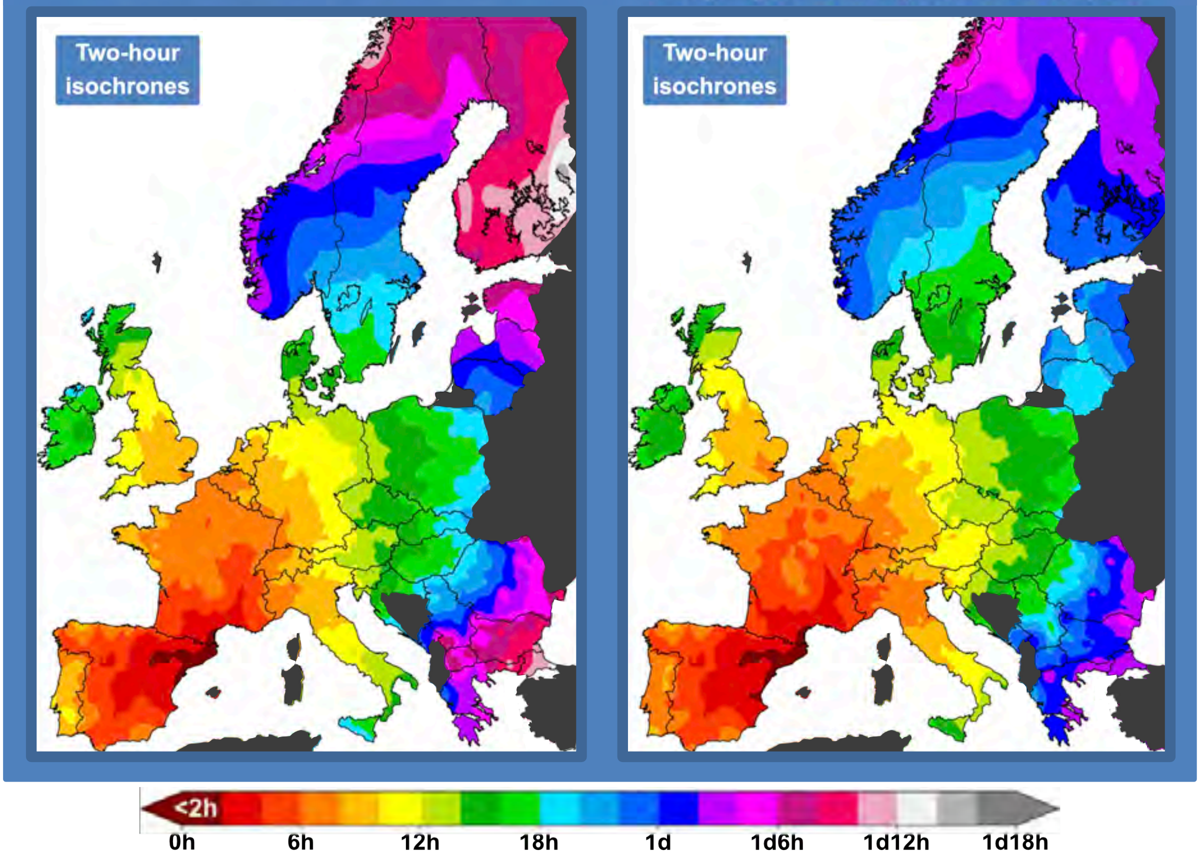

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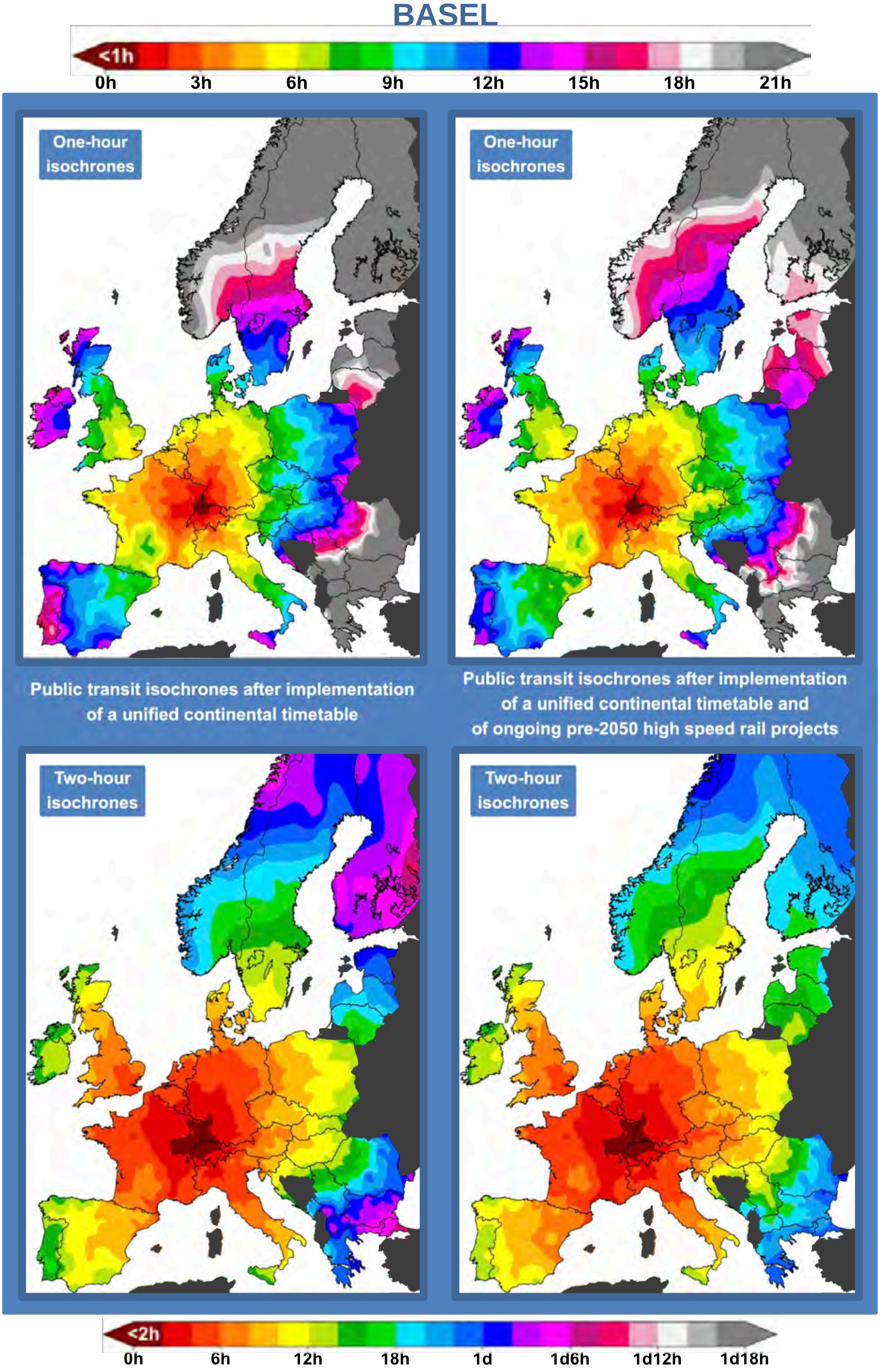

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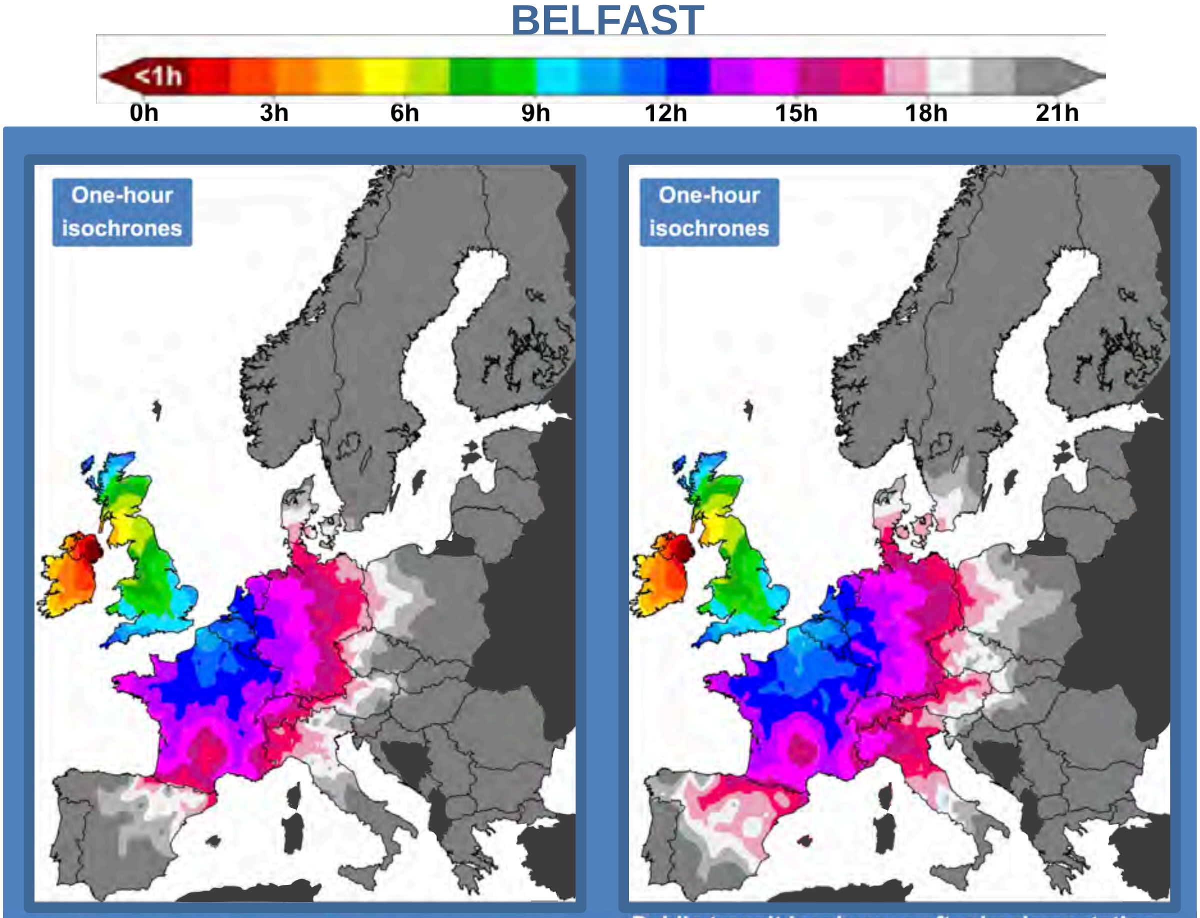

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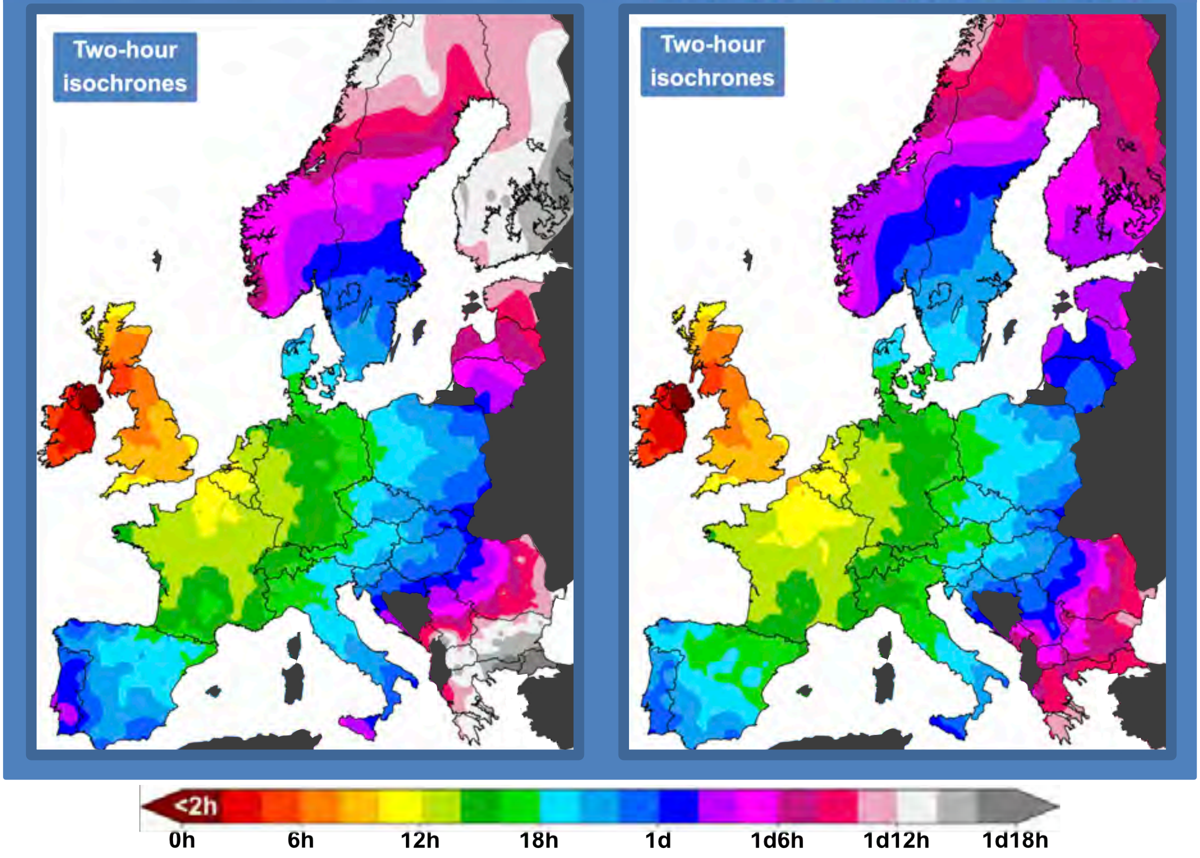

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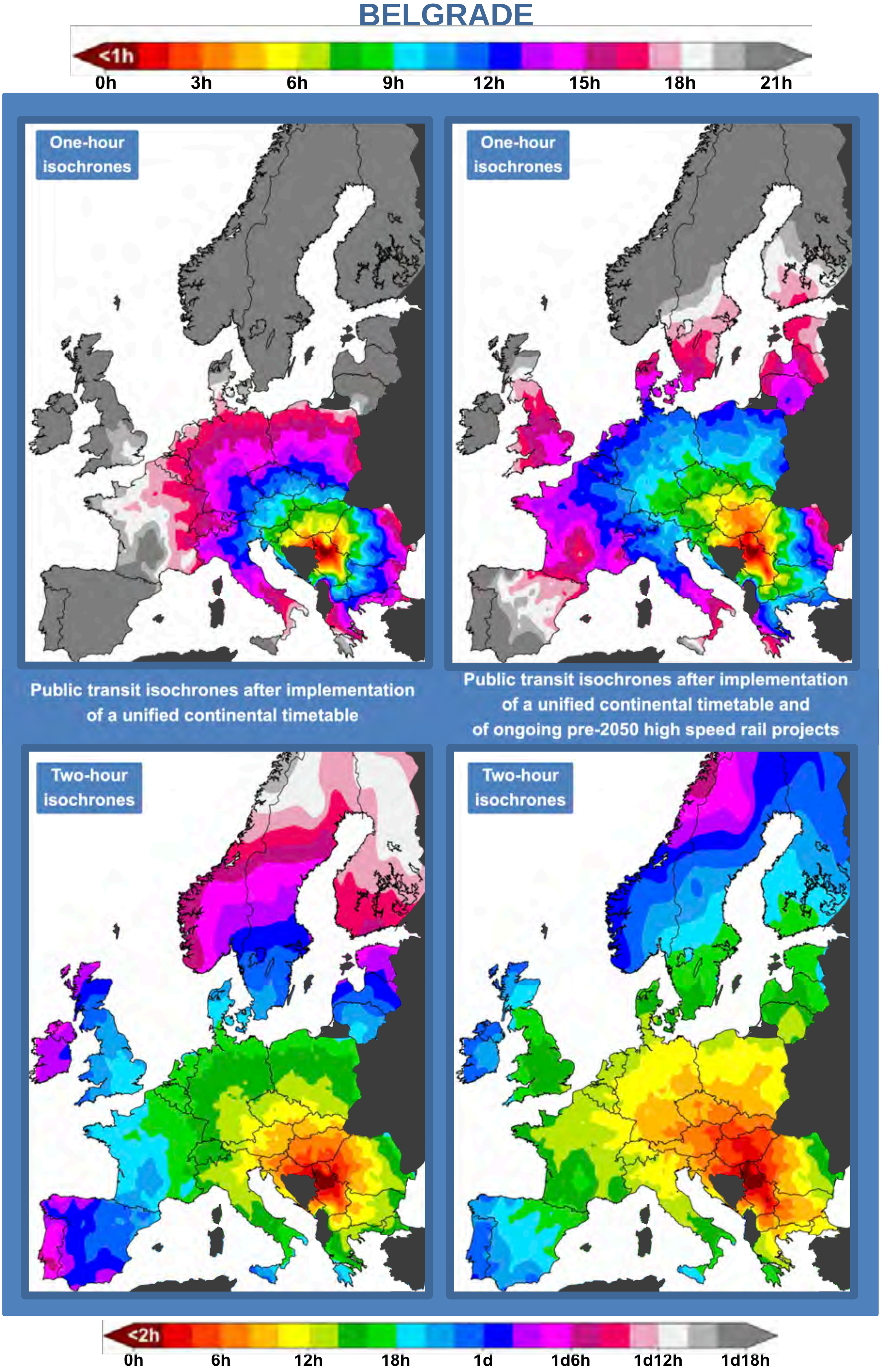

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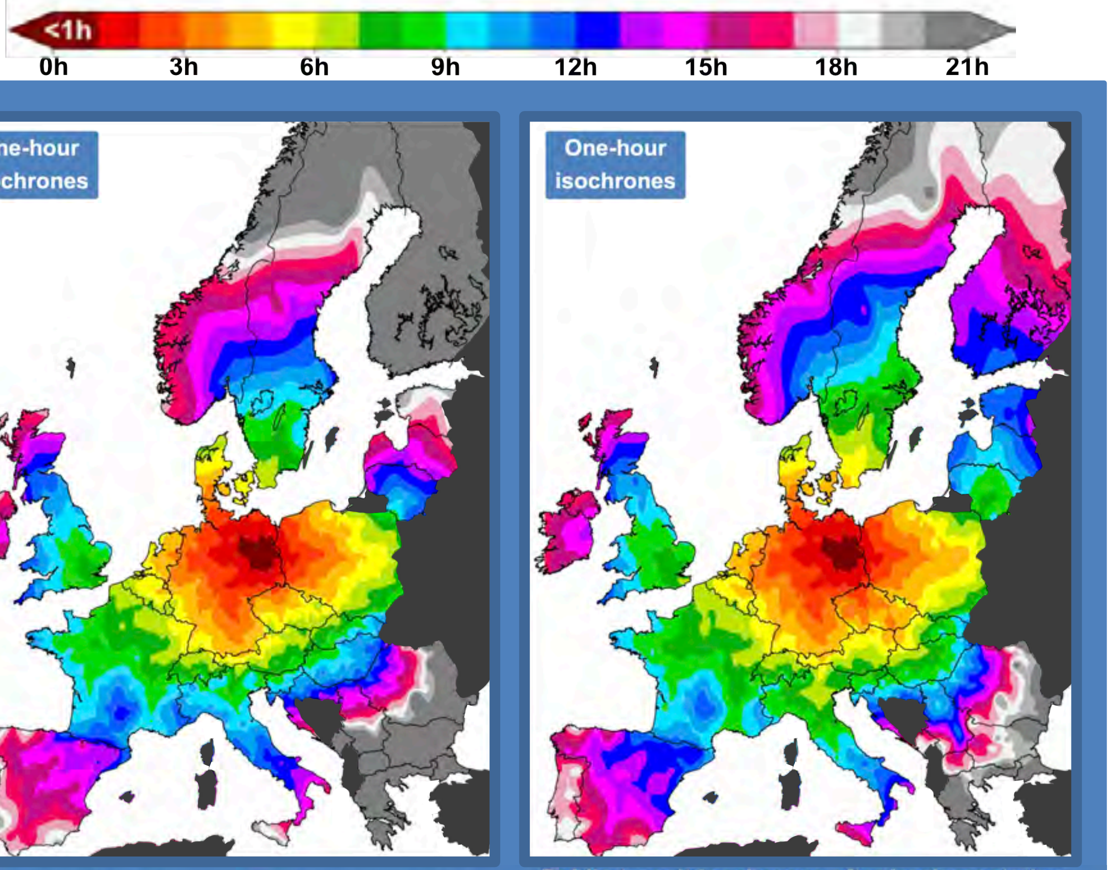

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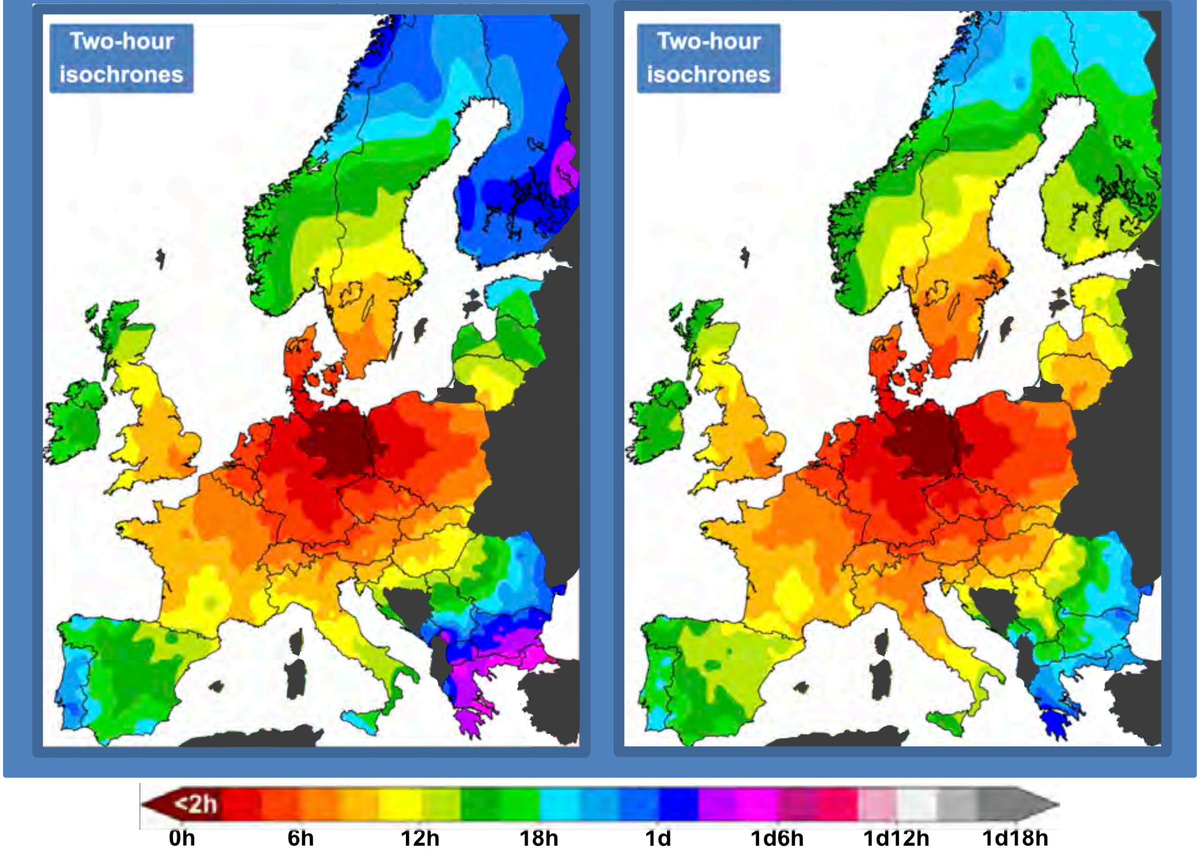

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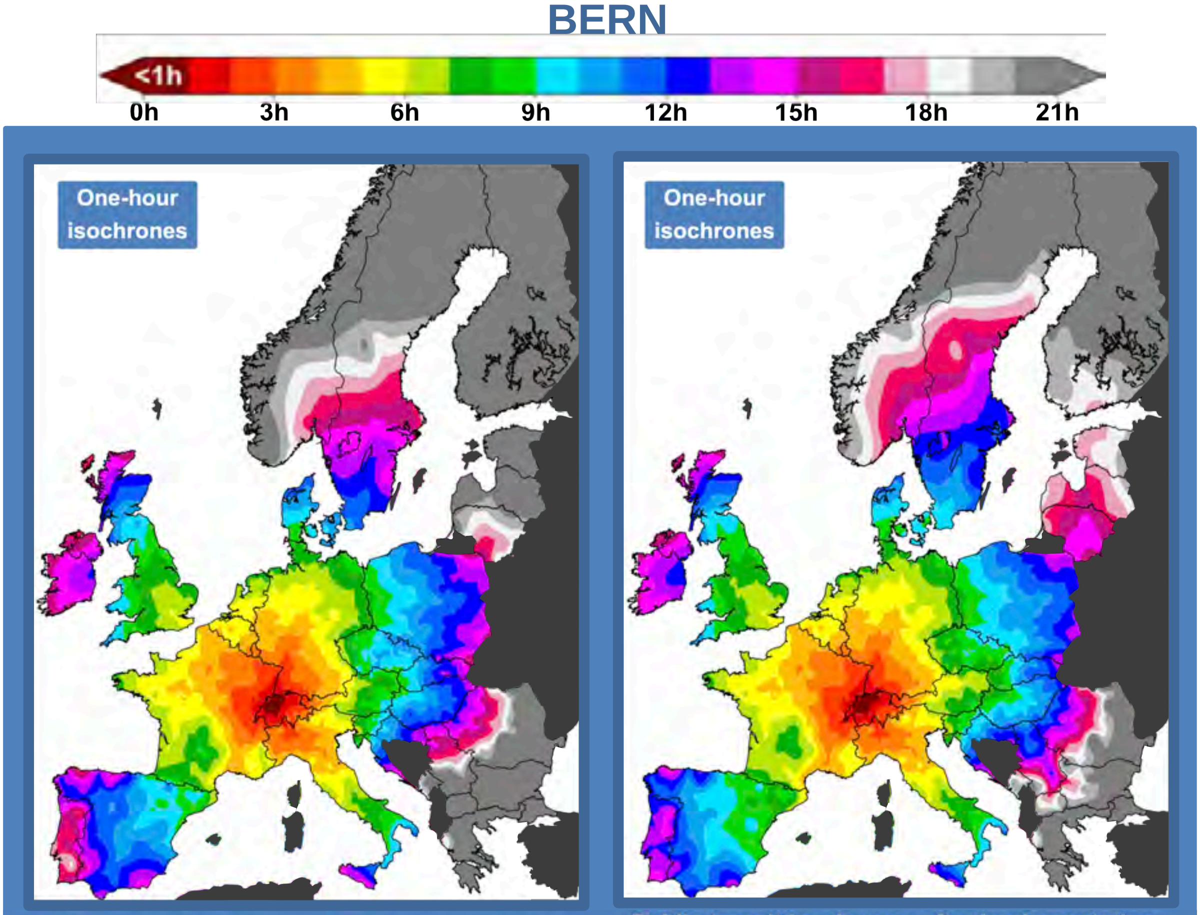

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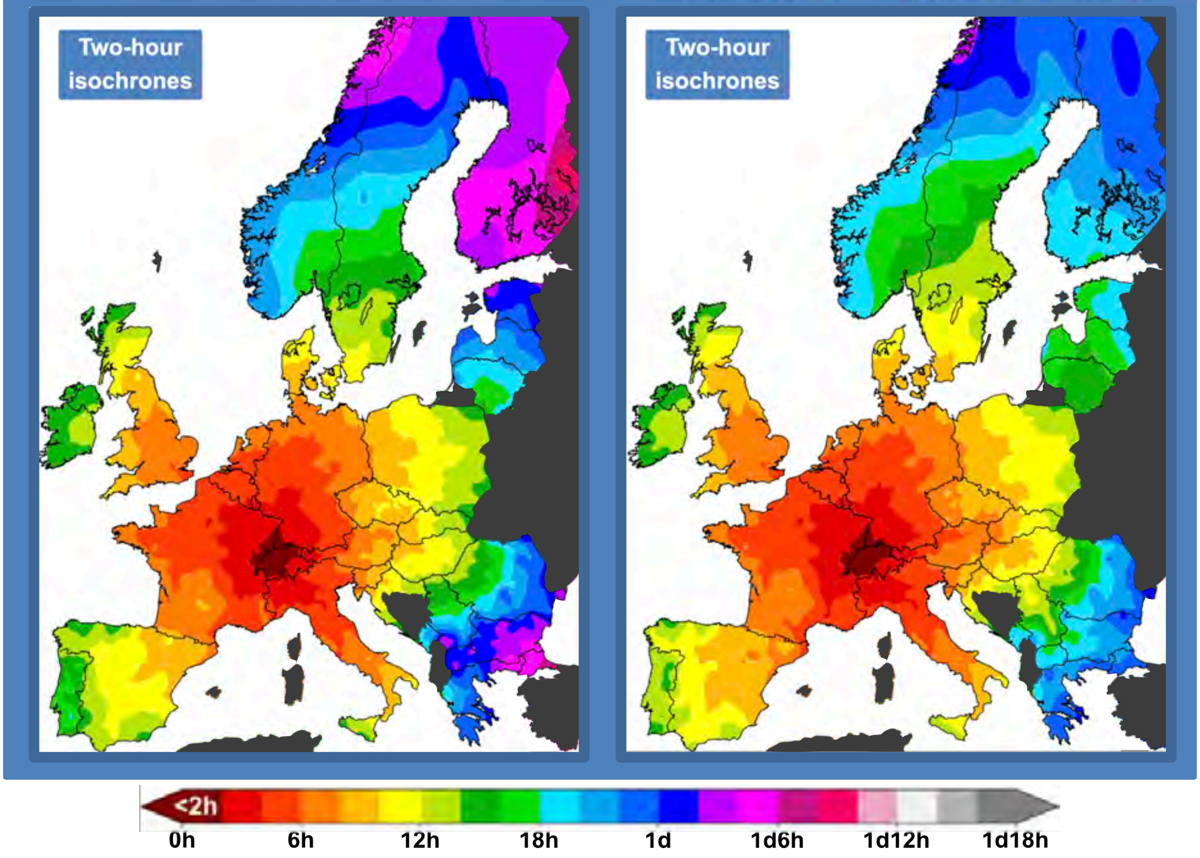

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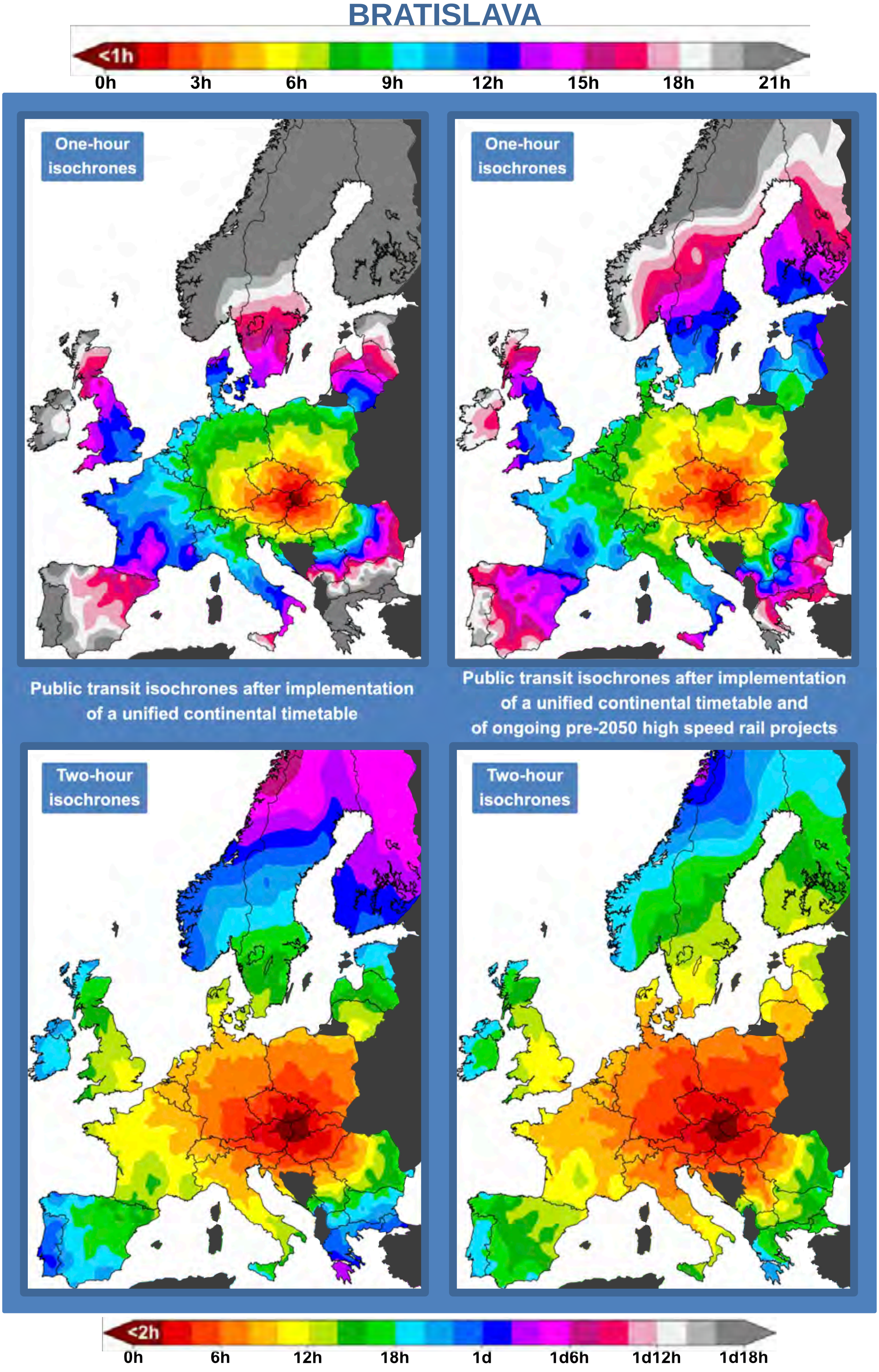

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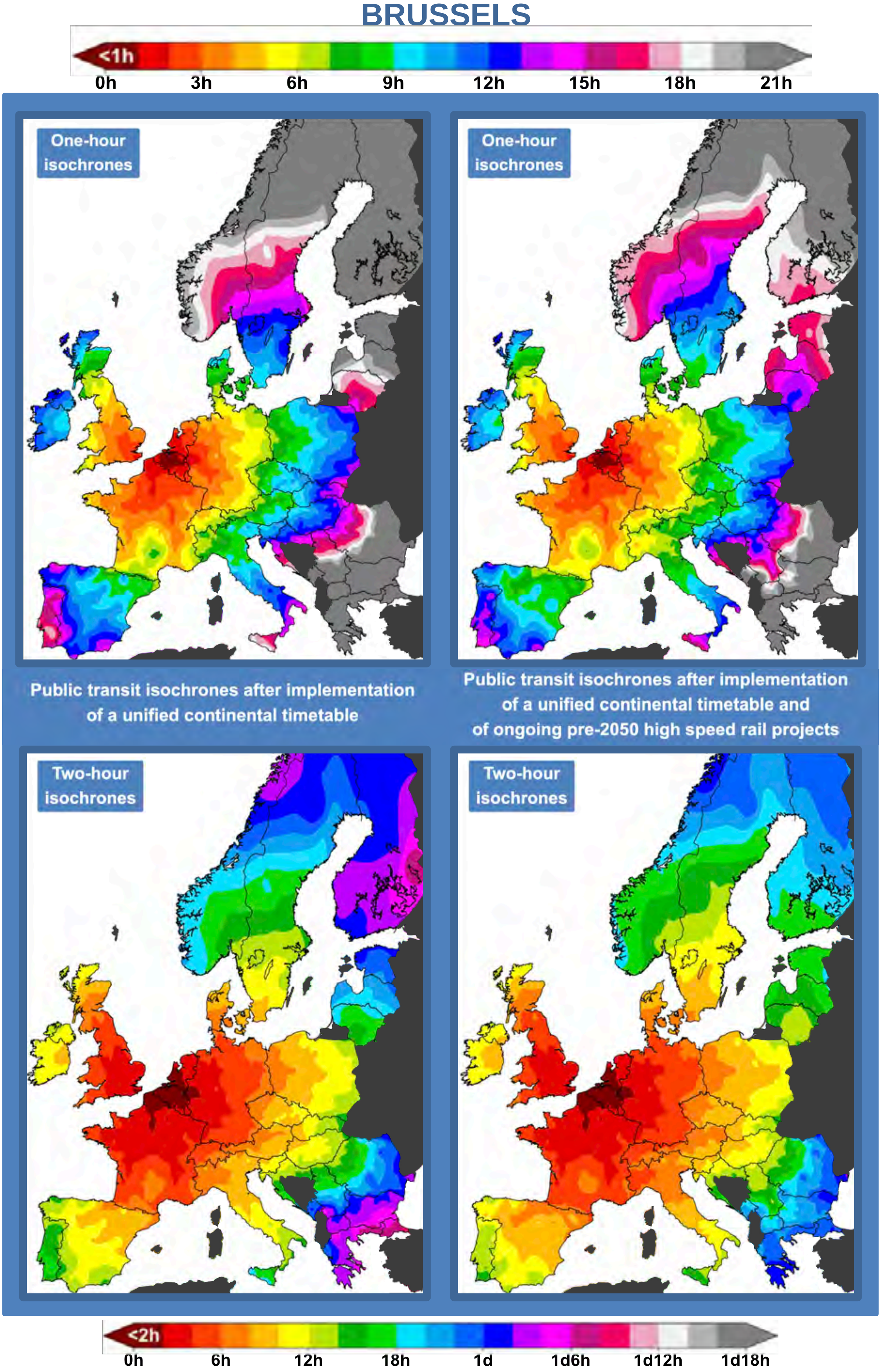

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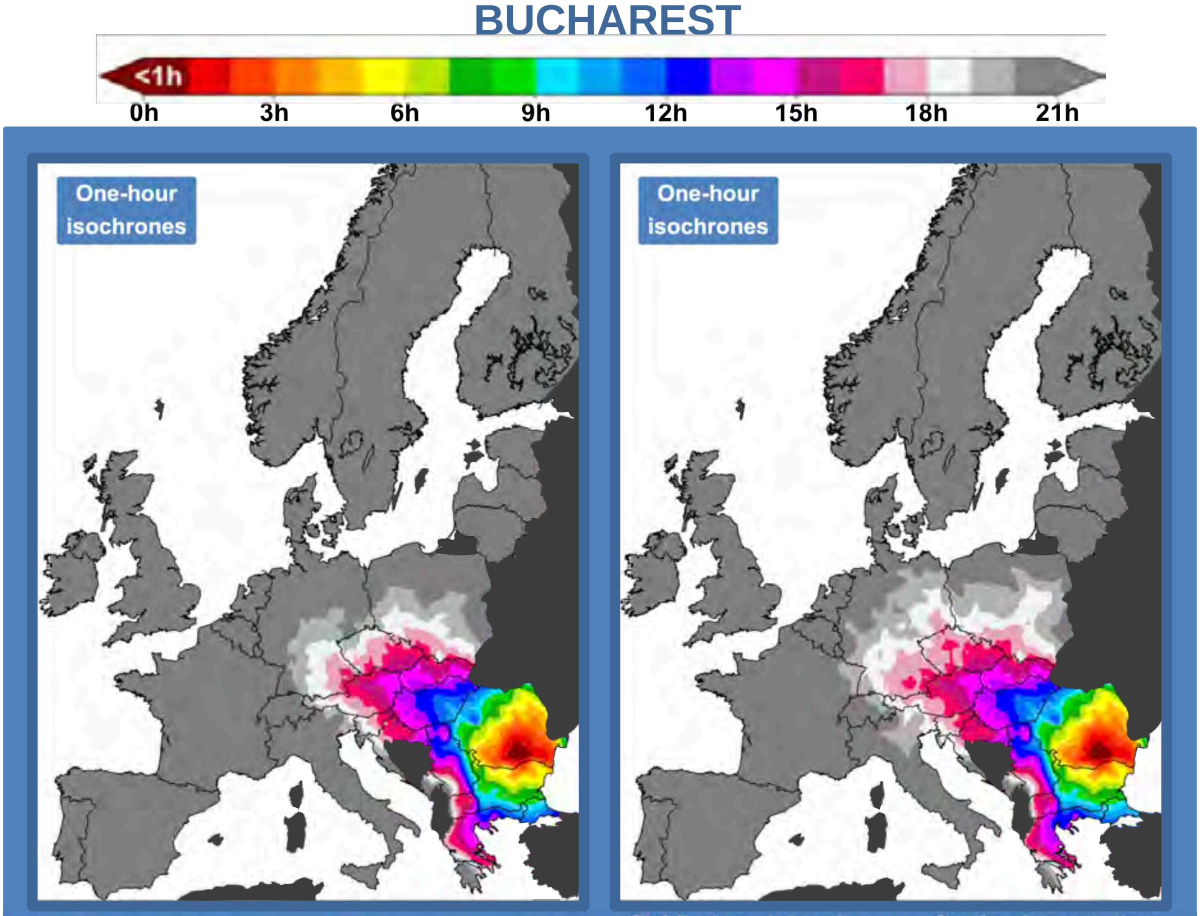

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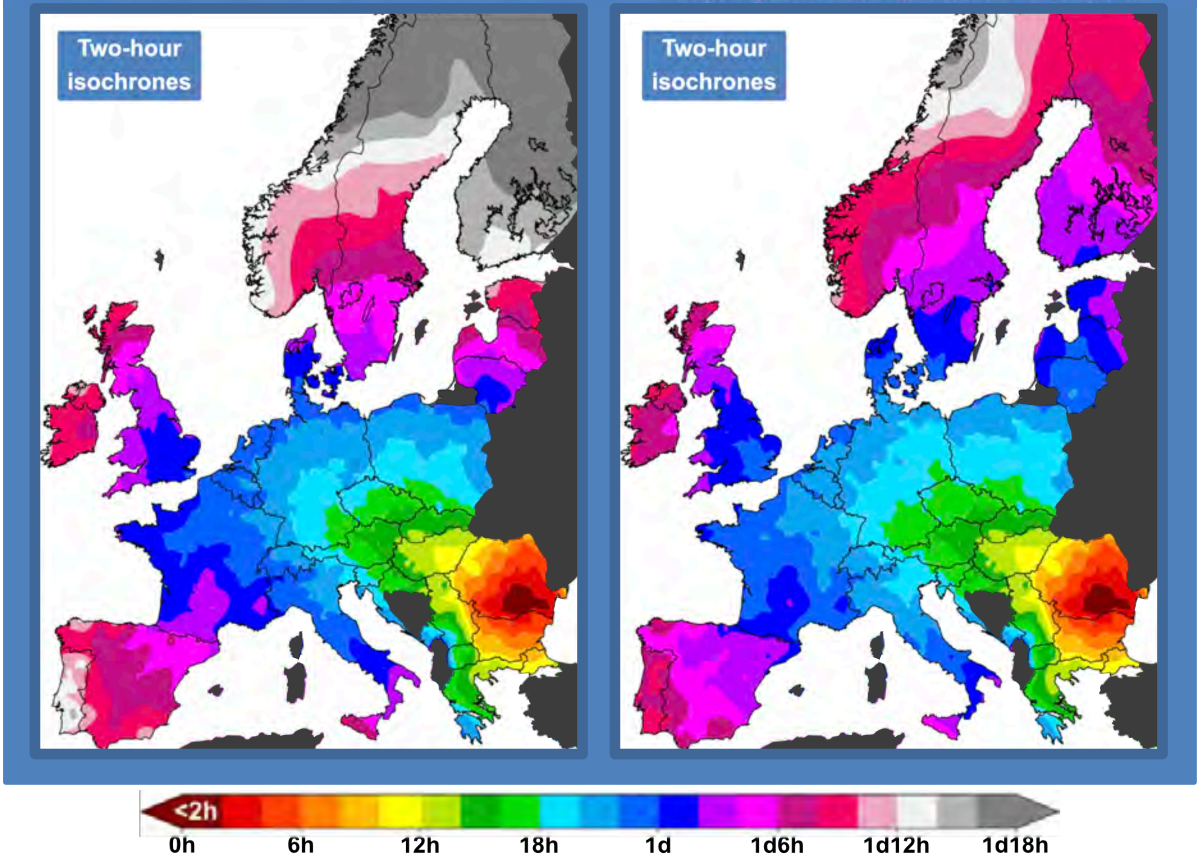

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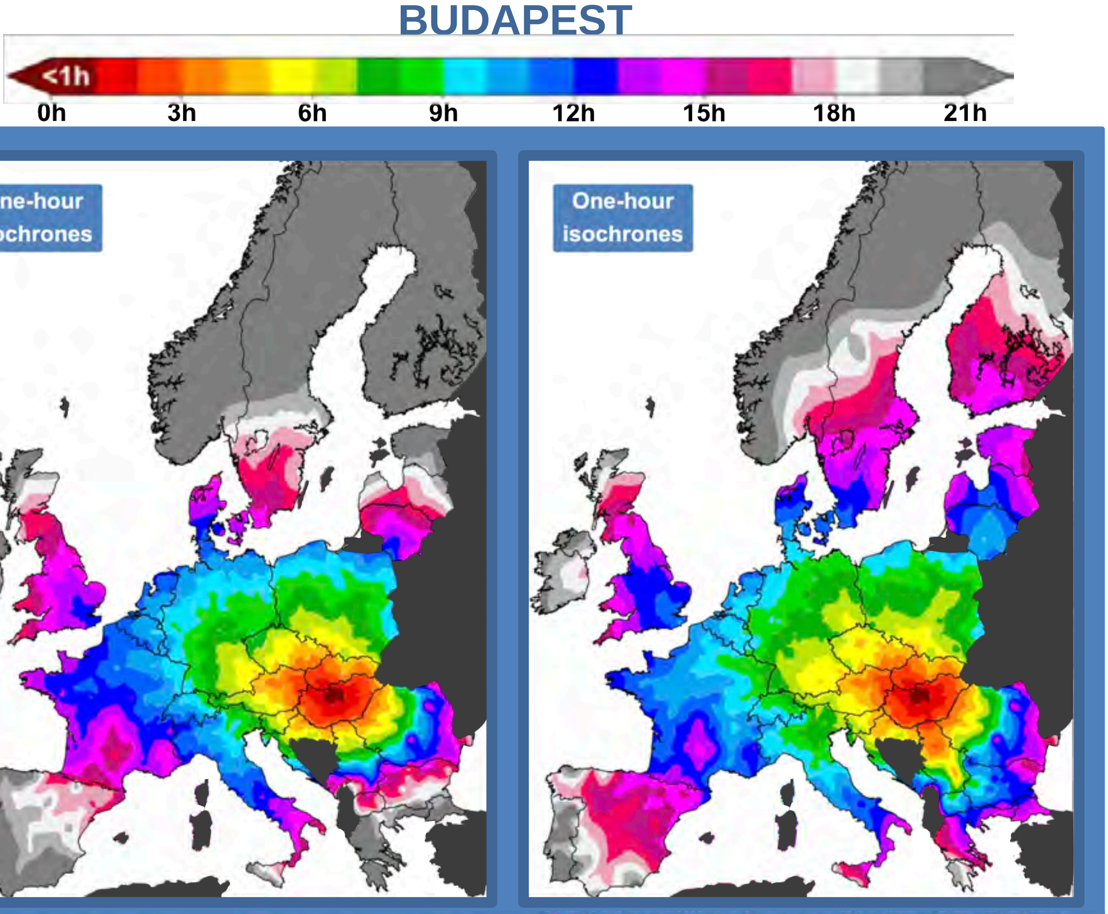

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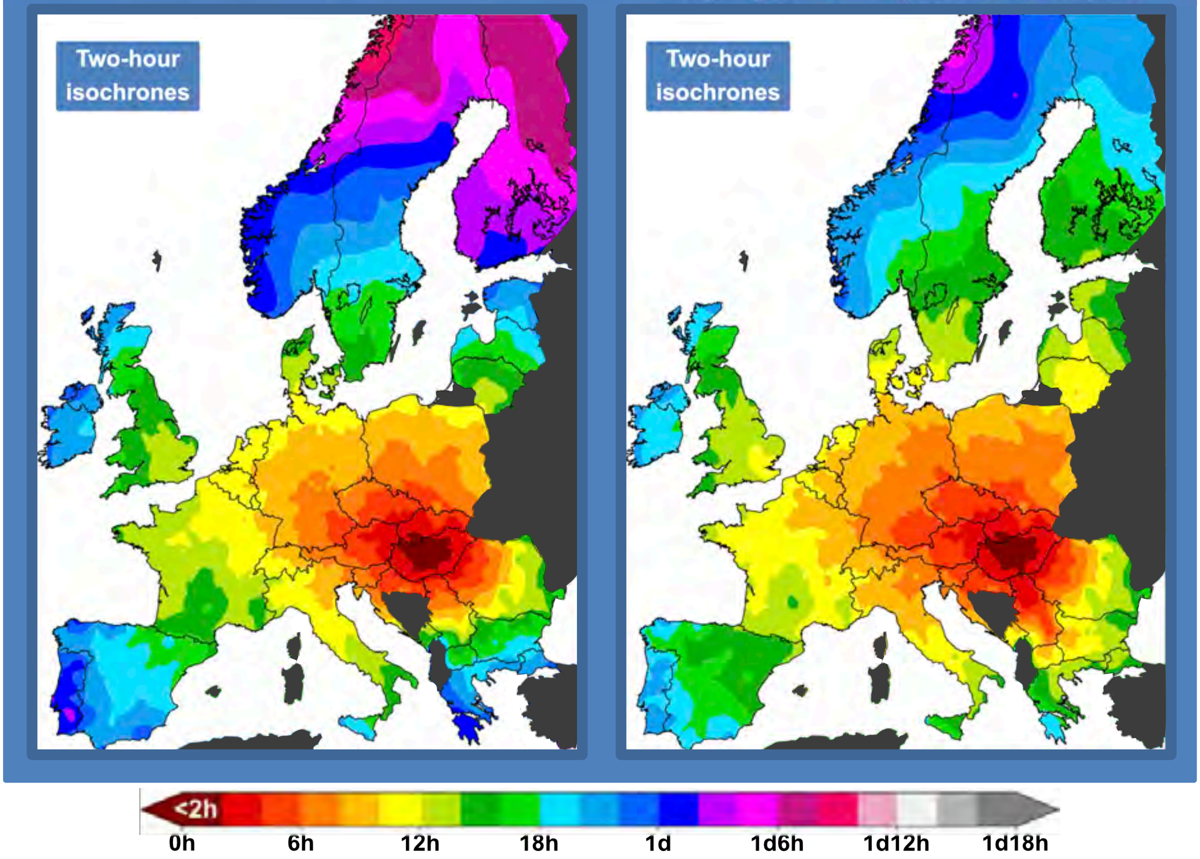

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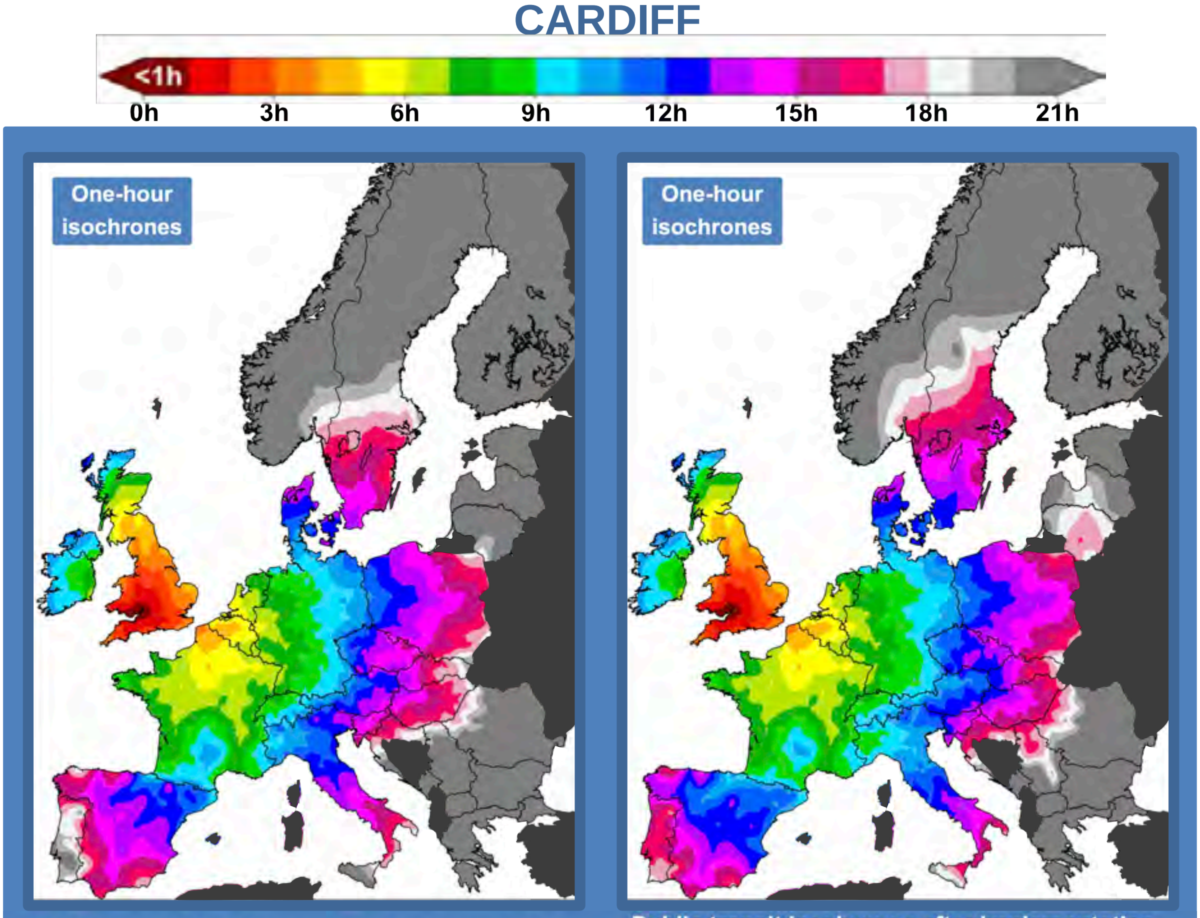

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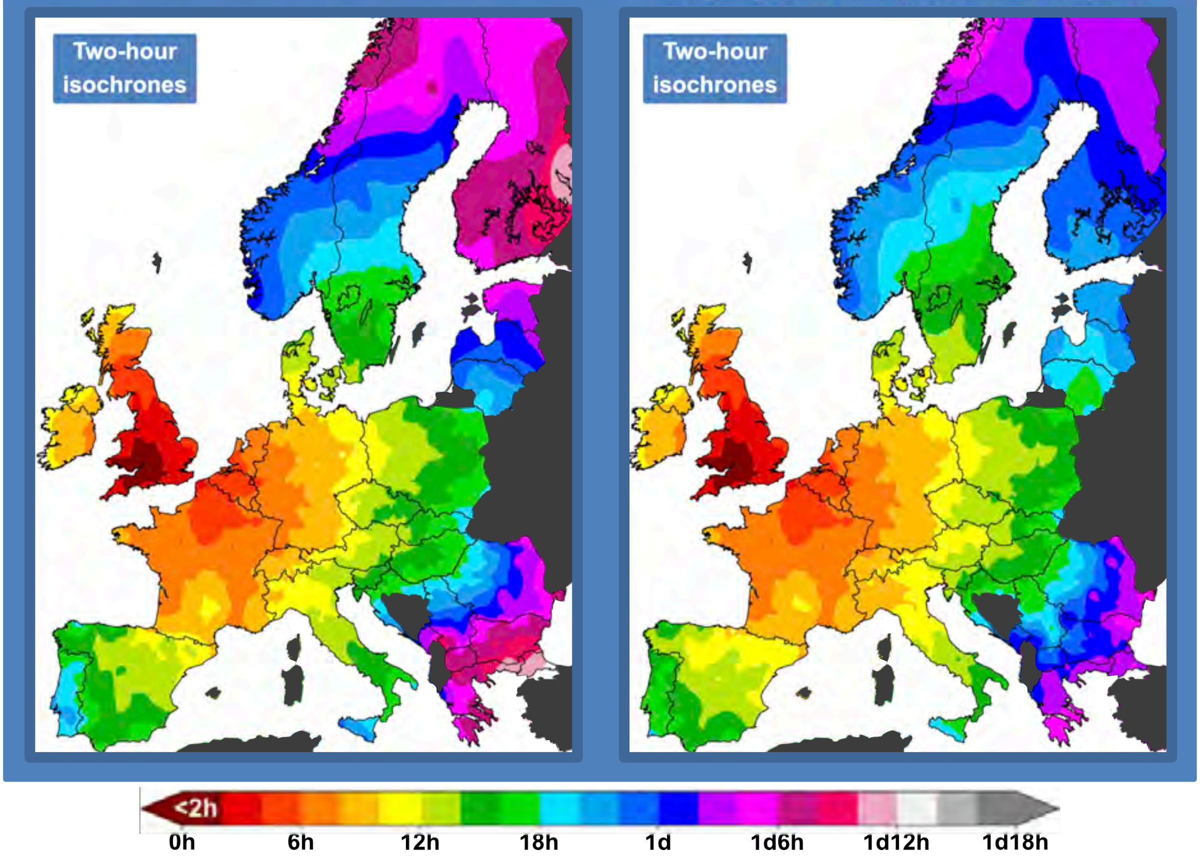

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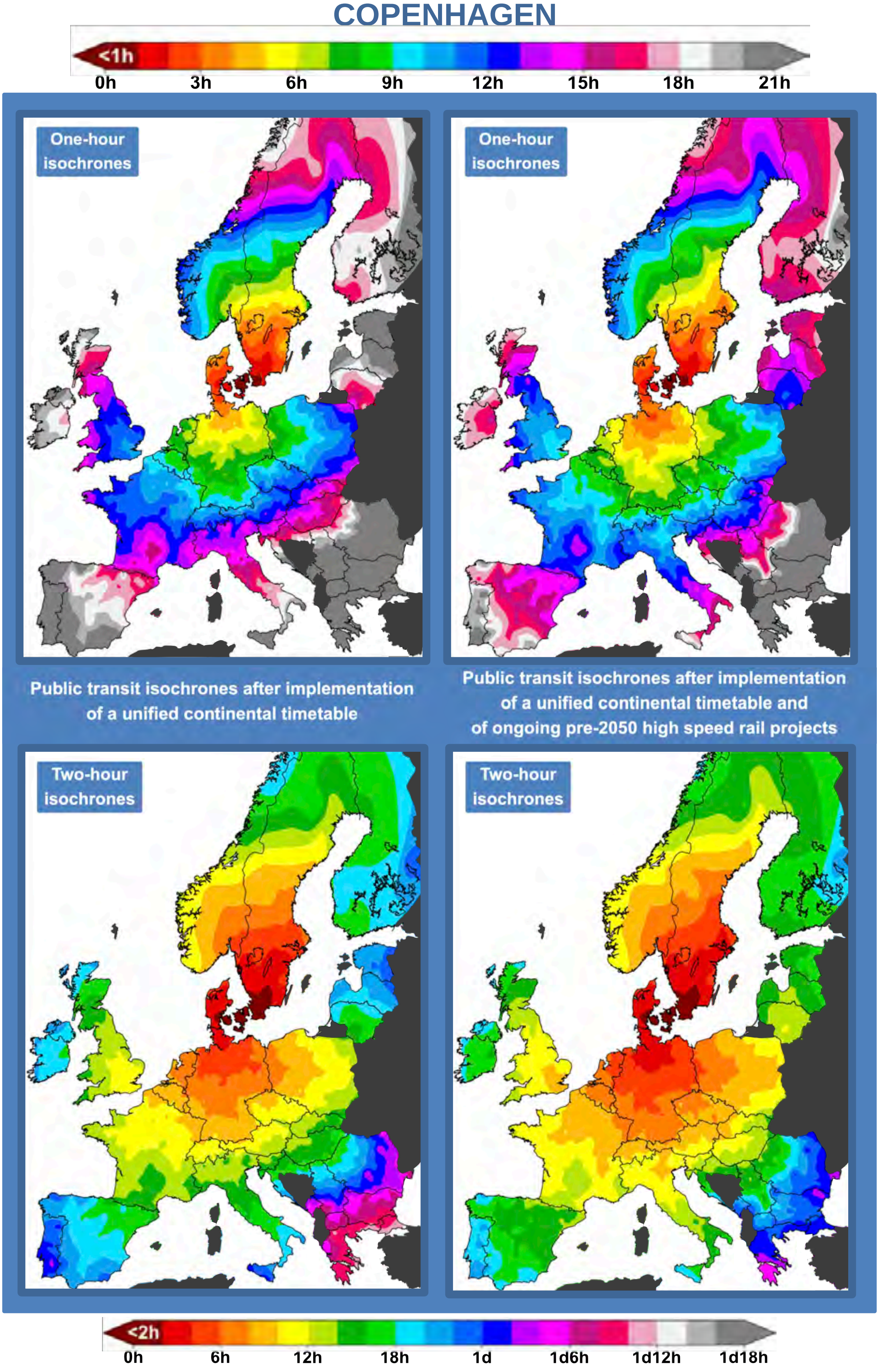

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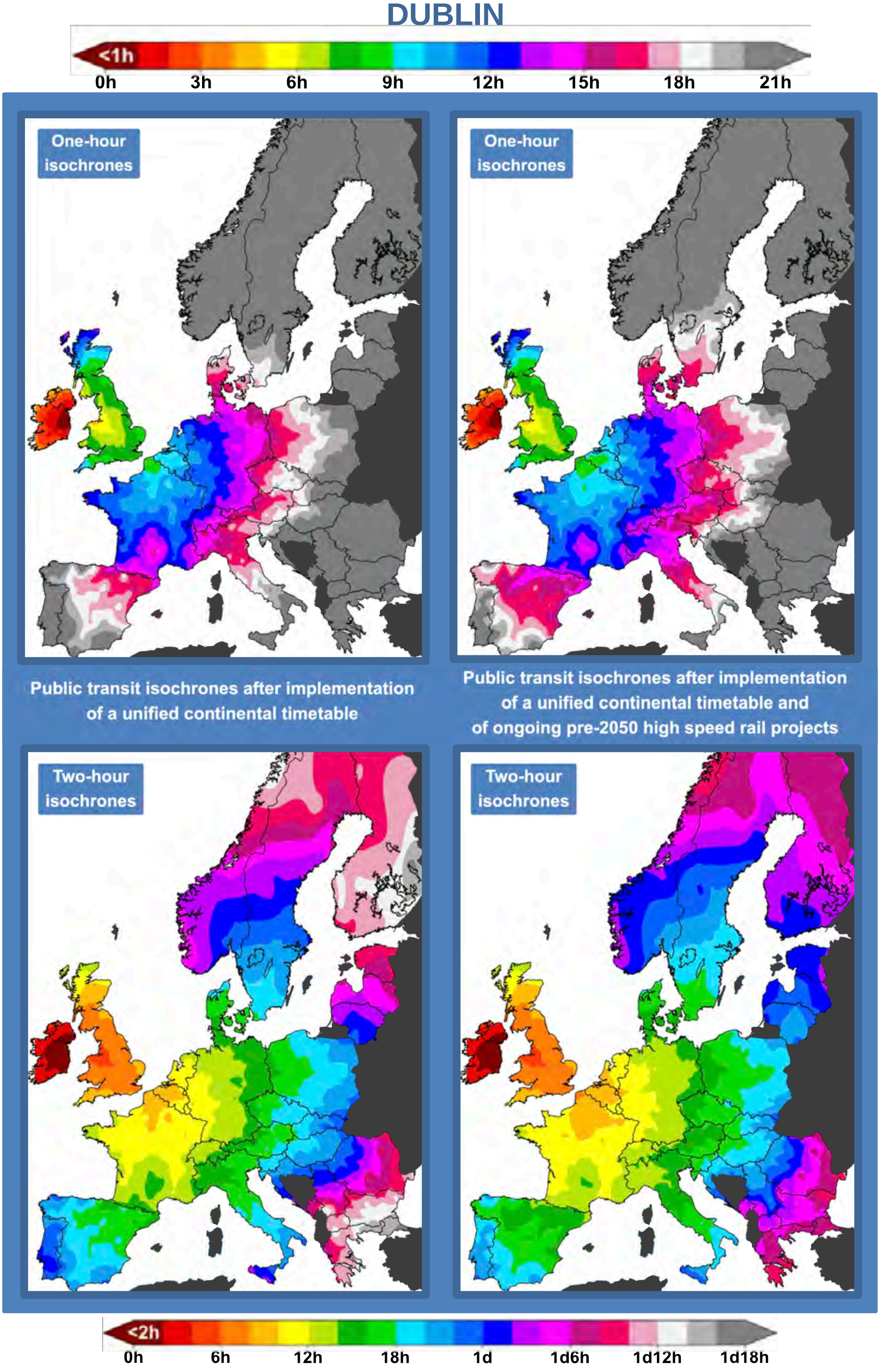

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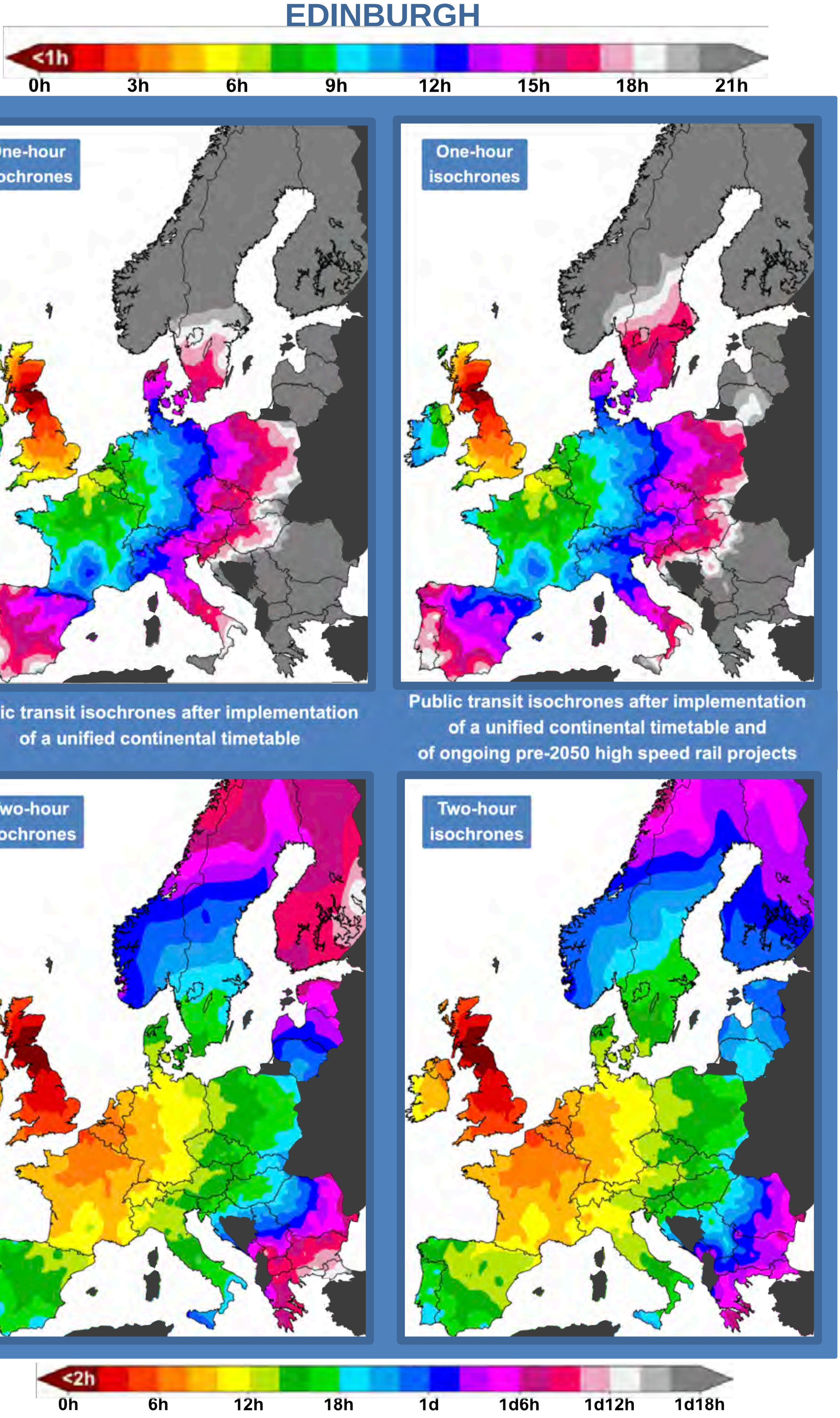

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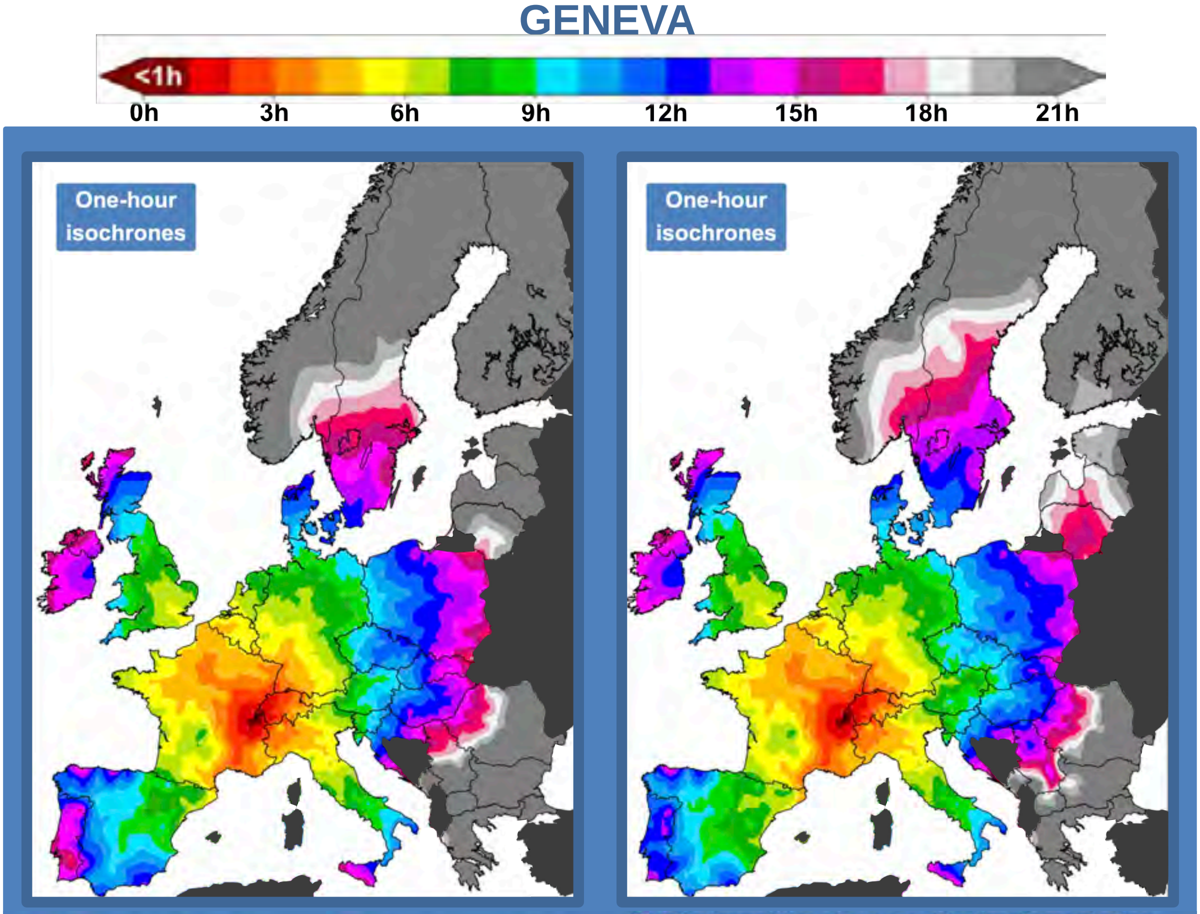

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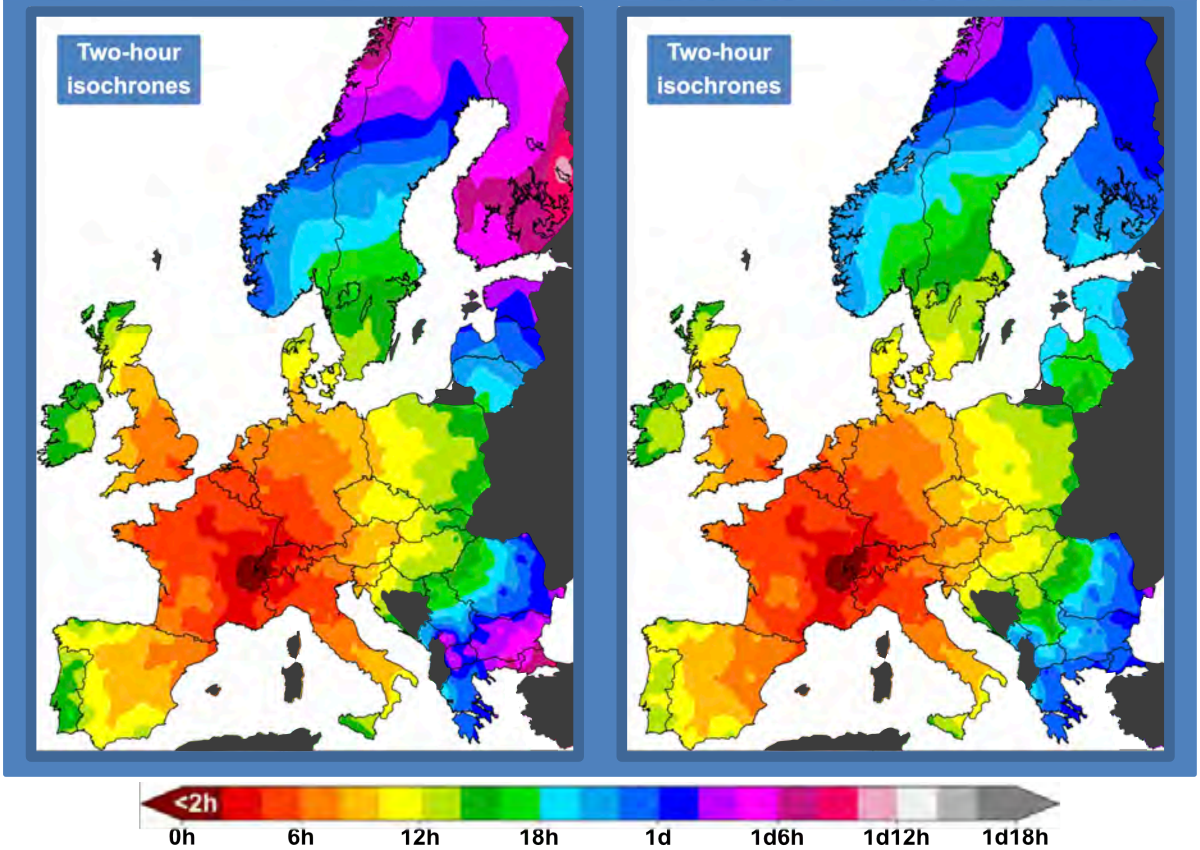

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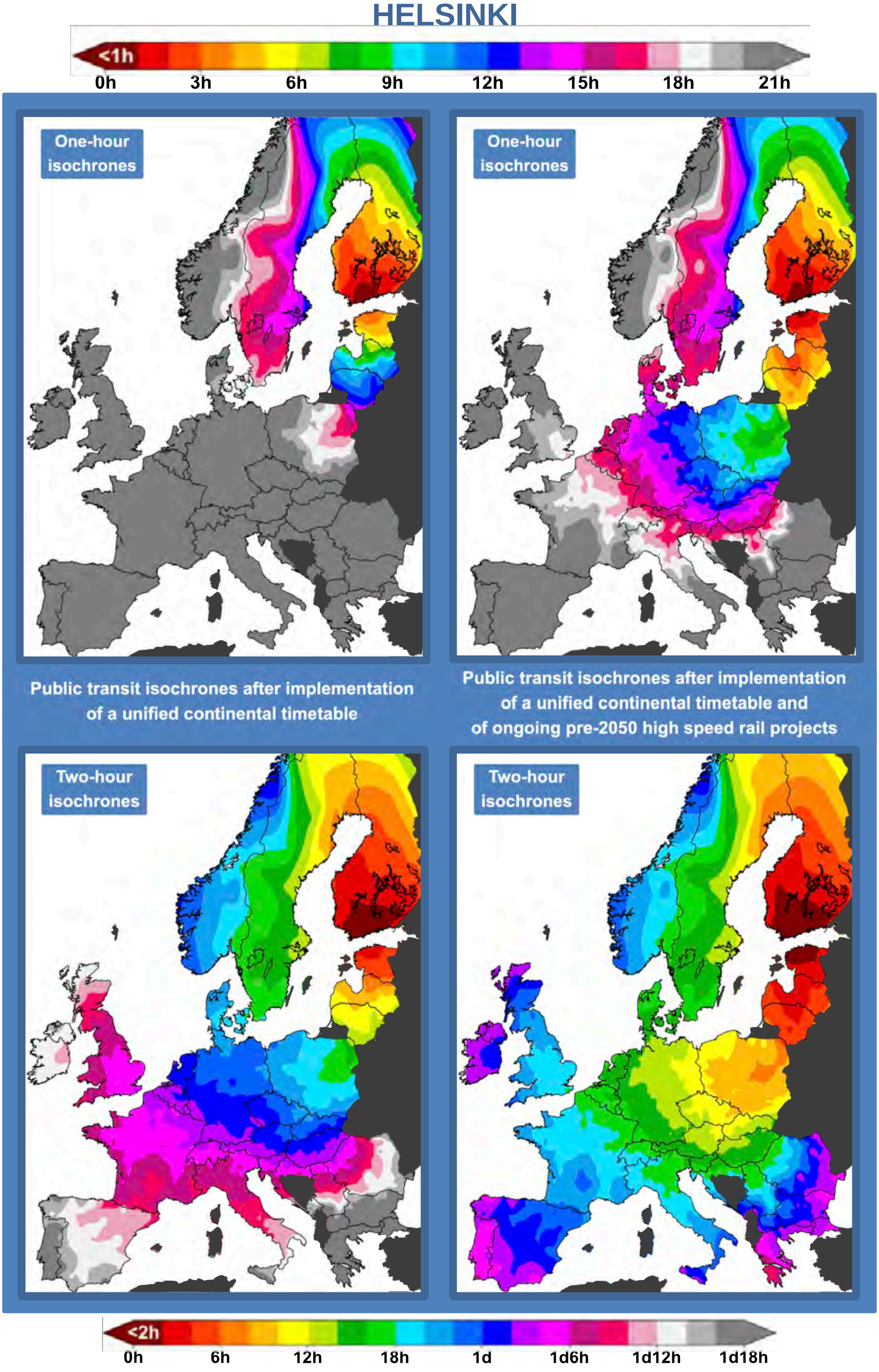

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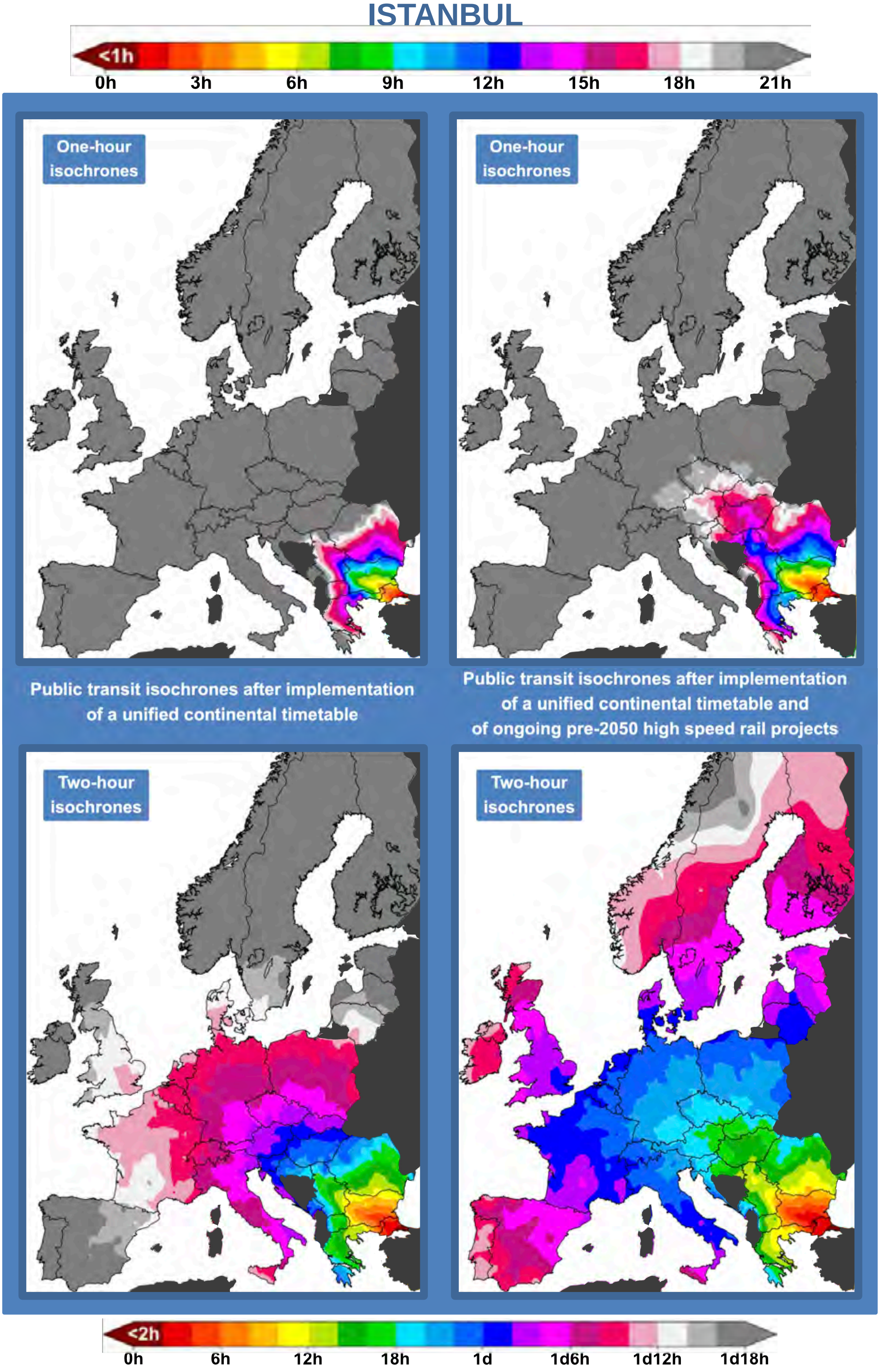

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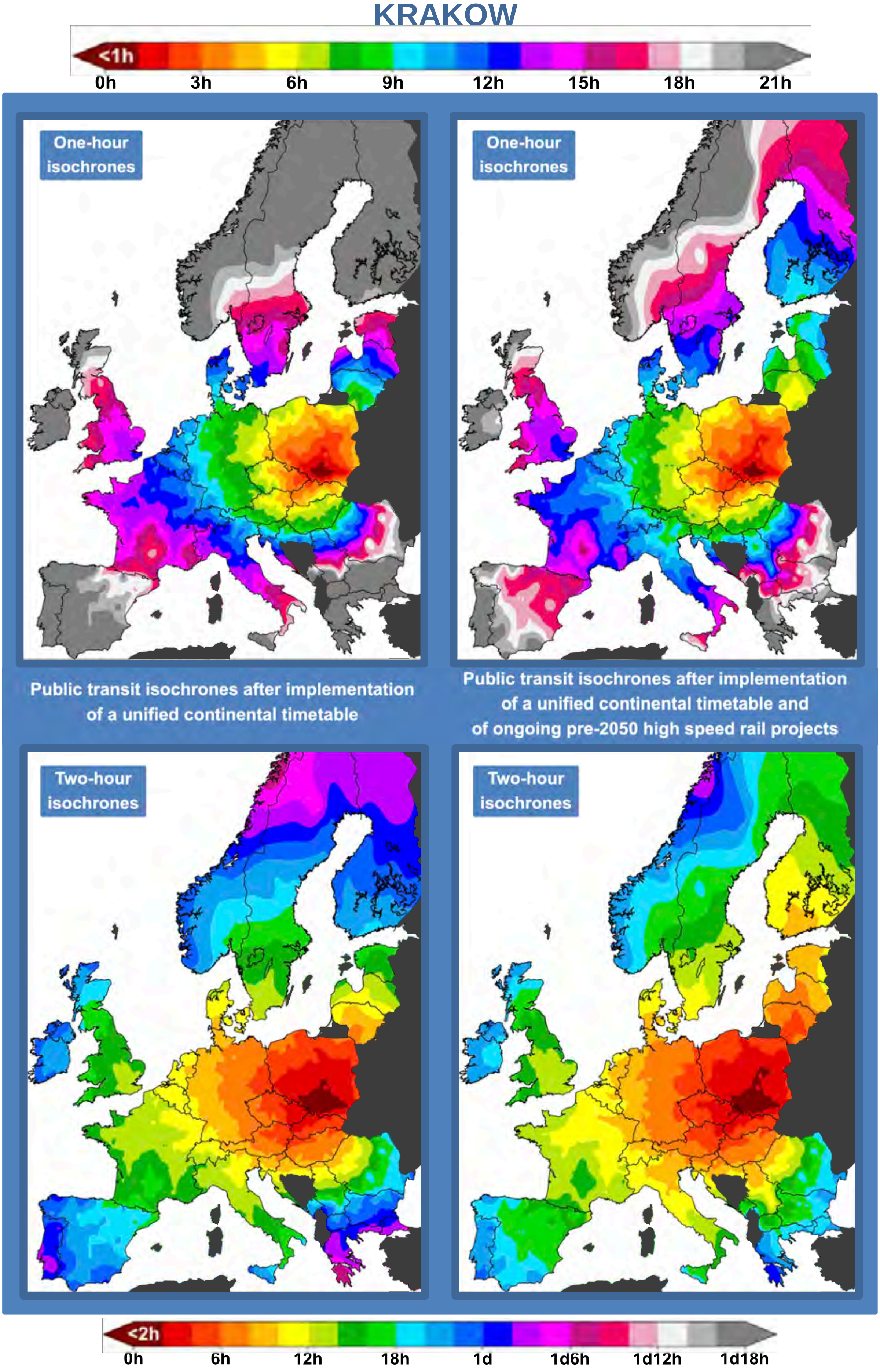

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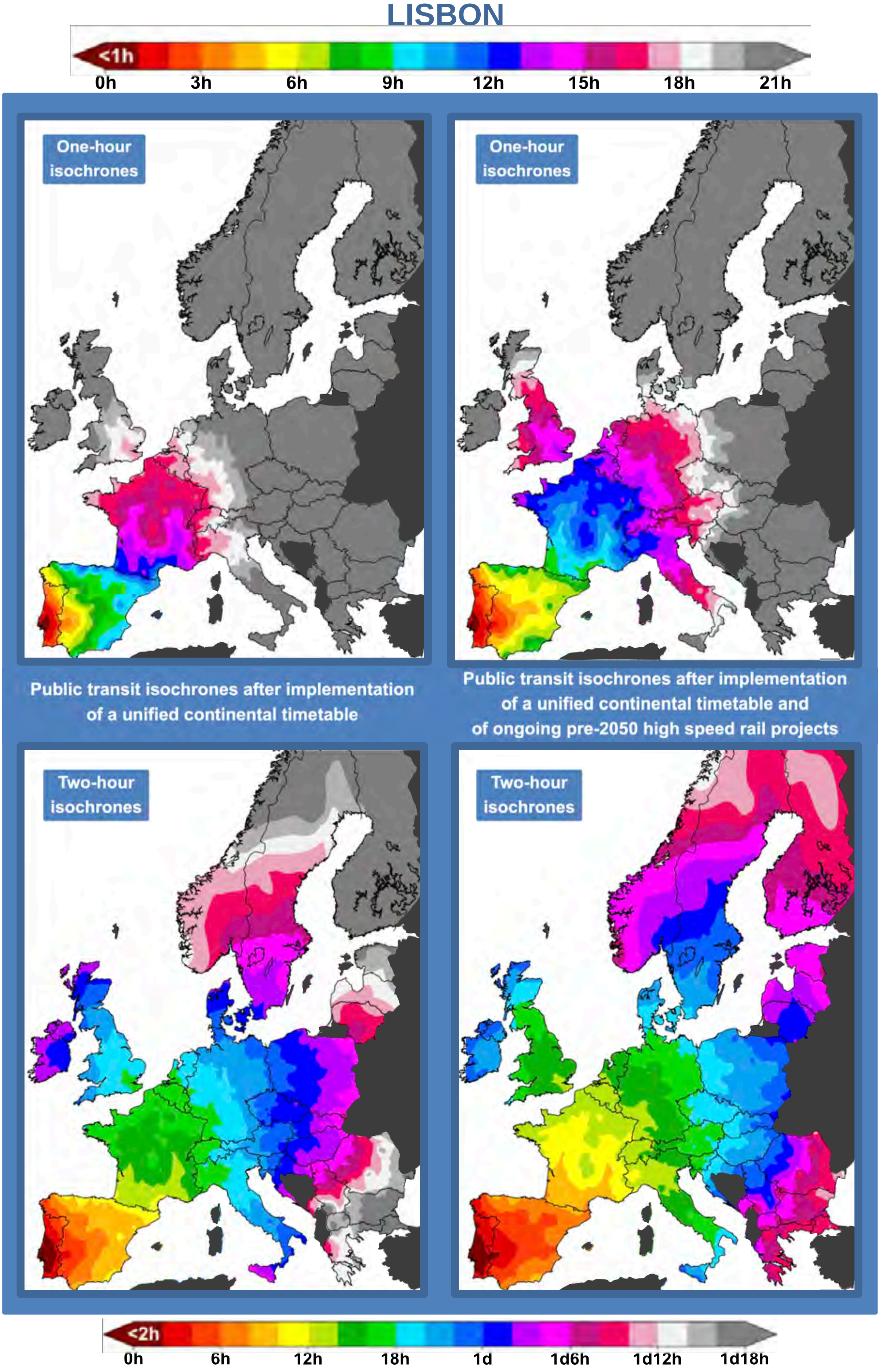

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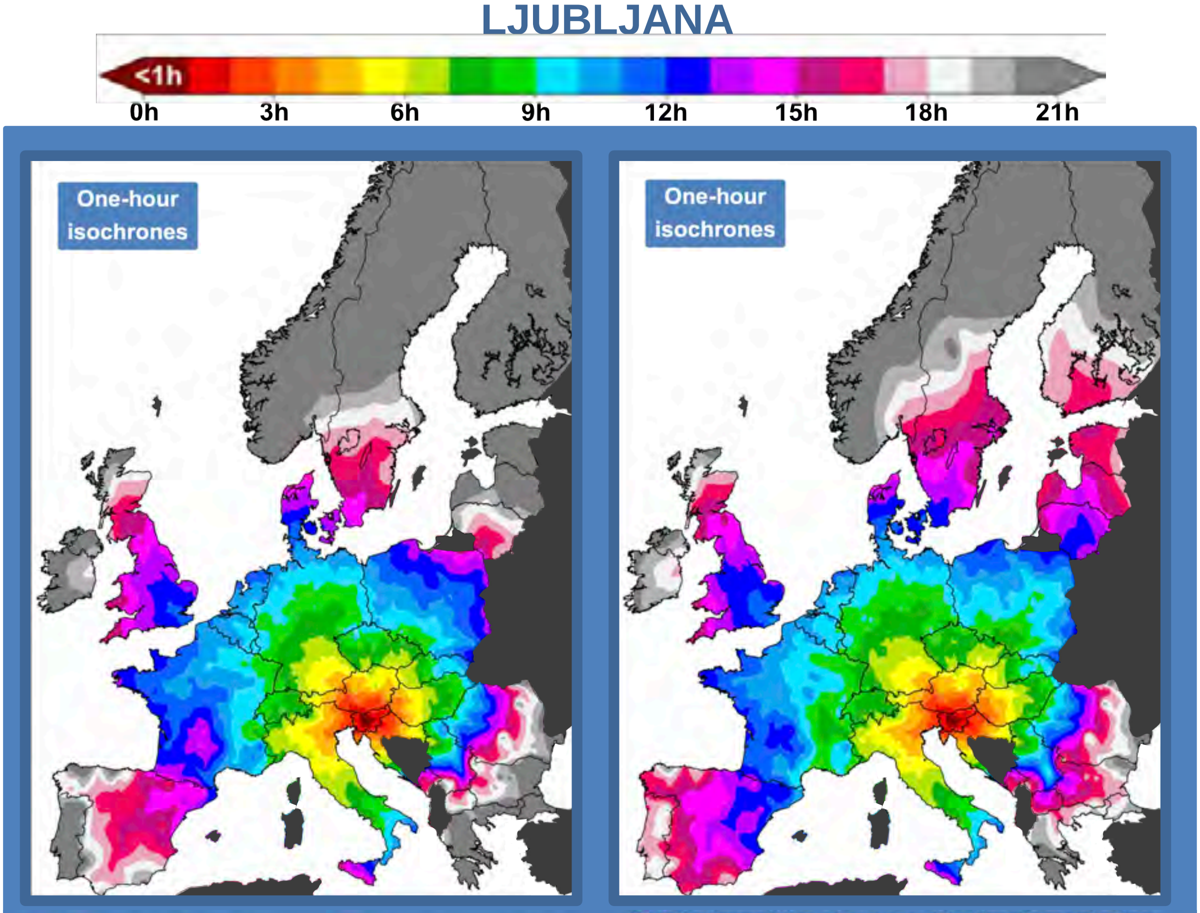

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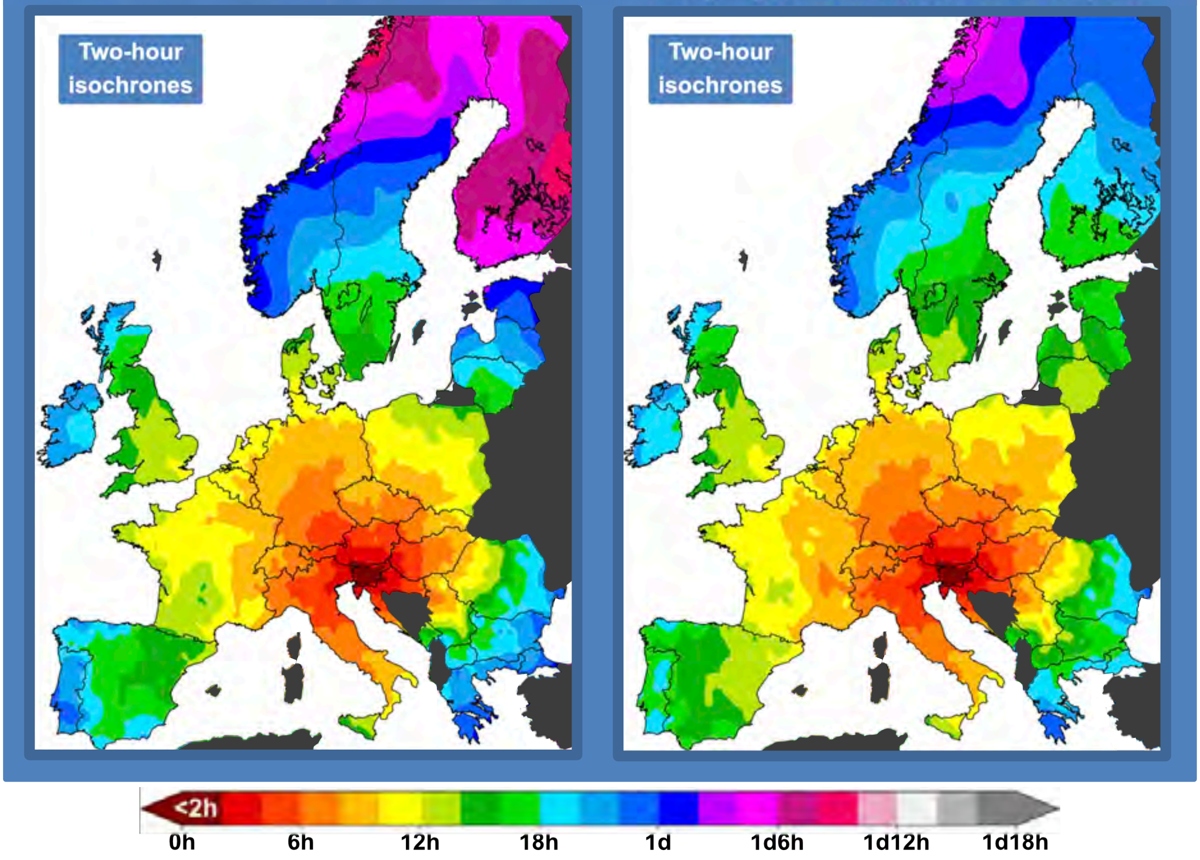

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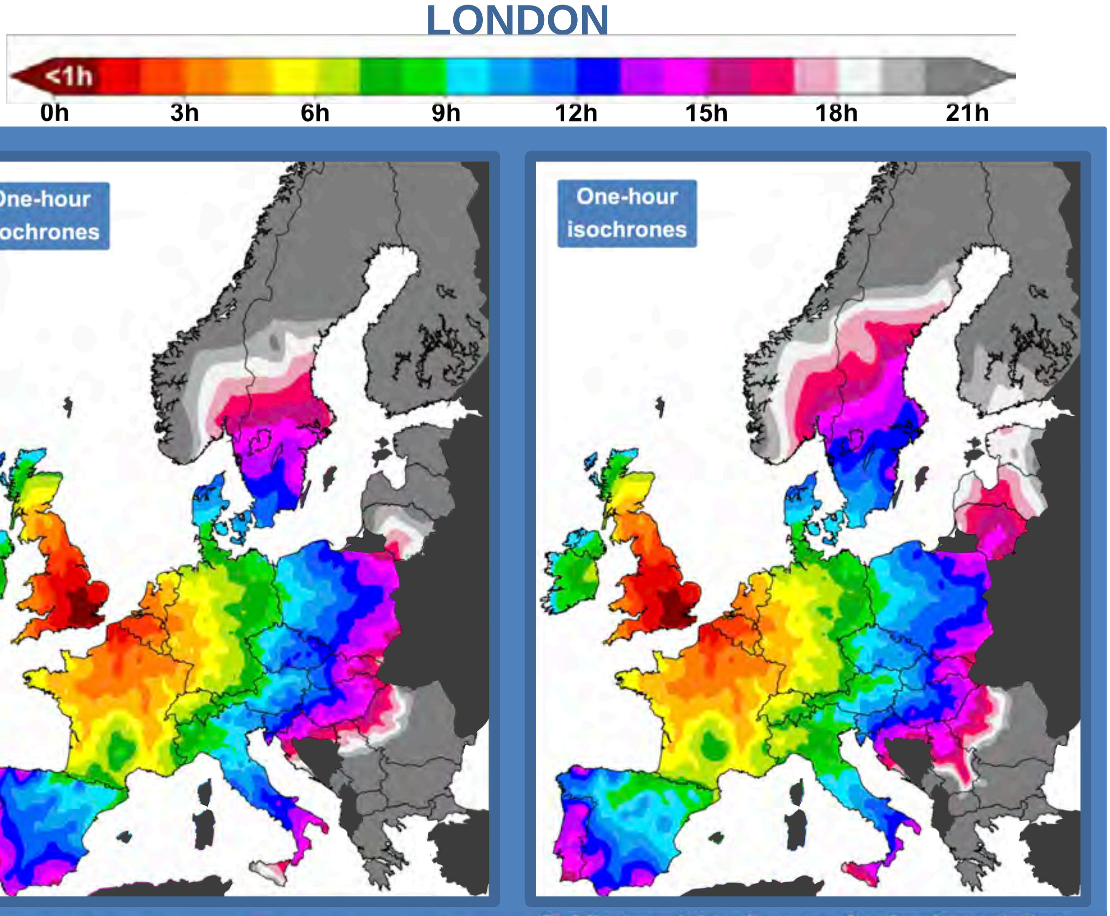

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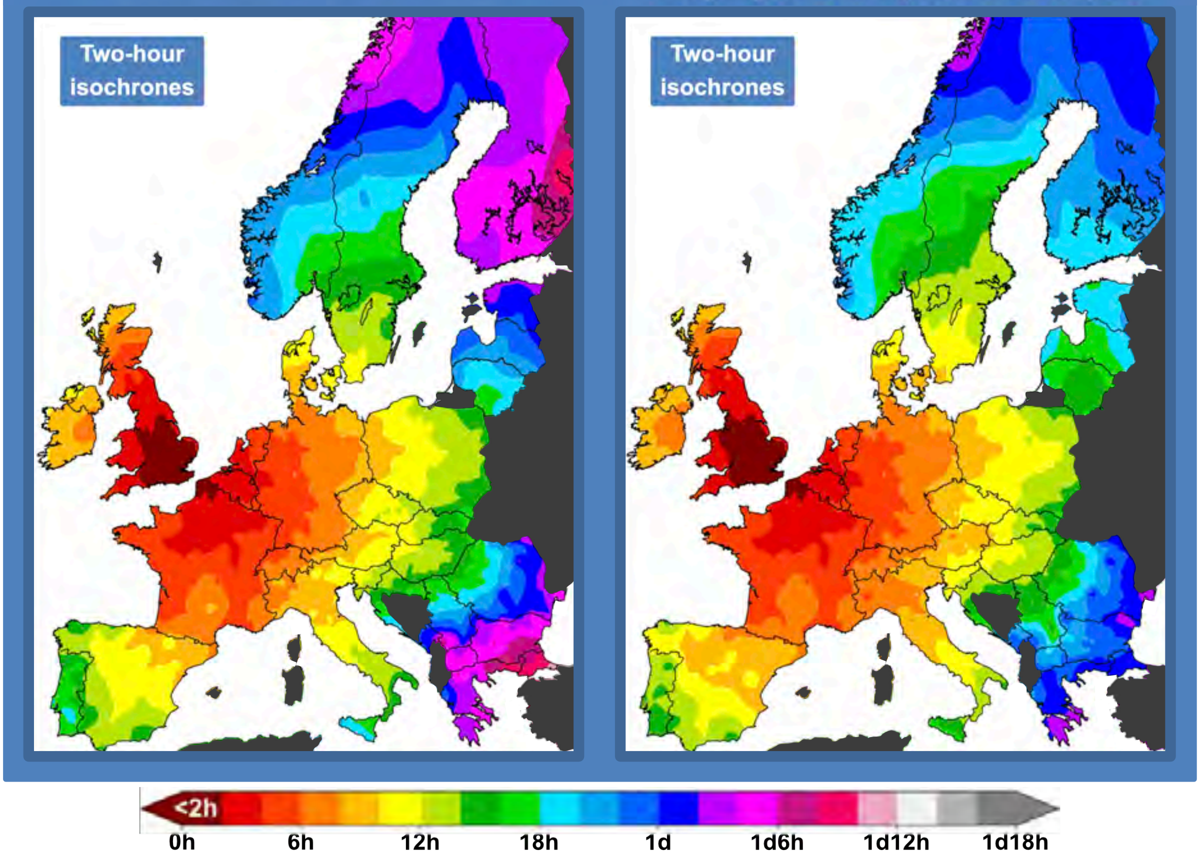

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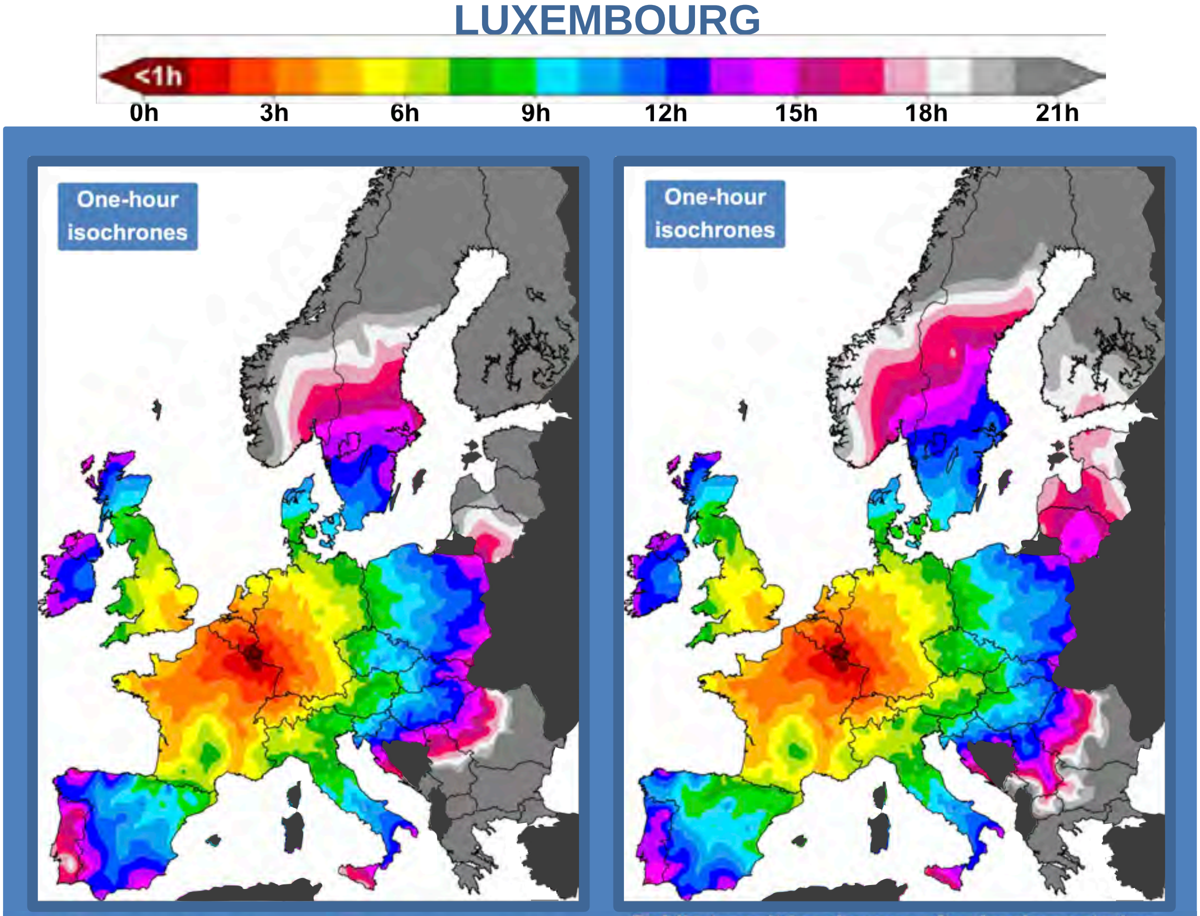

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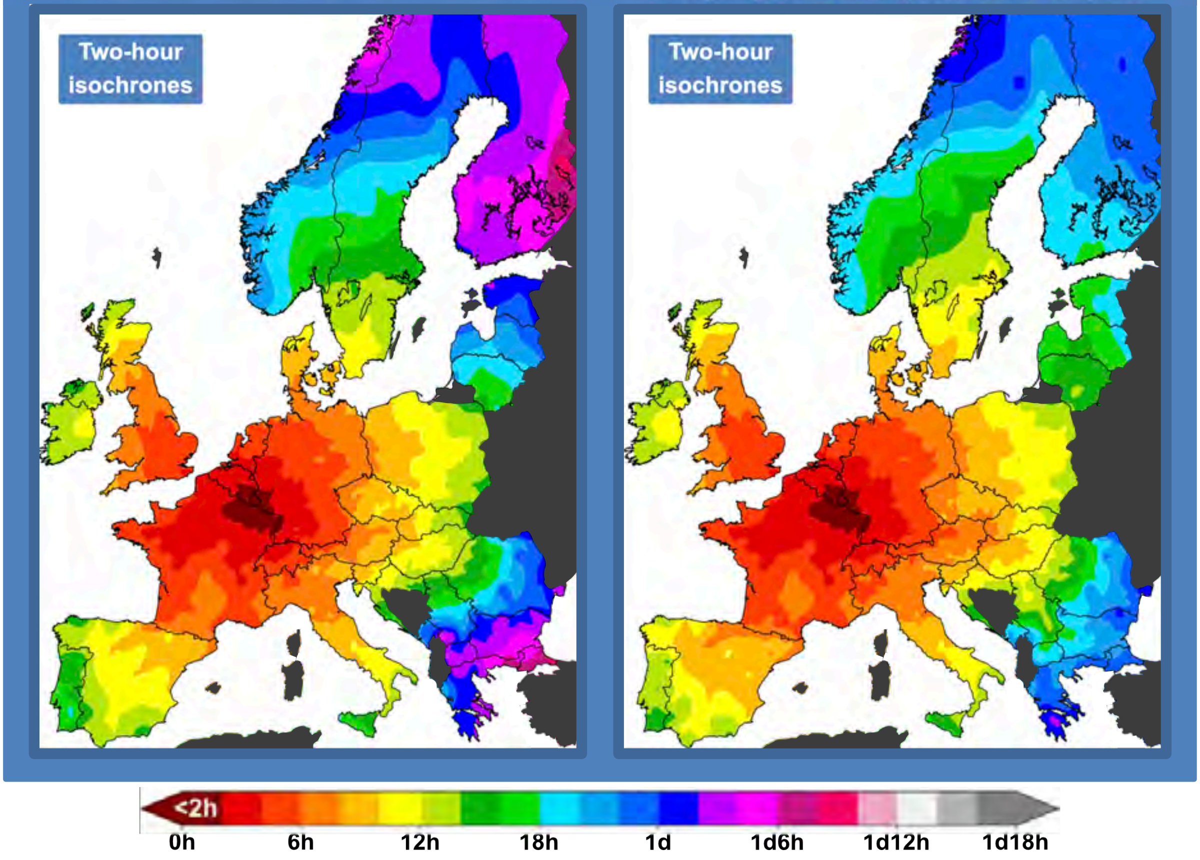

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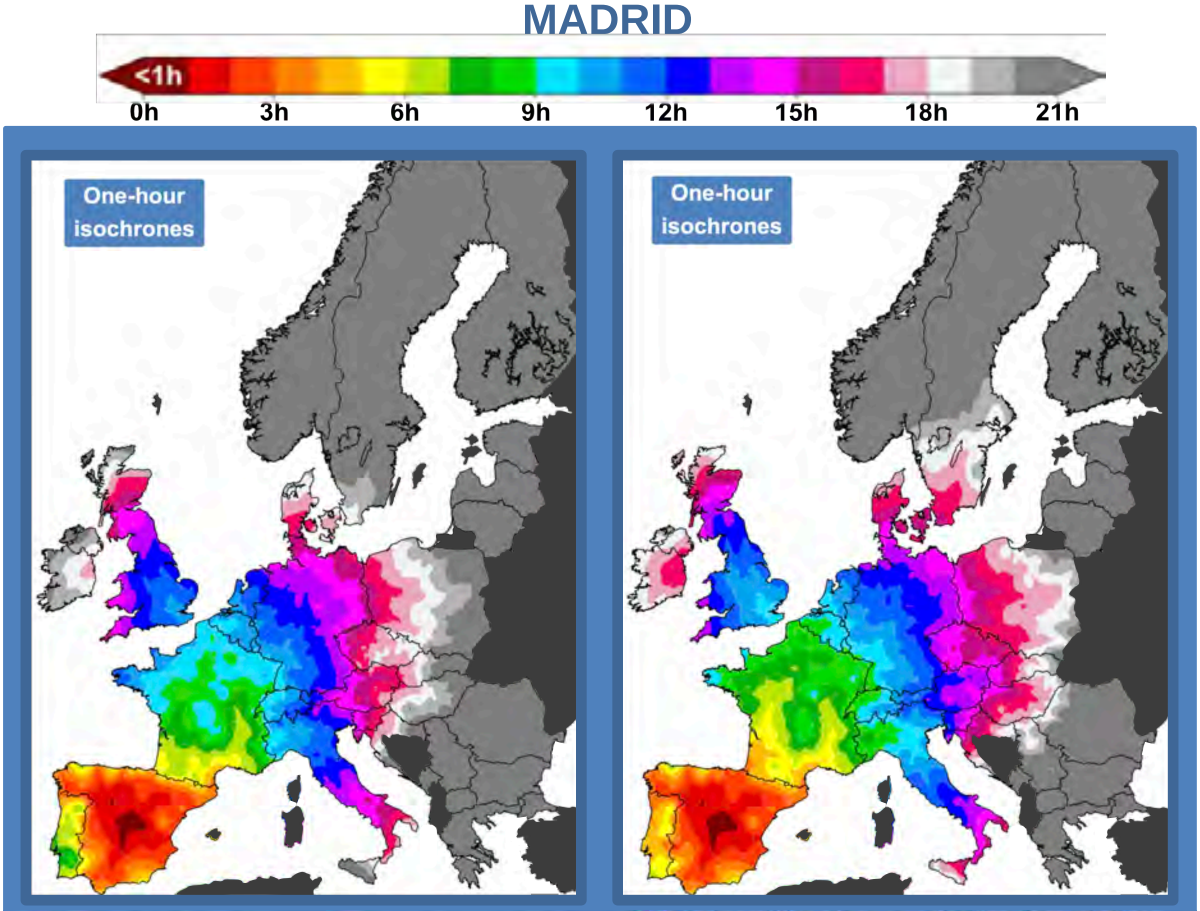

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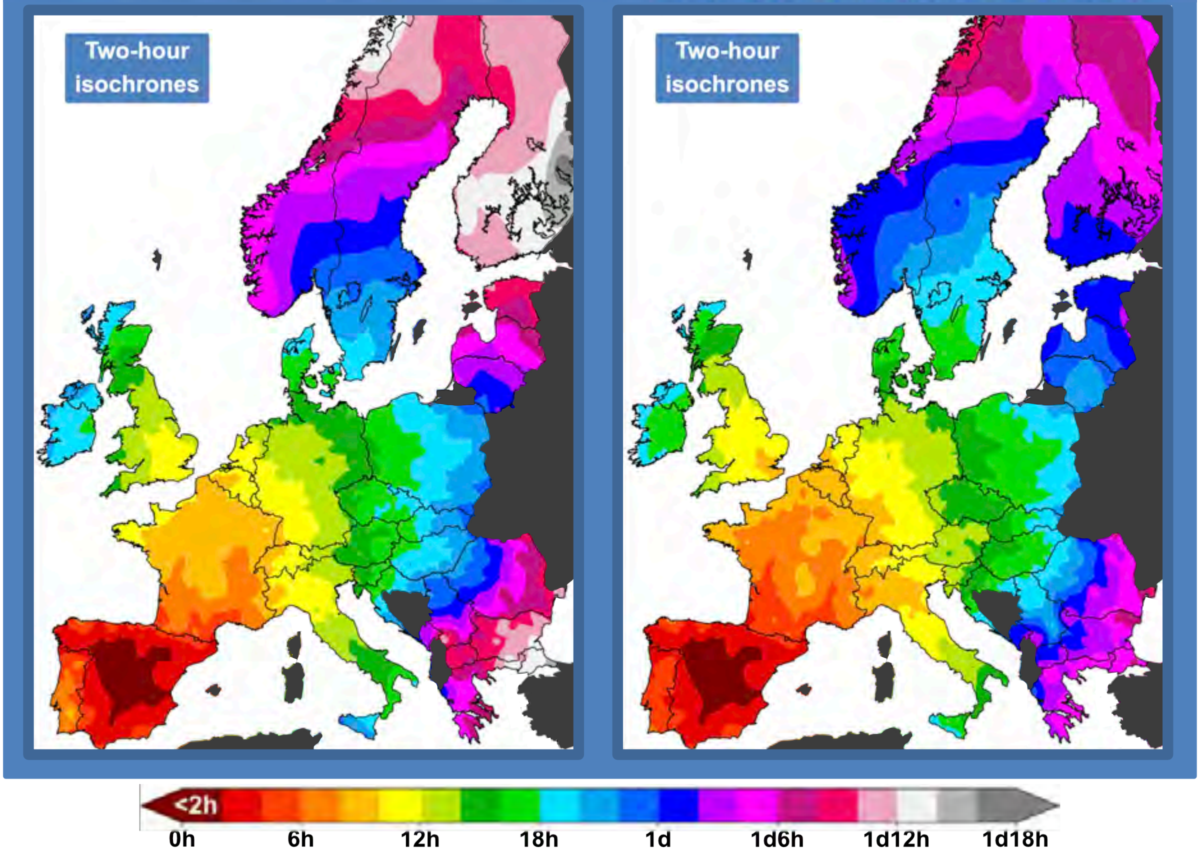

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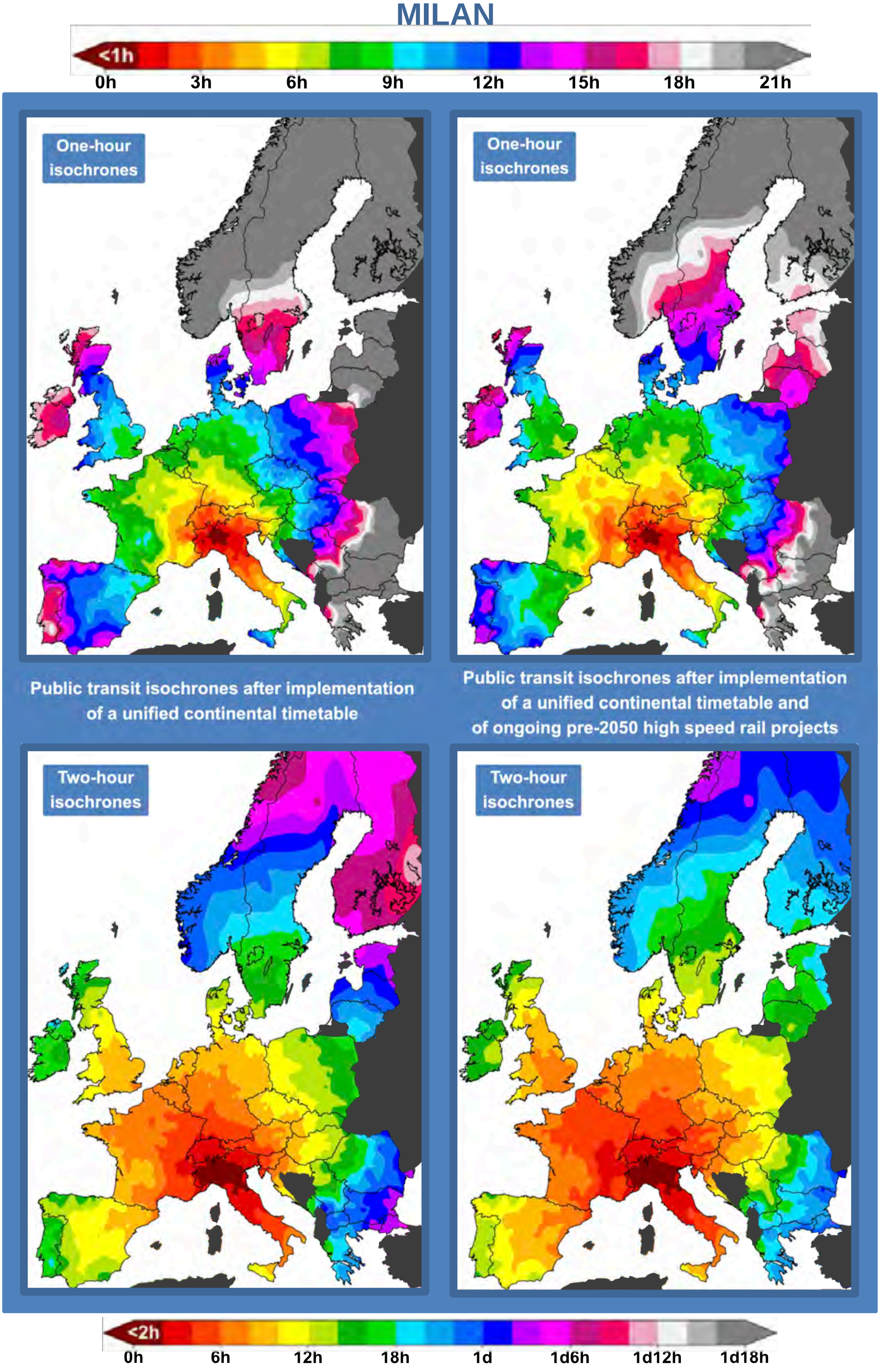

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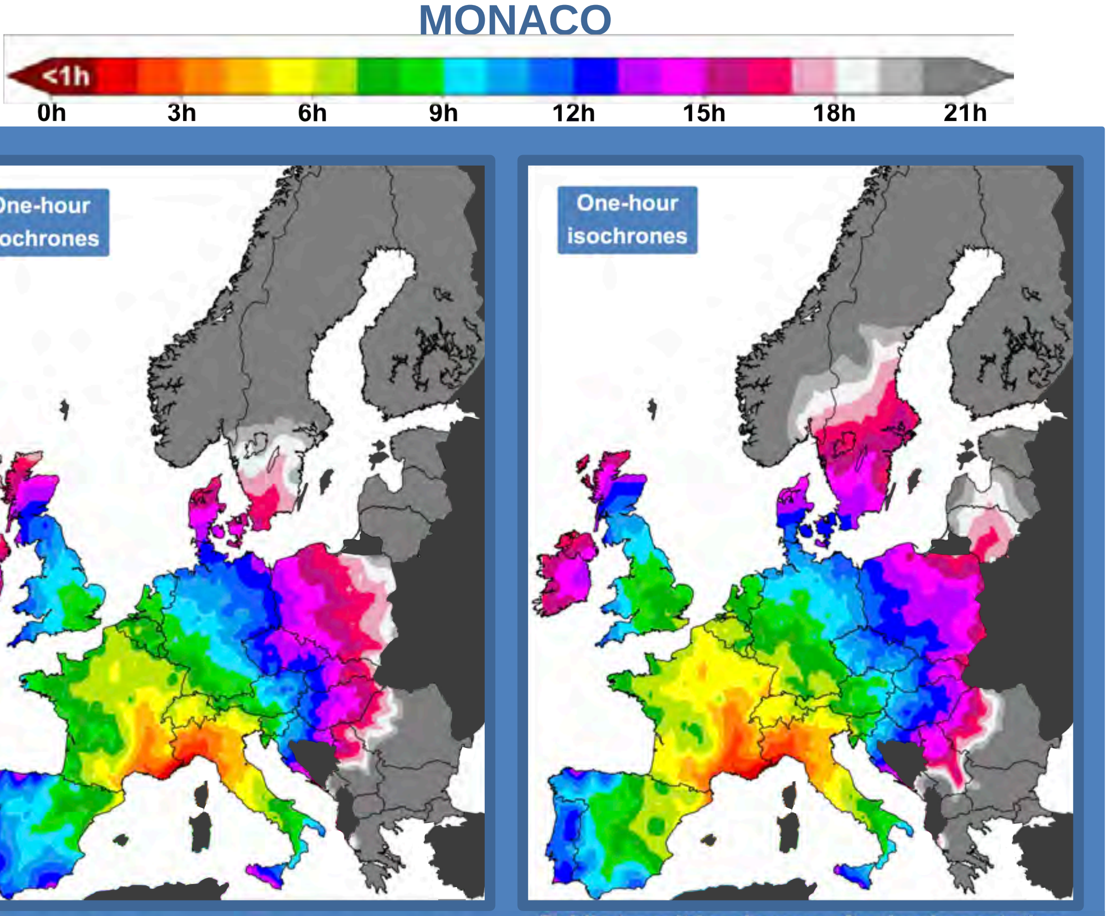

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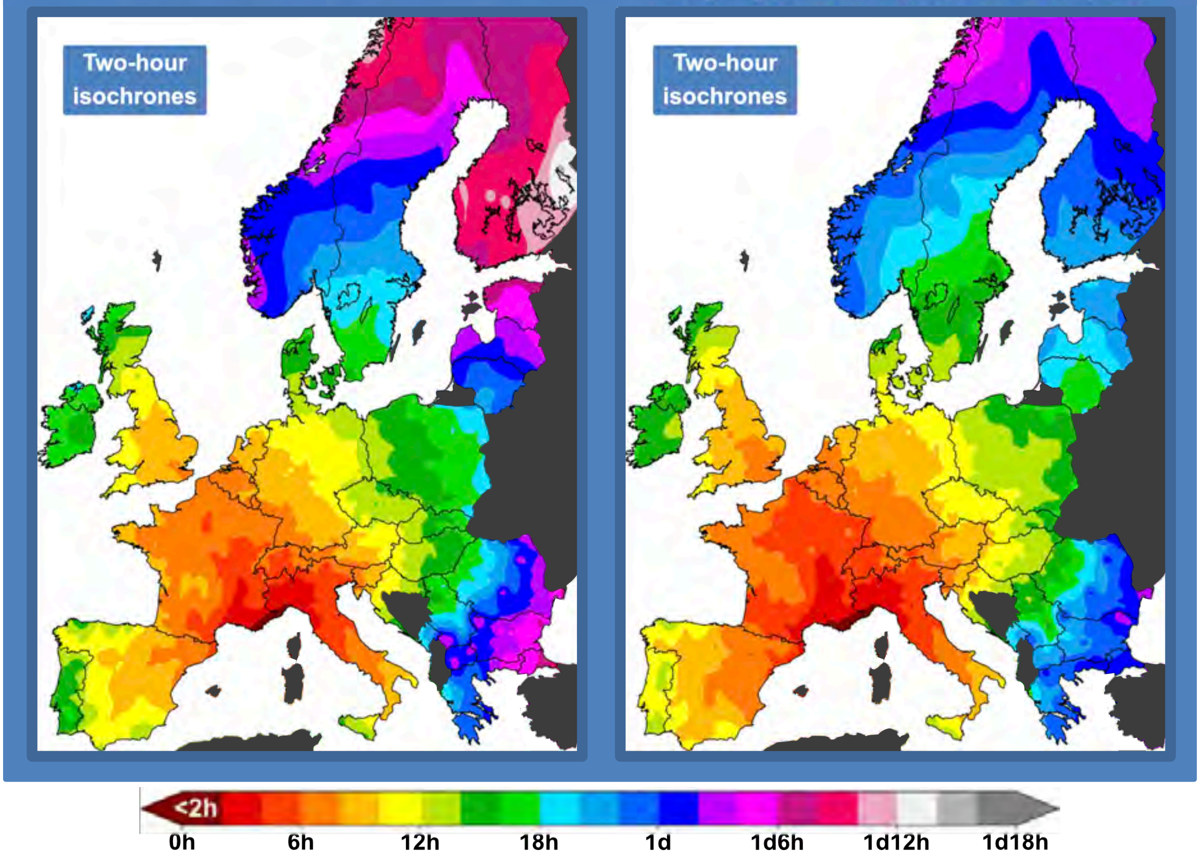

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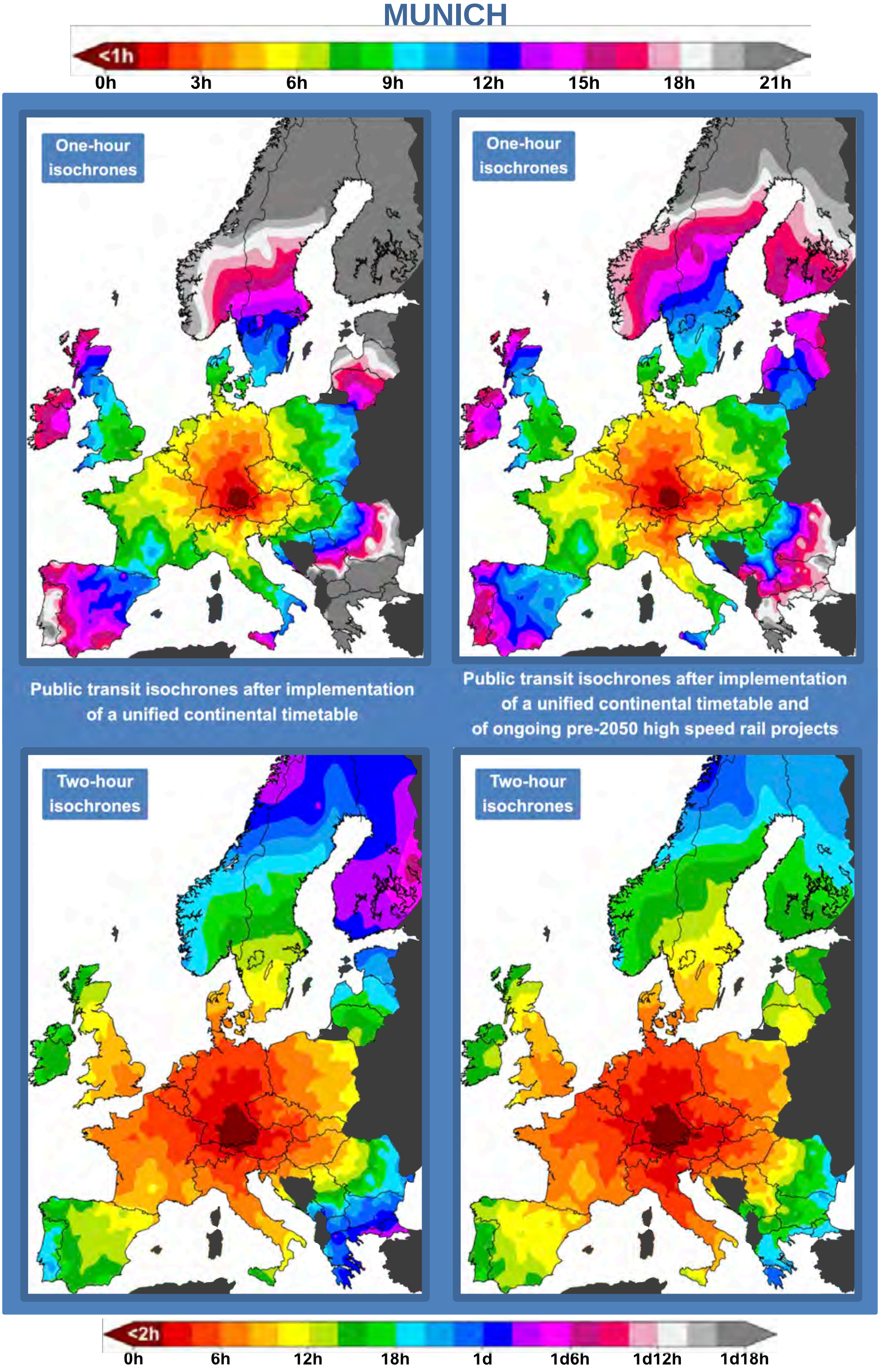
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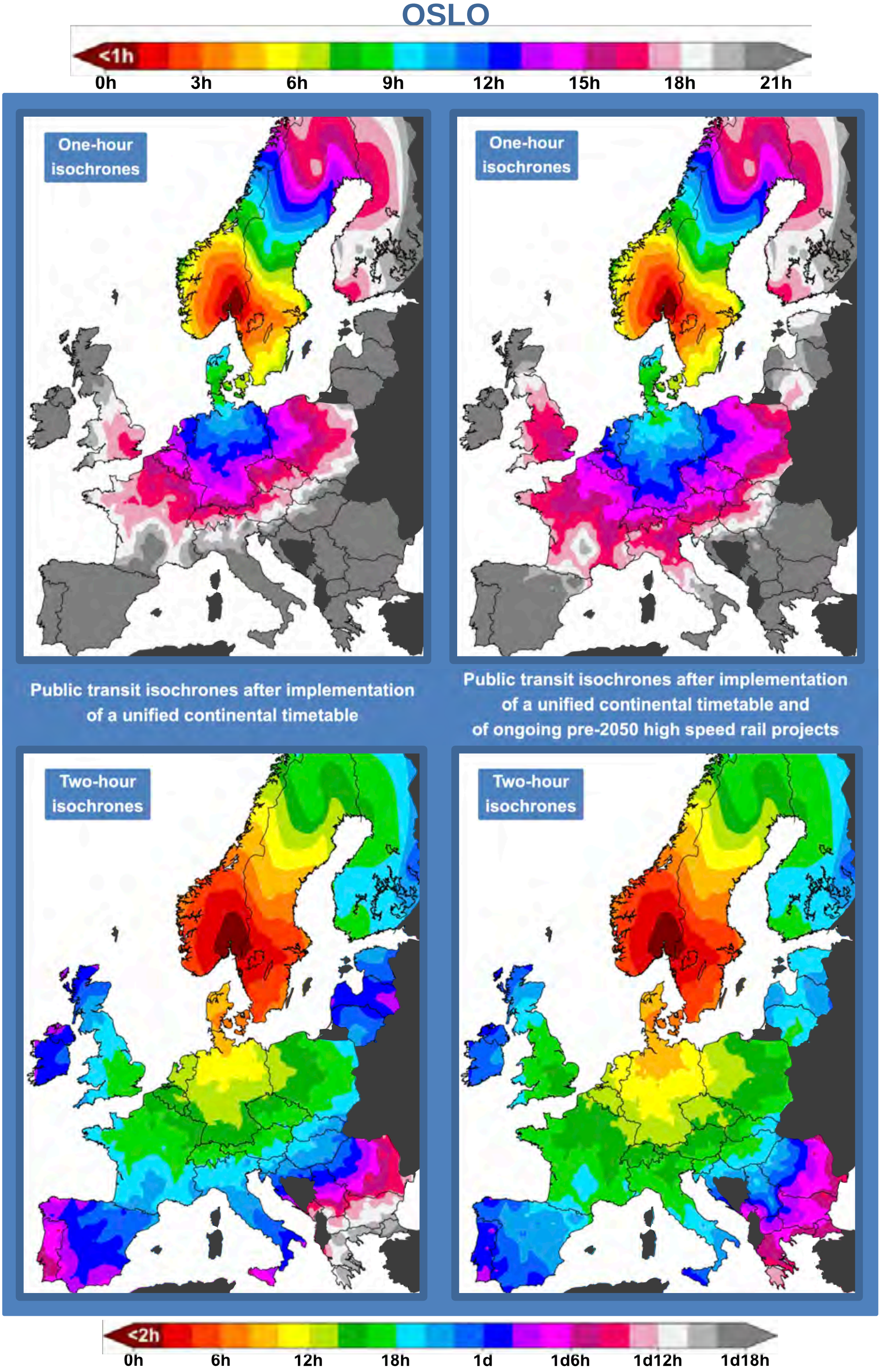

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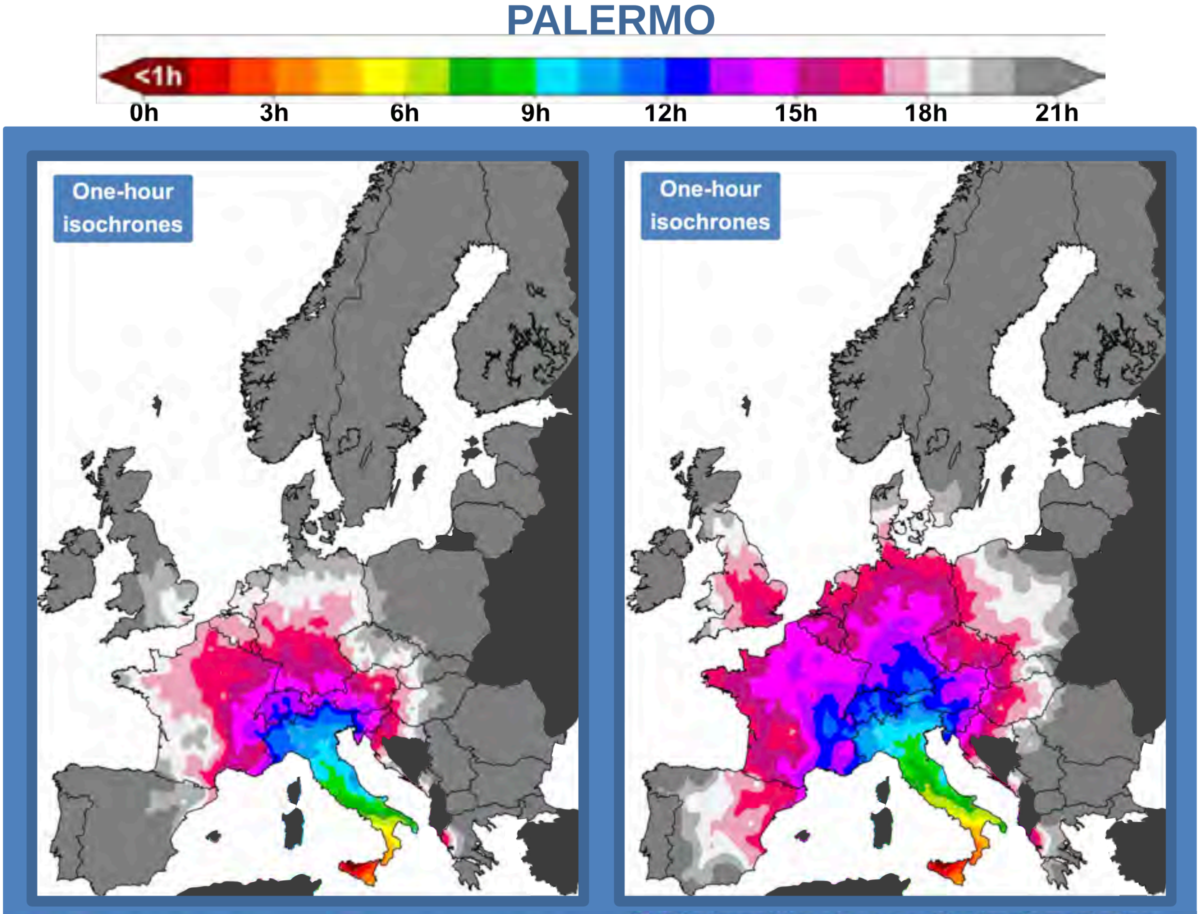

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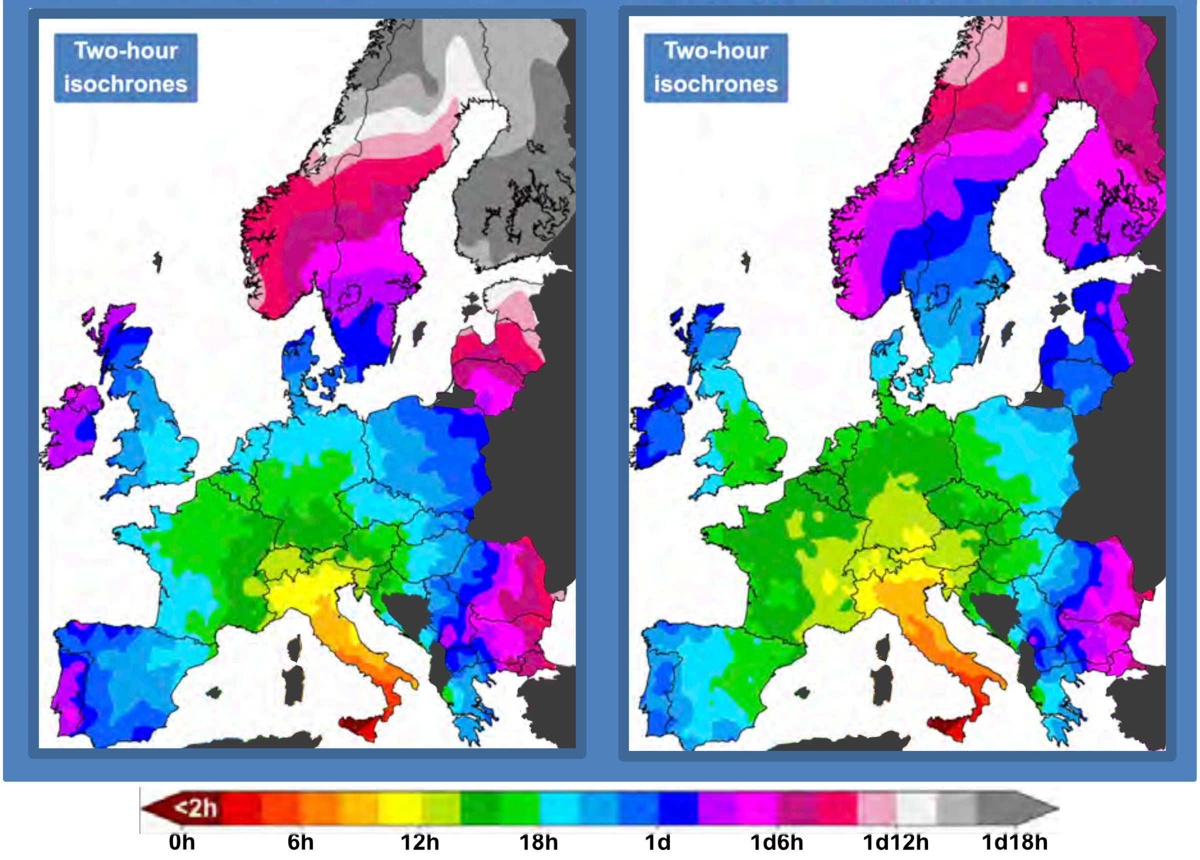

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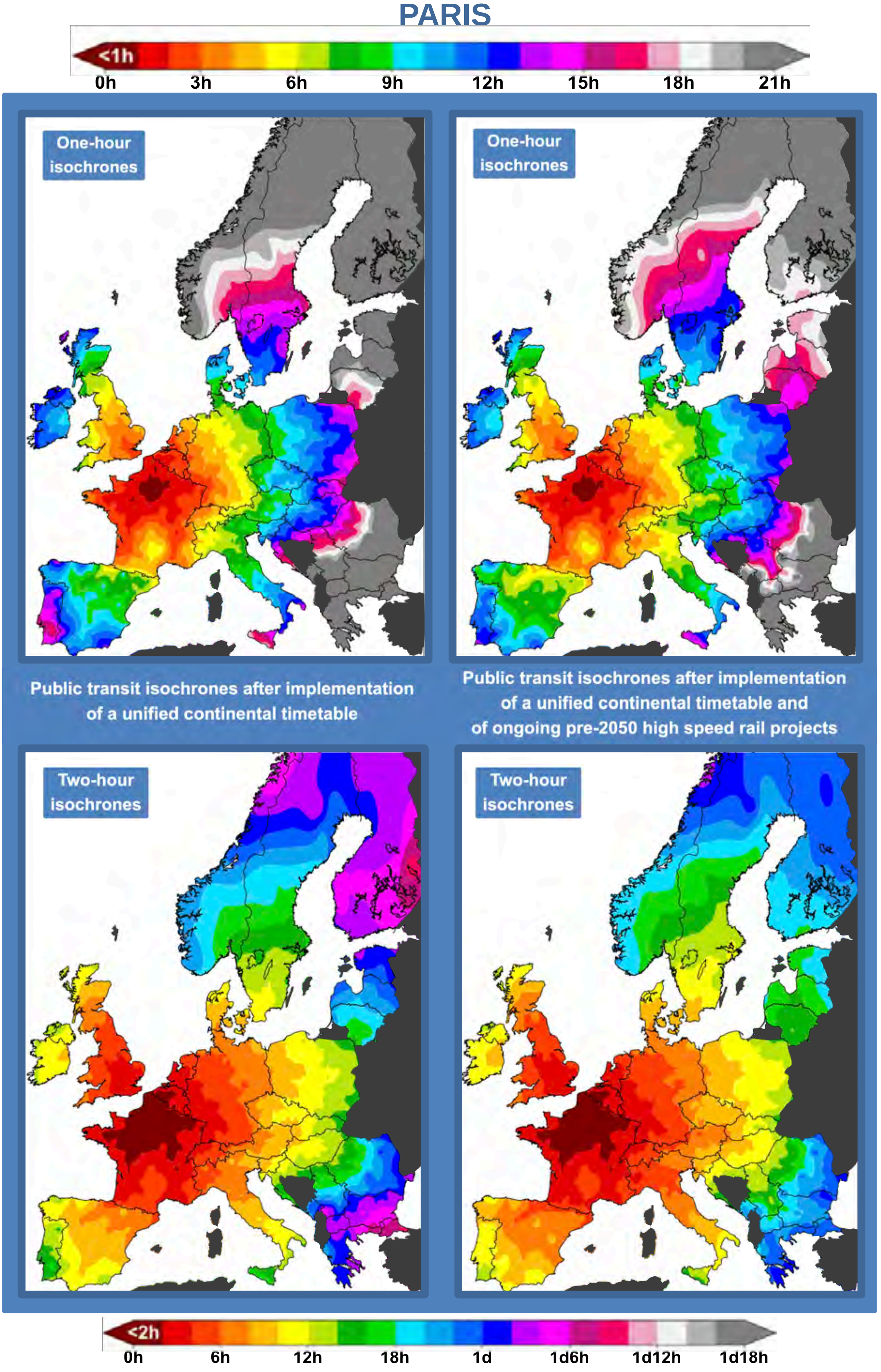

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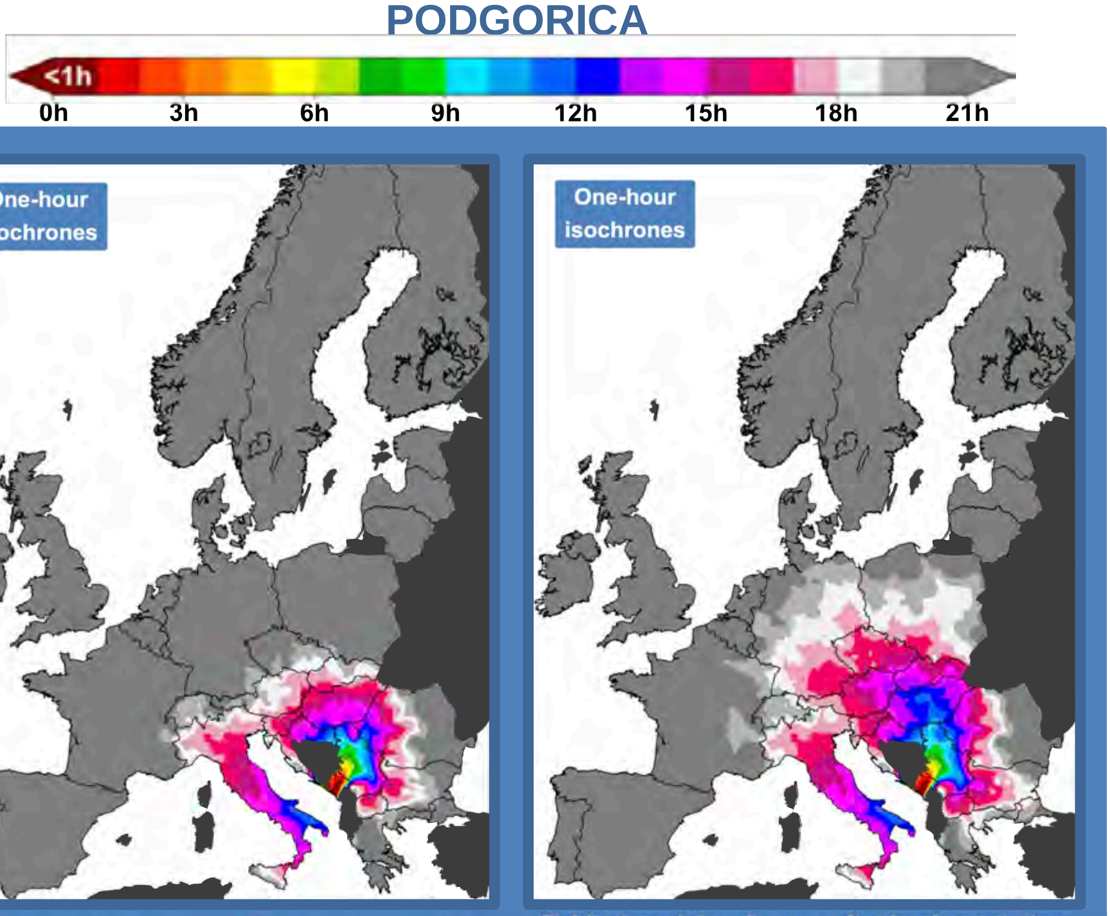

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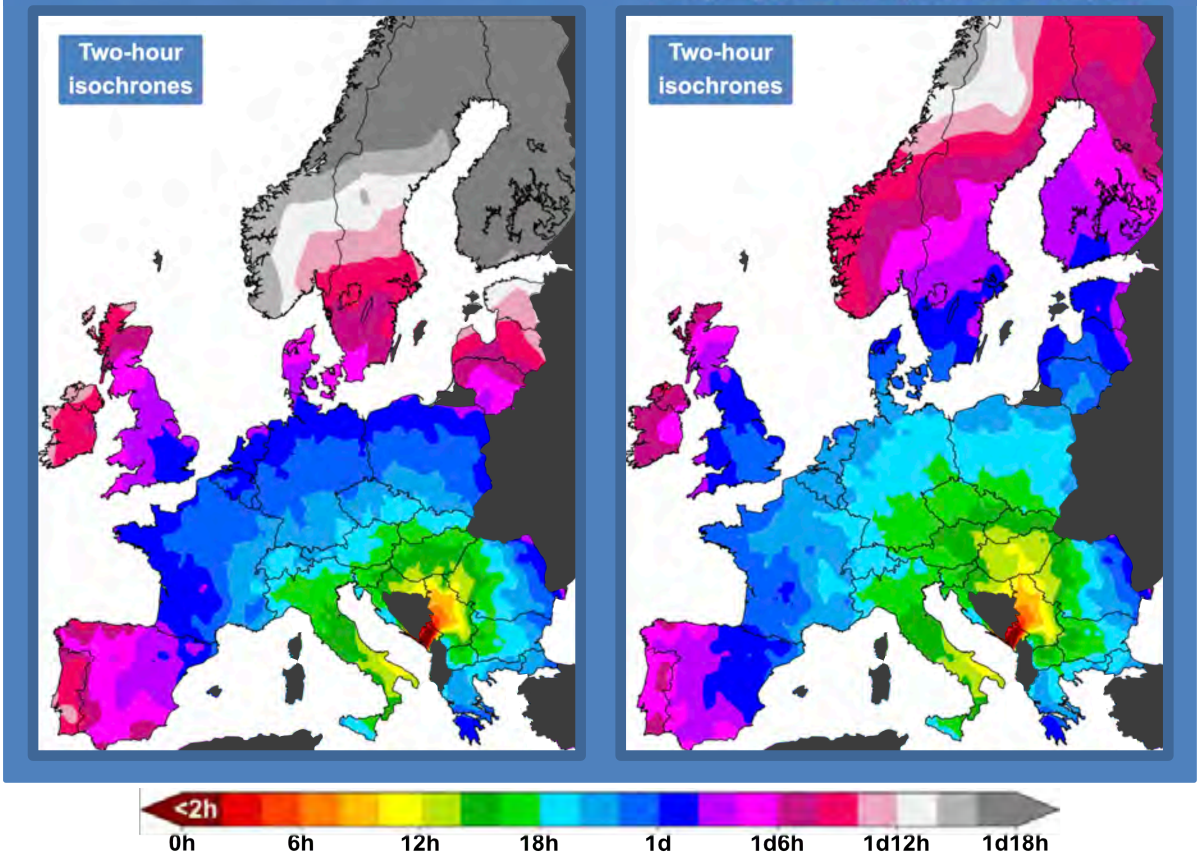

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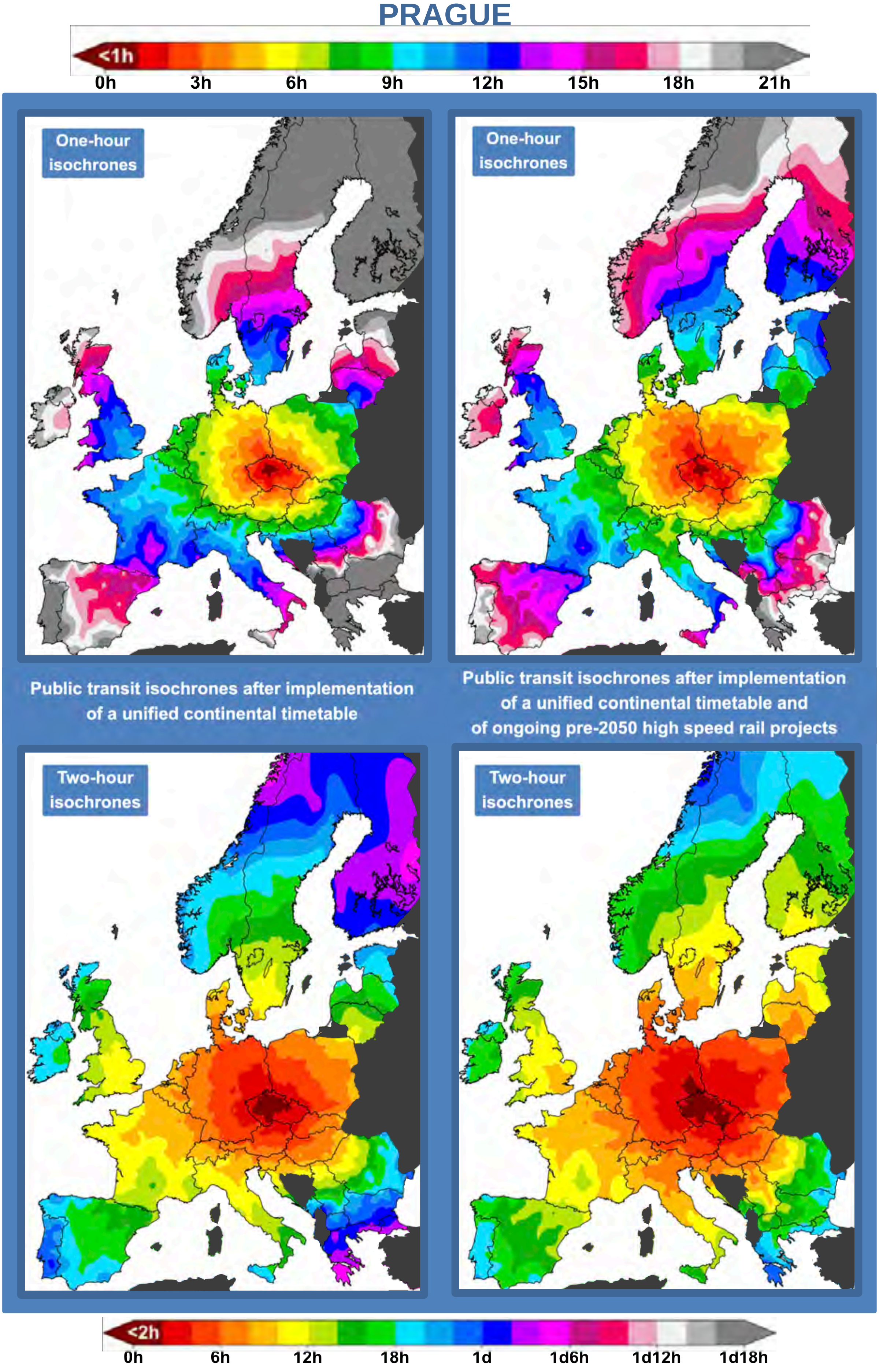

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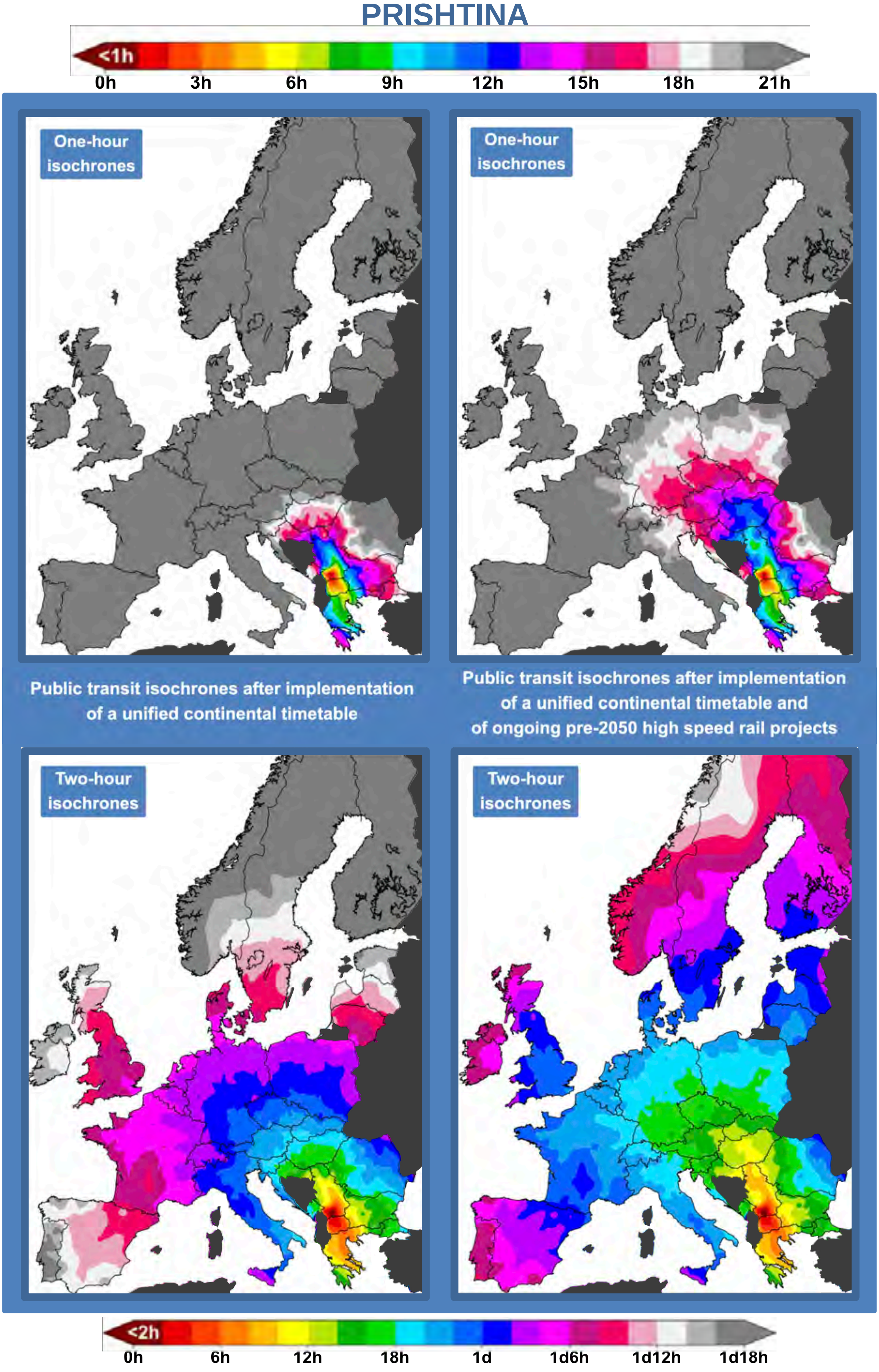

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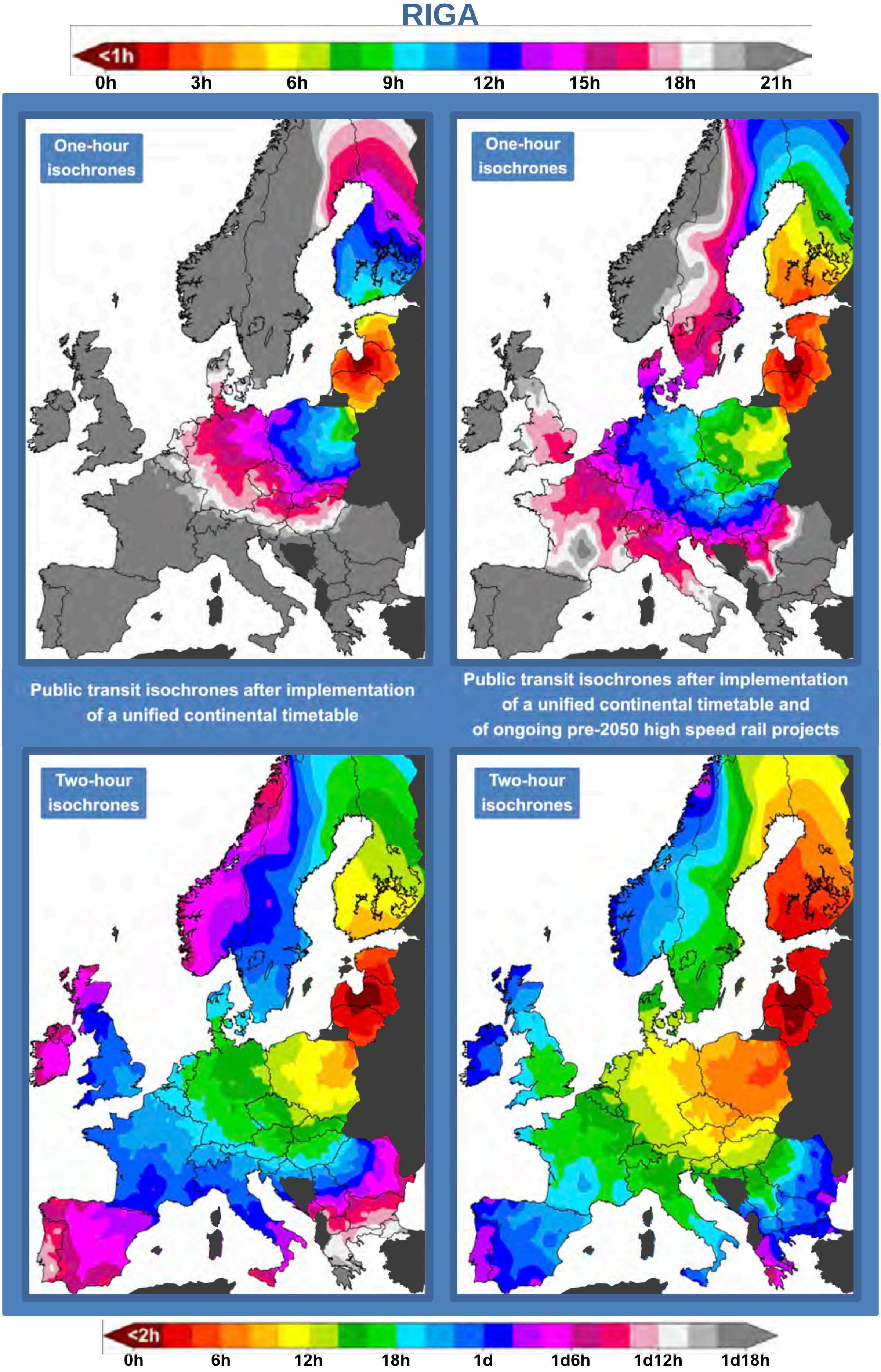

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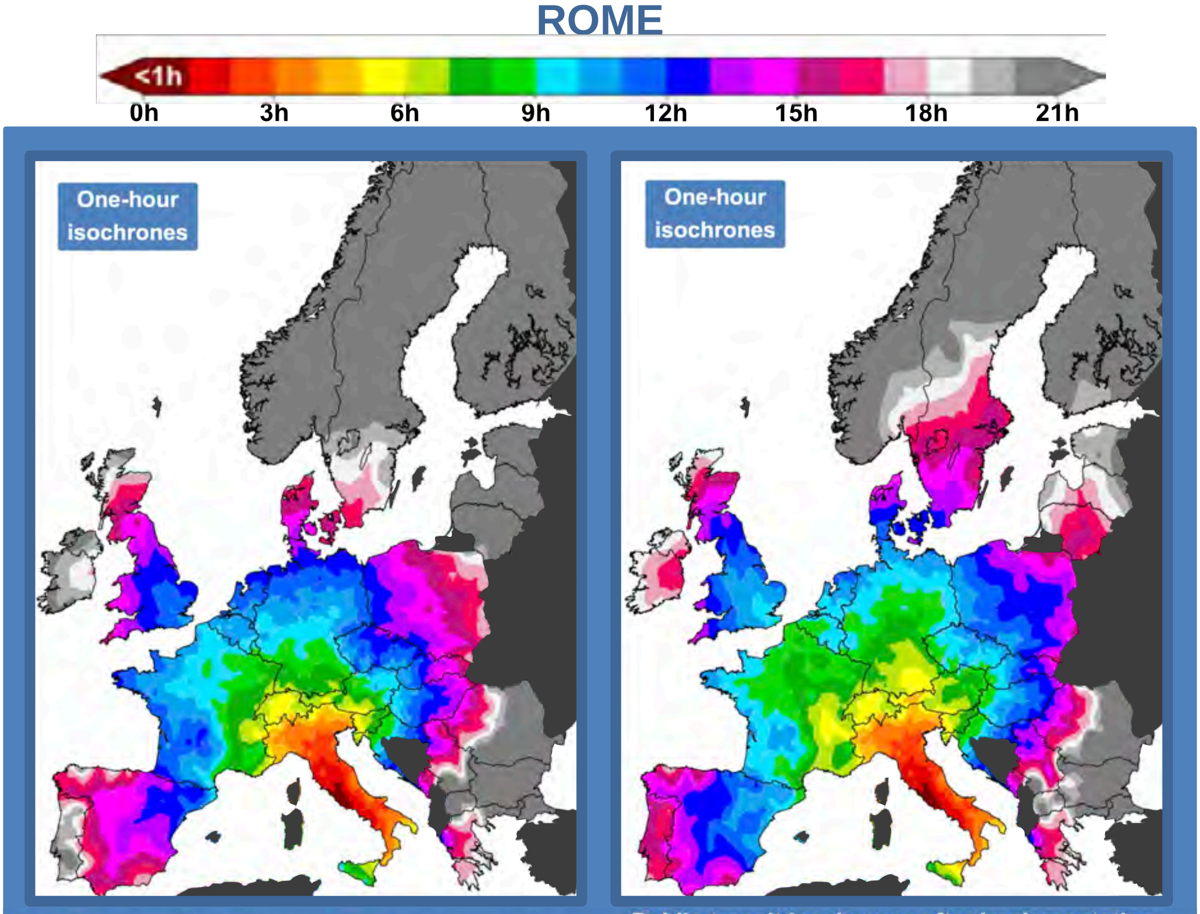

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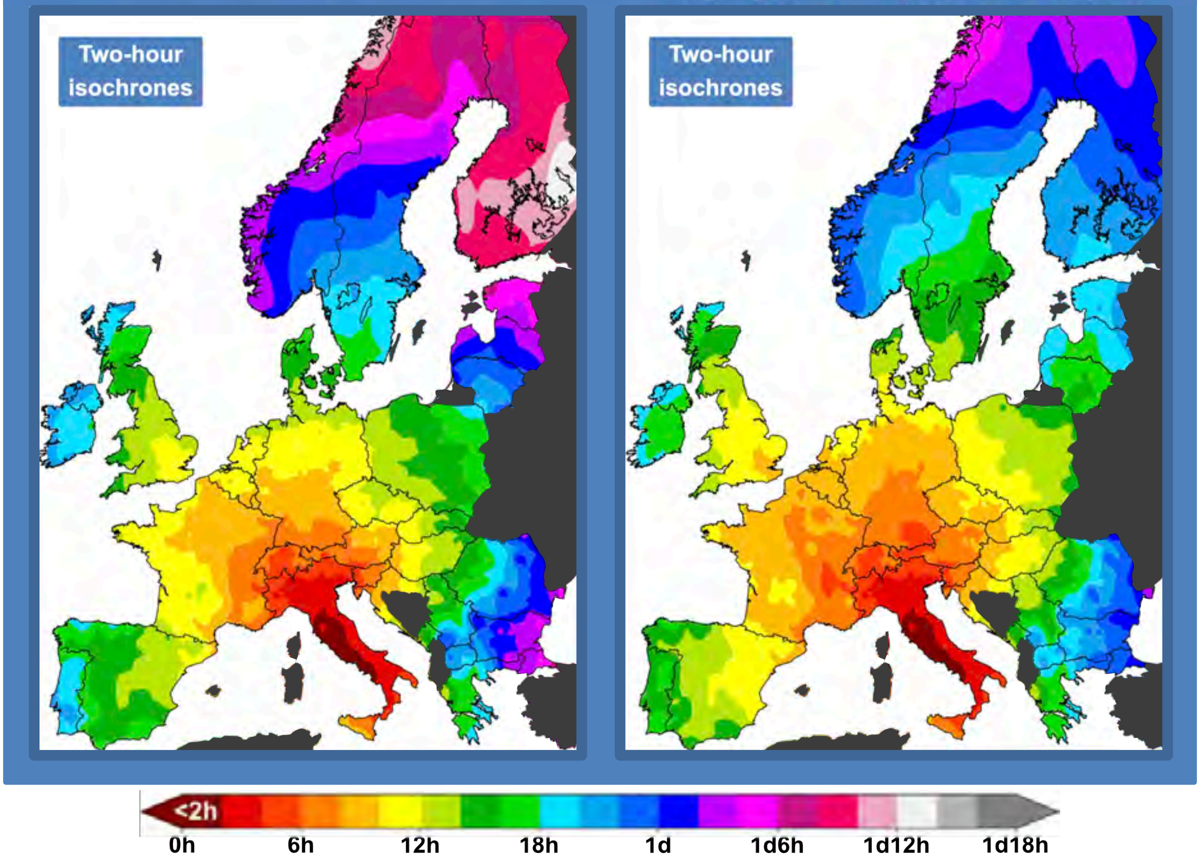

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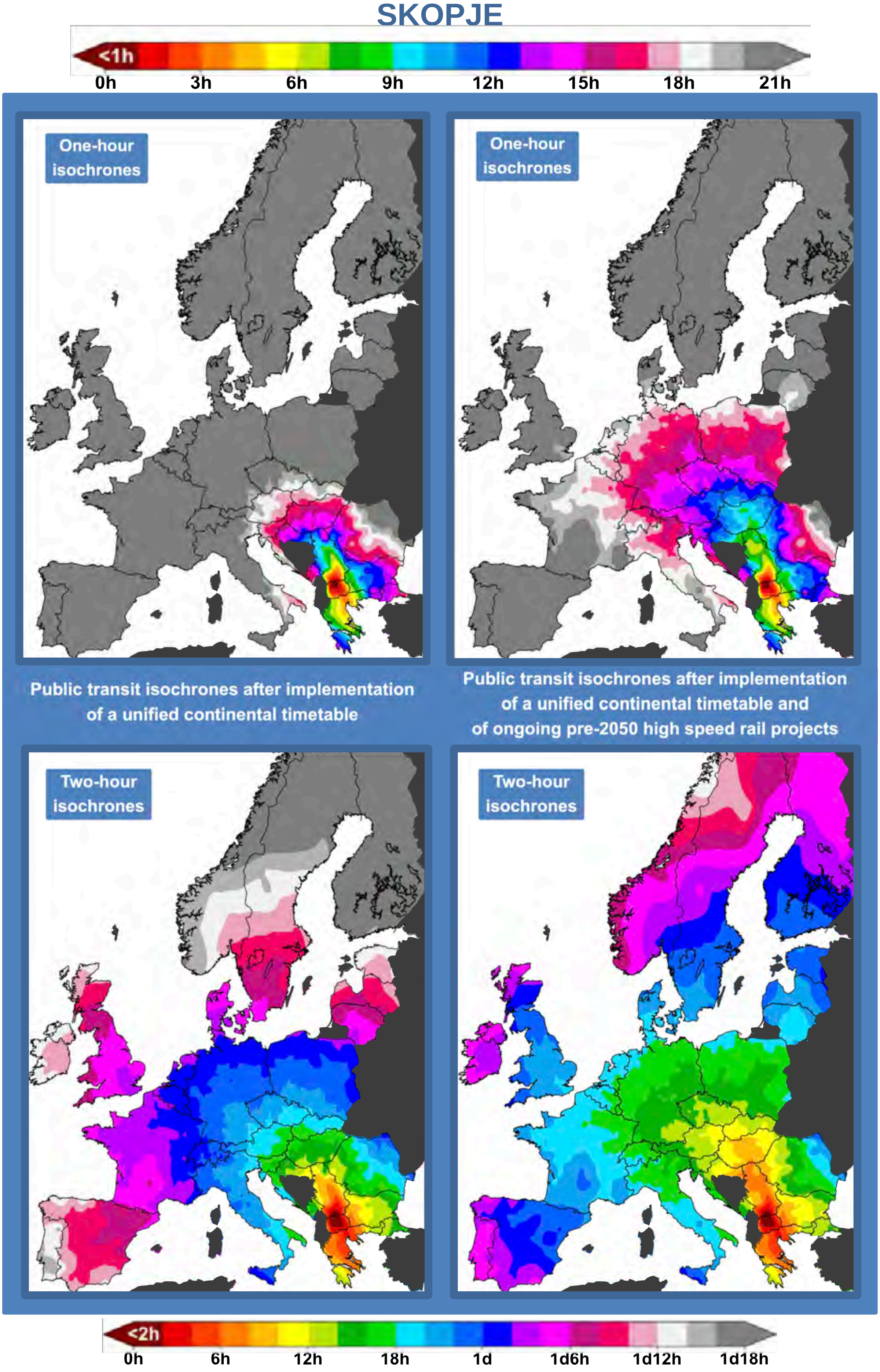

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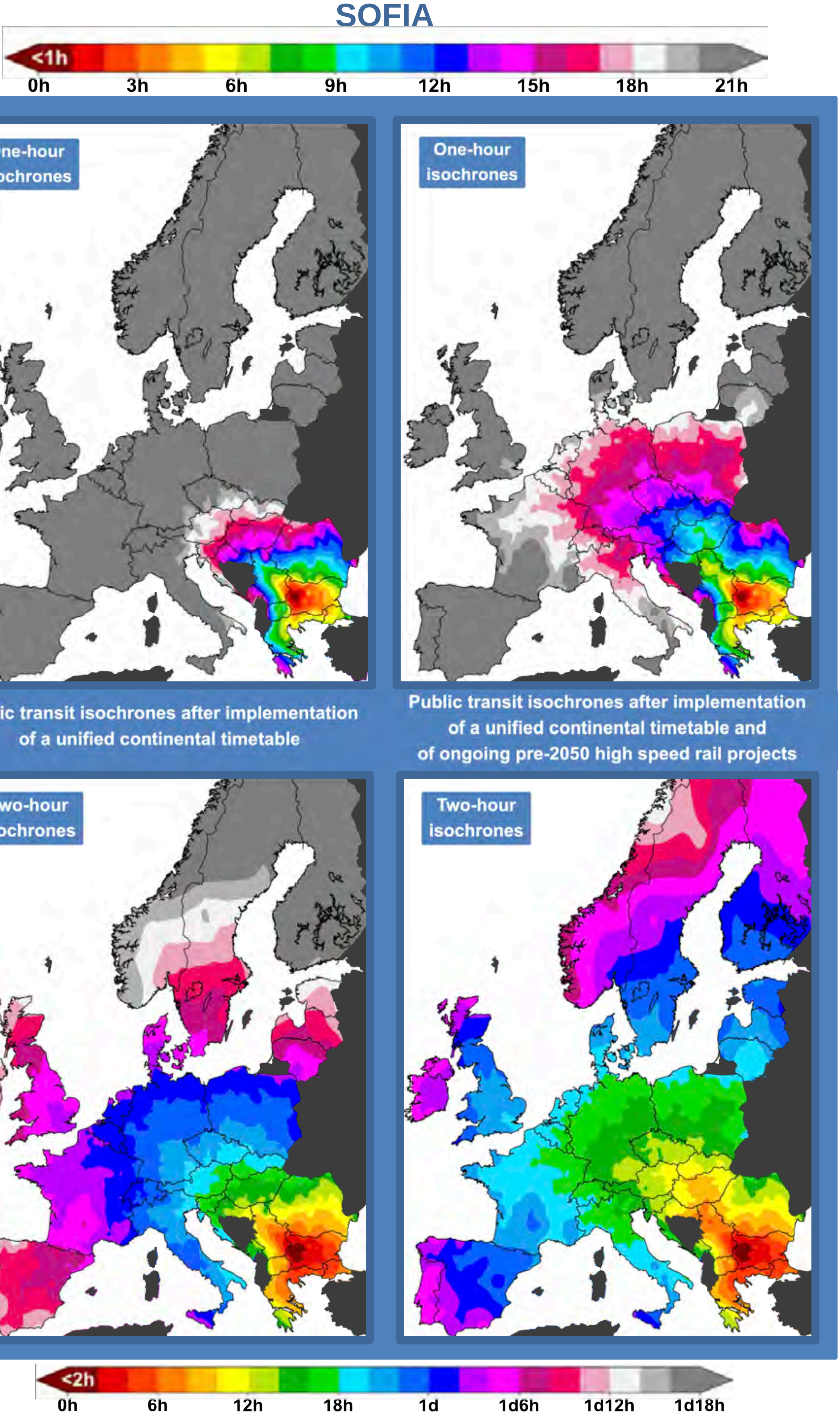
SOFIA



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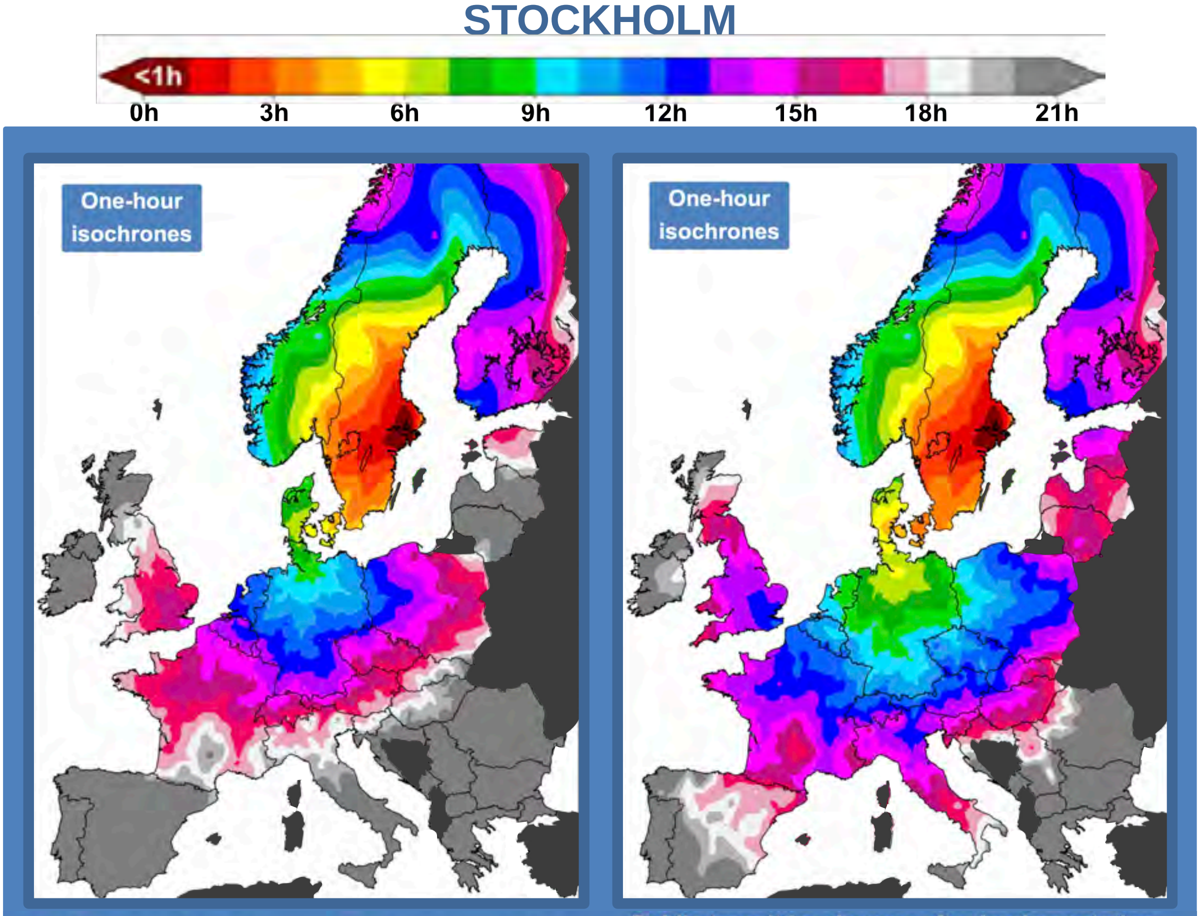
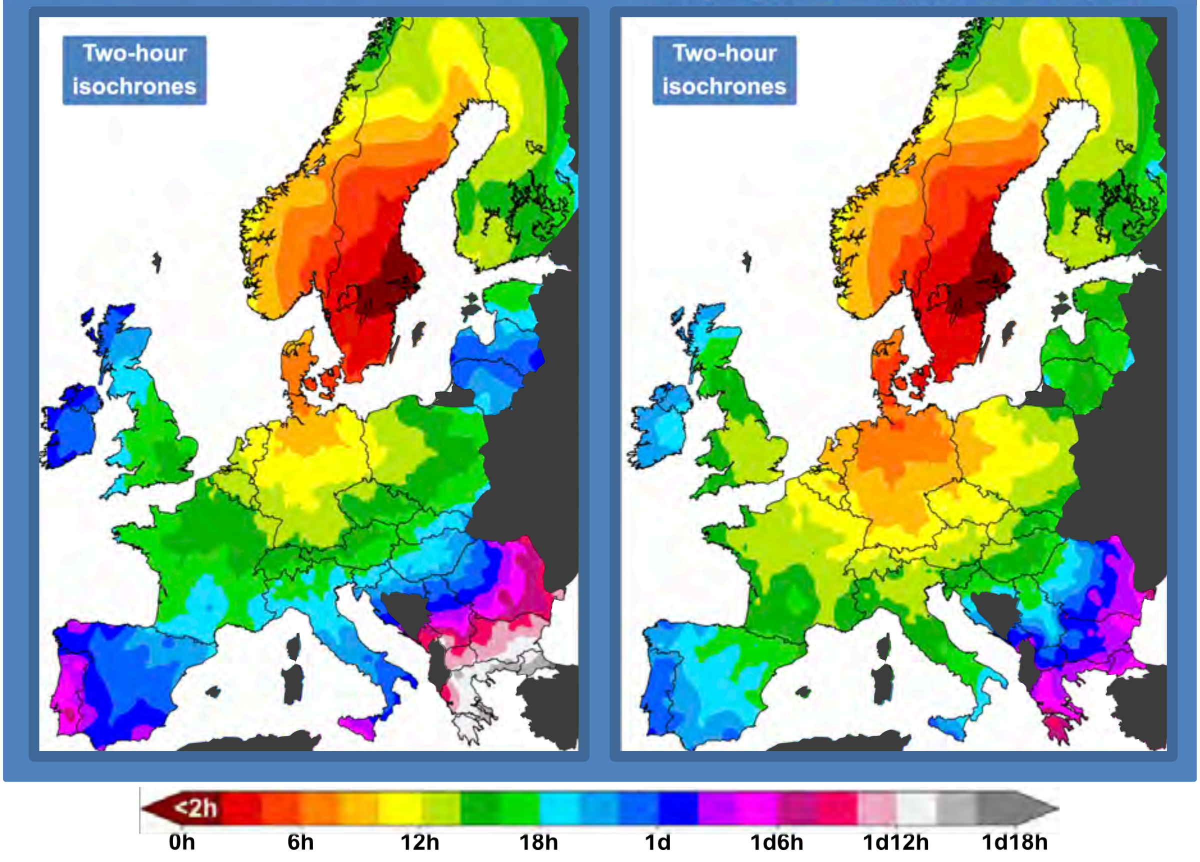
Public transit isochrones after implementation of a unified continental timetable and of ongoing pre-2050 high speed rail projects

STOCKHOLM



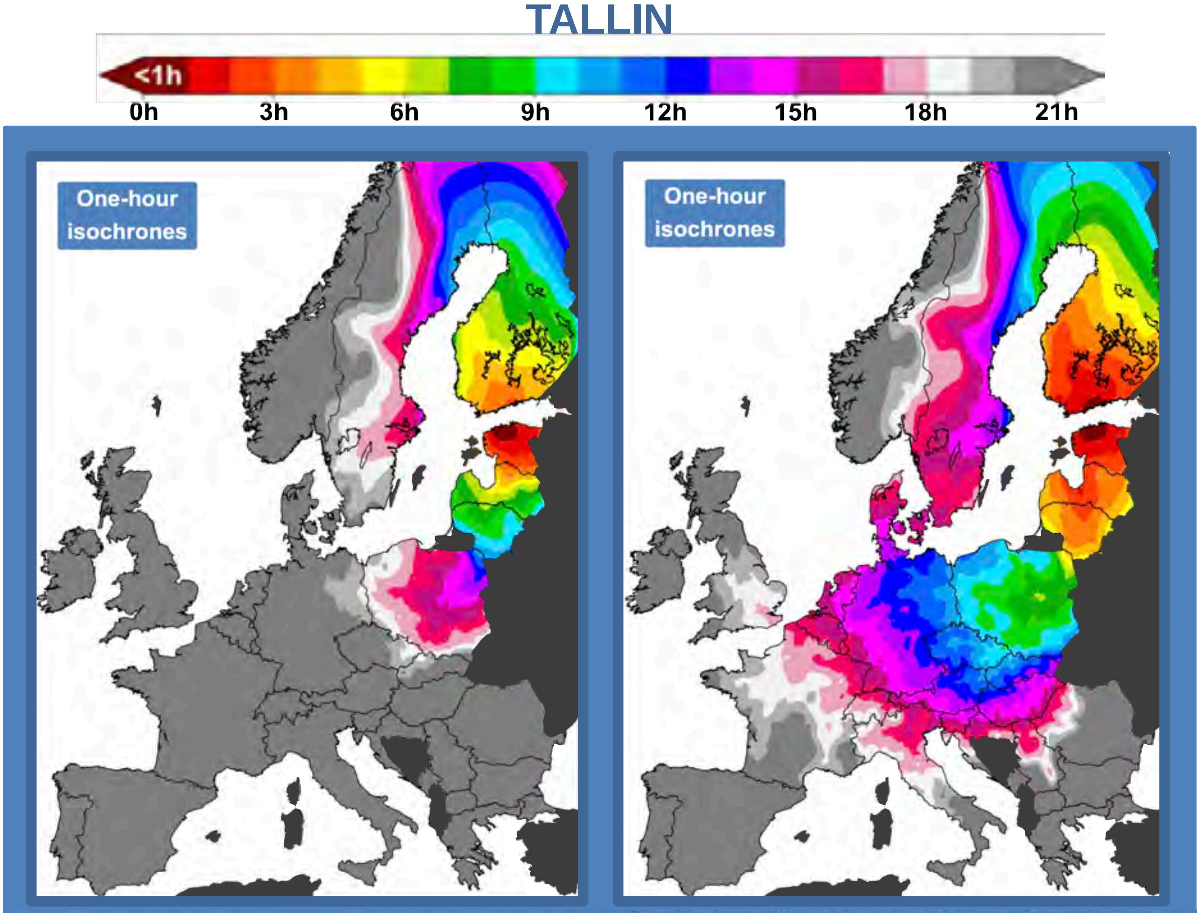
Public transit isochrones after implementation of a unified continental timetable

Public transit isochrones after implementation of a unified continental timetable and of ongoing pre-2050 high speed rail projects



A-XL

TALLIN



Public transit isochrones after implementation of a unified continental timetable

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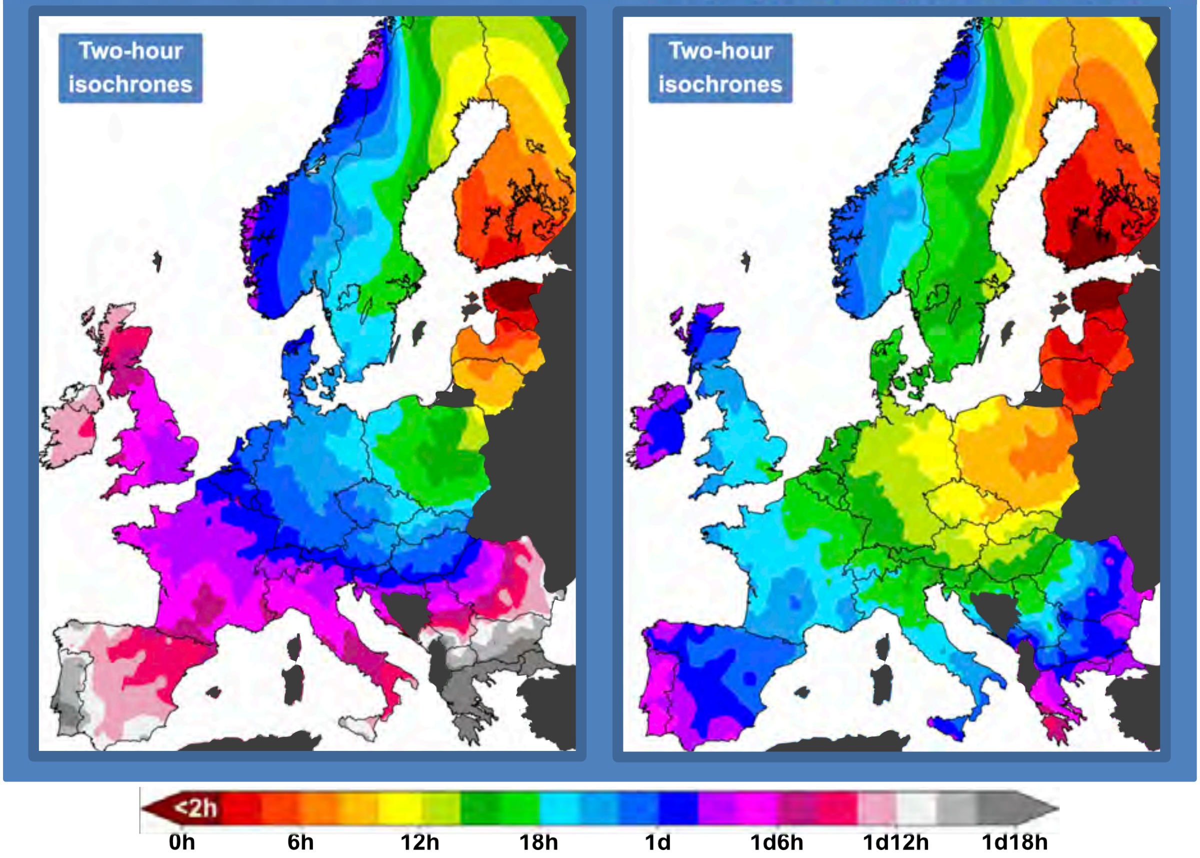
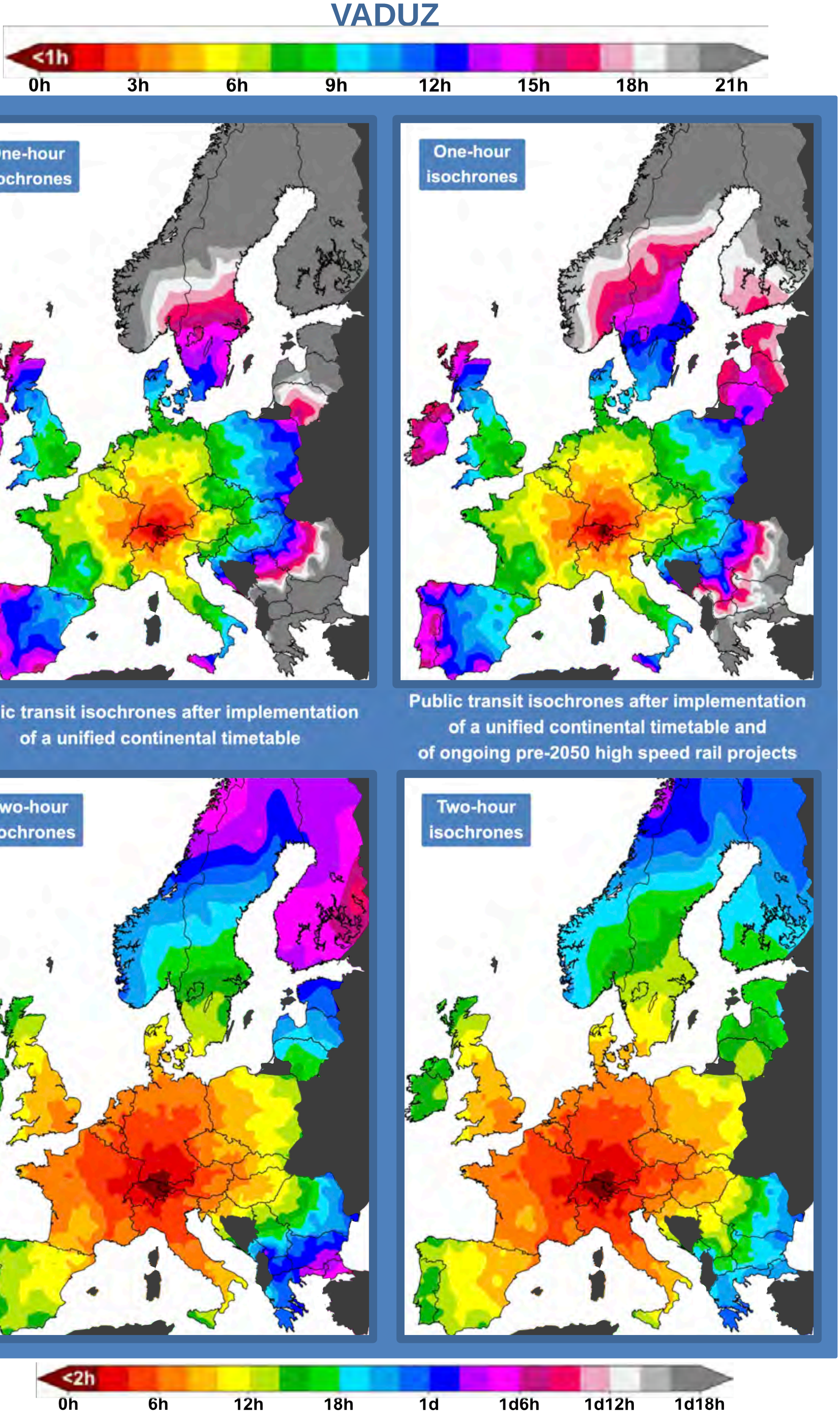


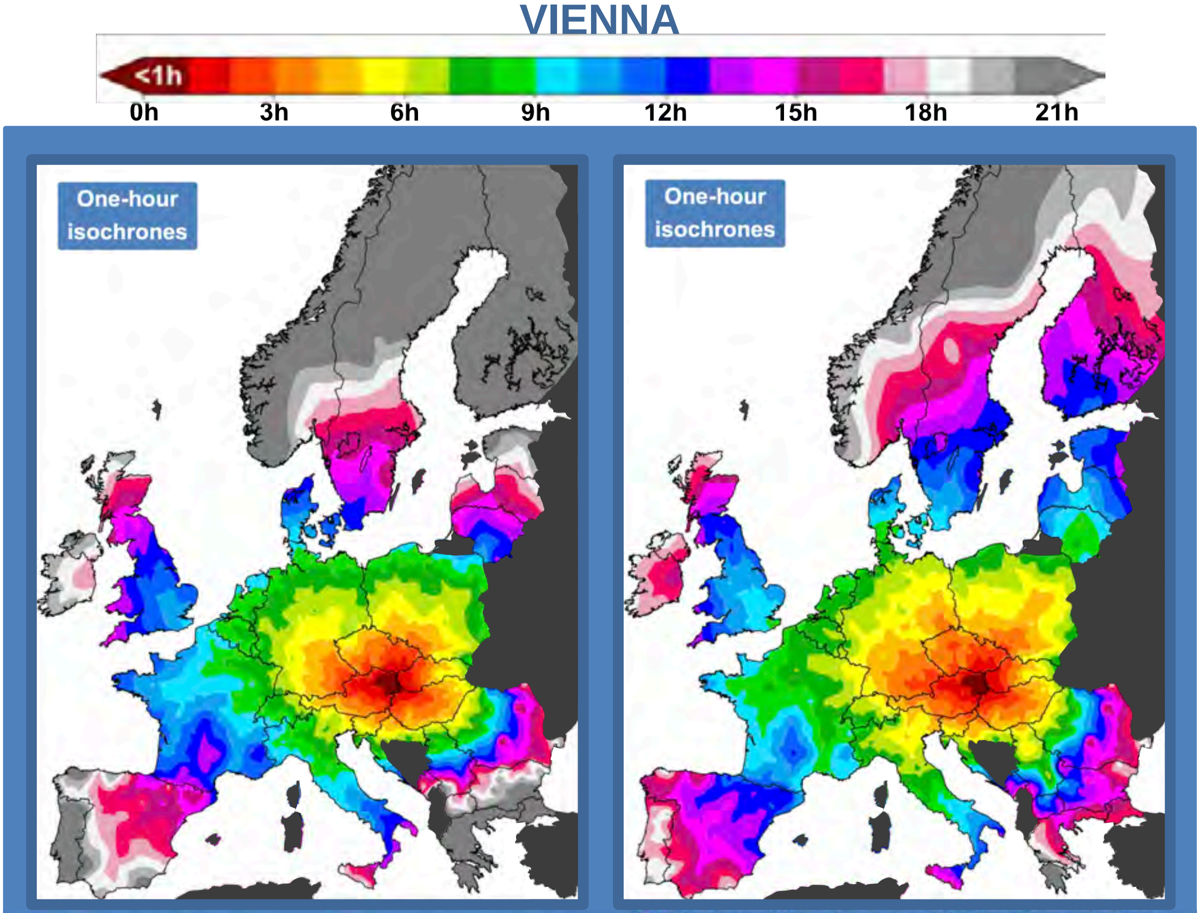
VADUZ



Public transit isochrones after implementation of a unified continental timetable

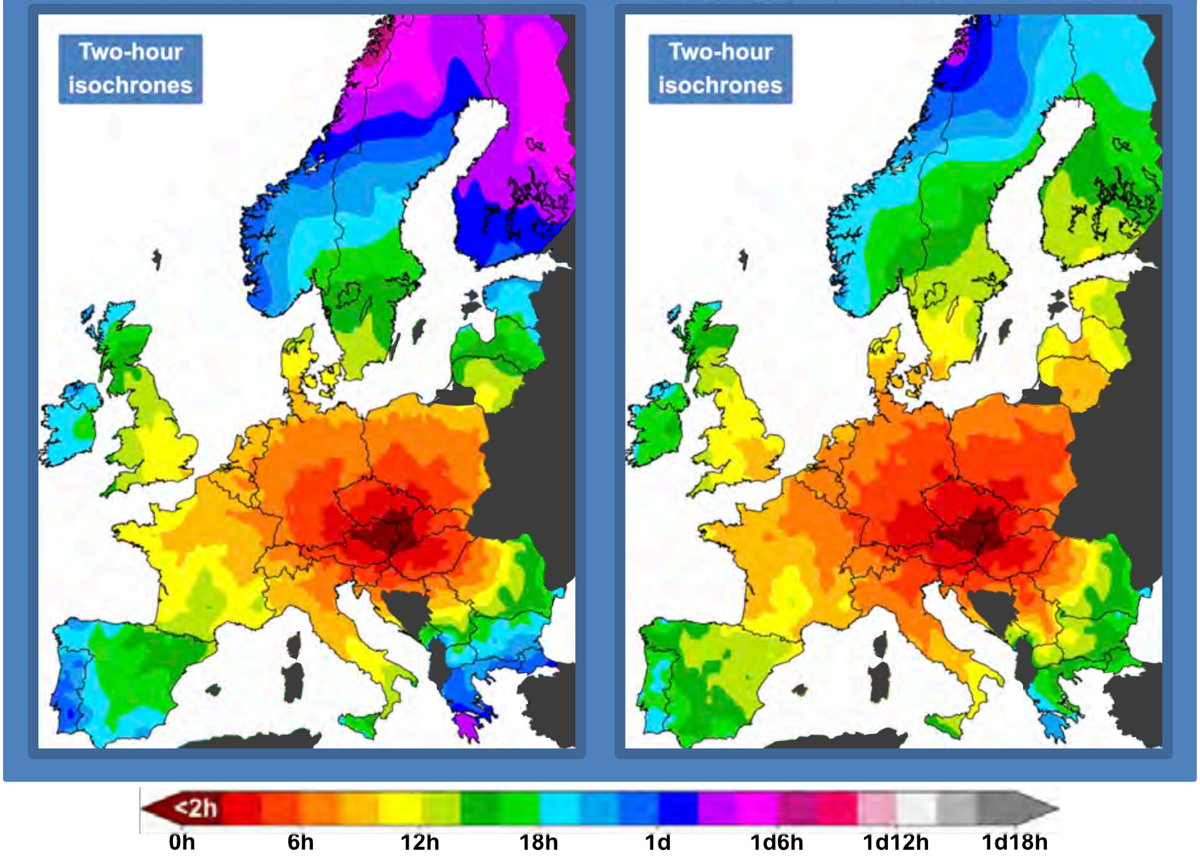
Public transit isochrones after implementation of a unified continental timetable and of ongoing pre-2050 high speed rail projects

VIENNA

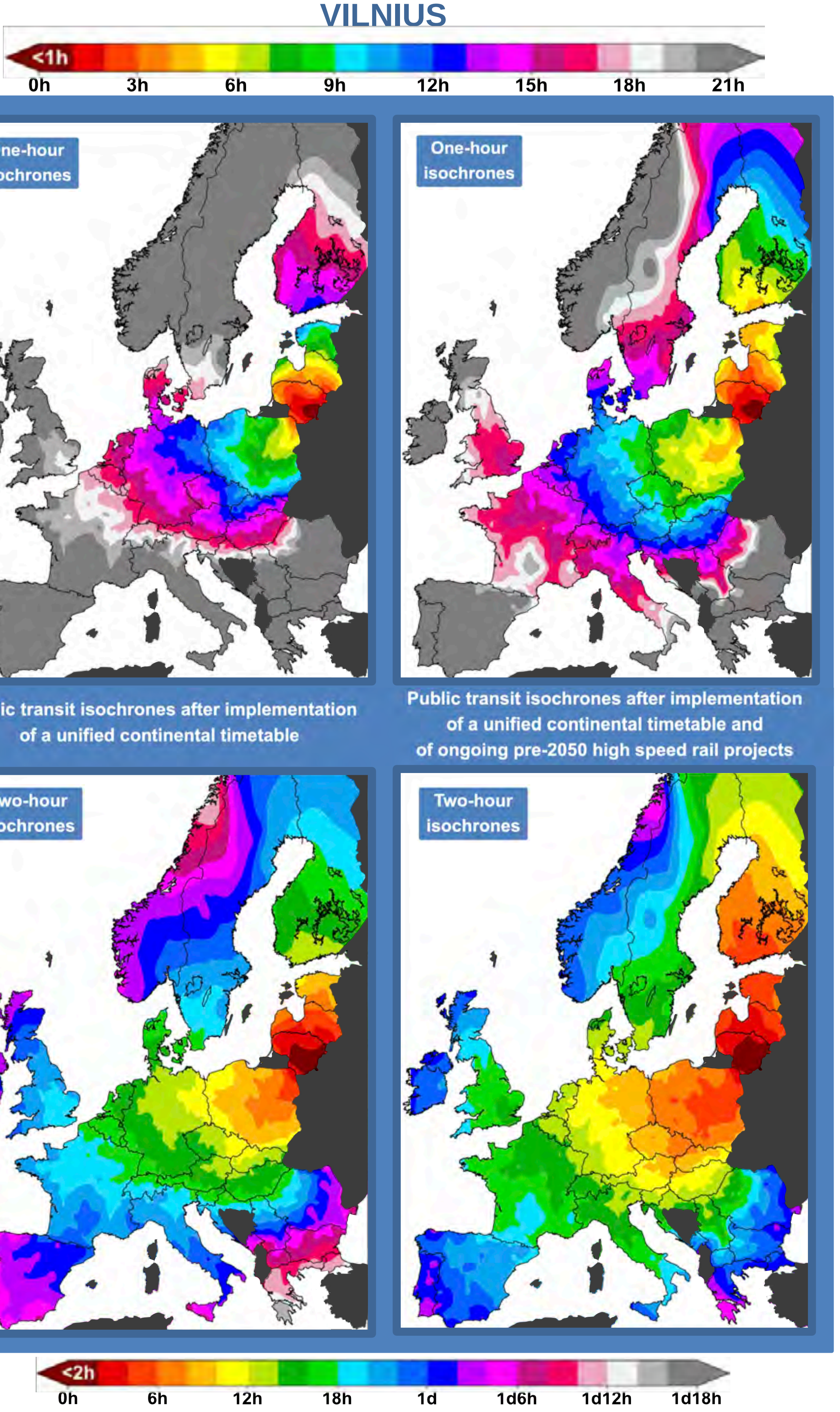


Public transit isochrones after implementation of a unified continental timetable

Public transit isochrones after implementation of a unified continental timetable and of ongoing pre-2050 high speed rail projects



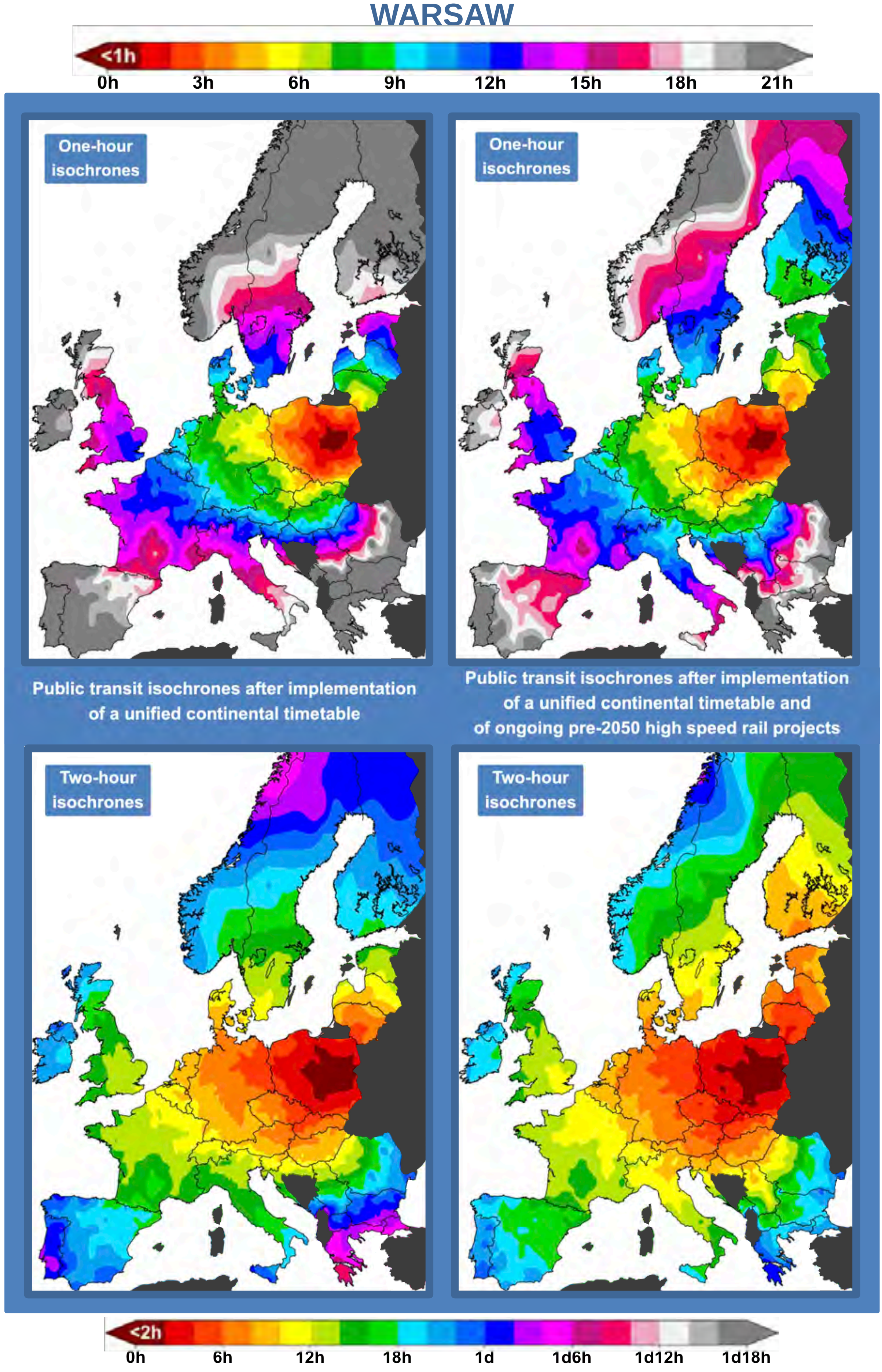
VILNIUS



Public transit isochrones after implementation of a unified continental timetable

Public transit isochrones after implementation of a unified continental timetable and of ongoing pre-2050 high speed rail projects

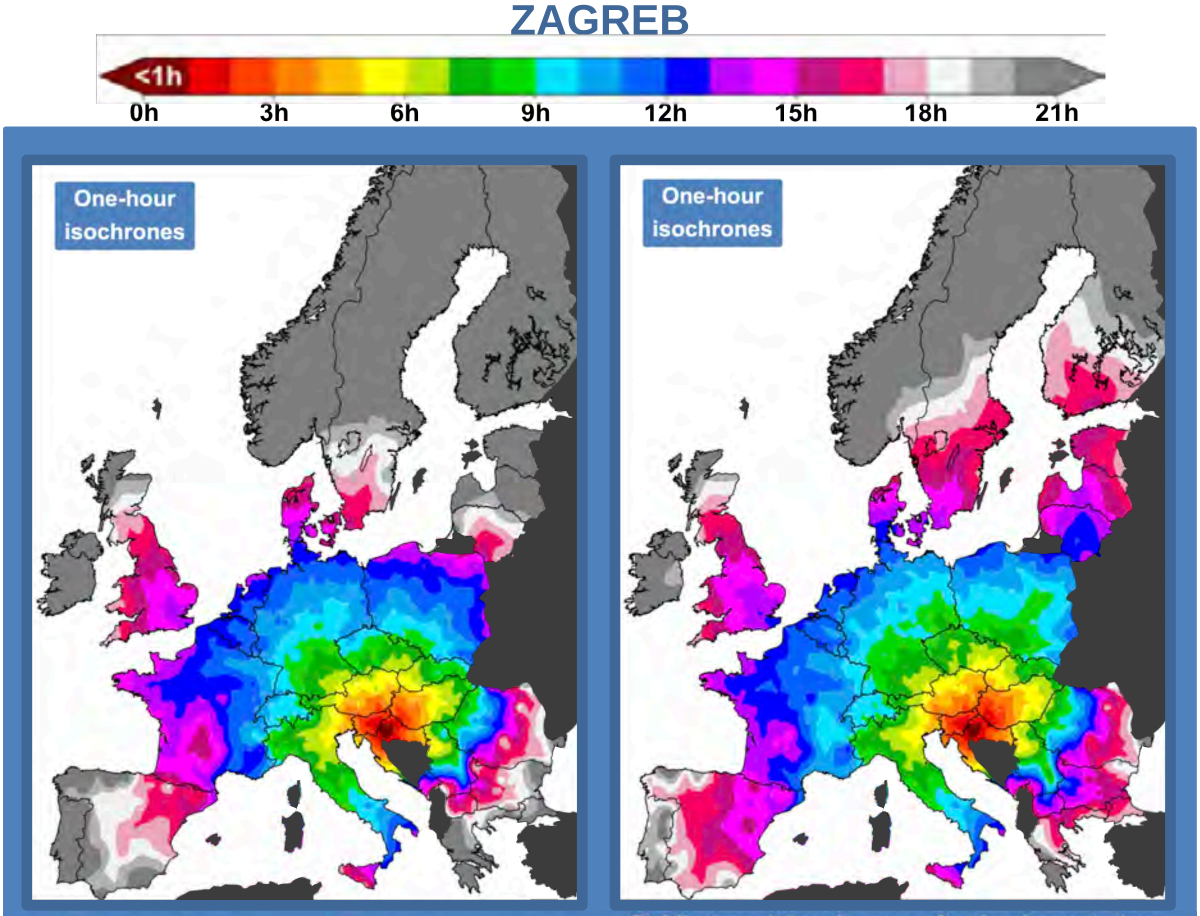
WARSAW



Public transit isochrones after implementation of a unified continental timetable

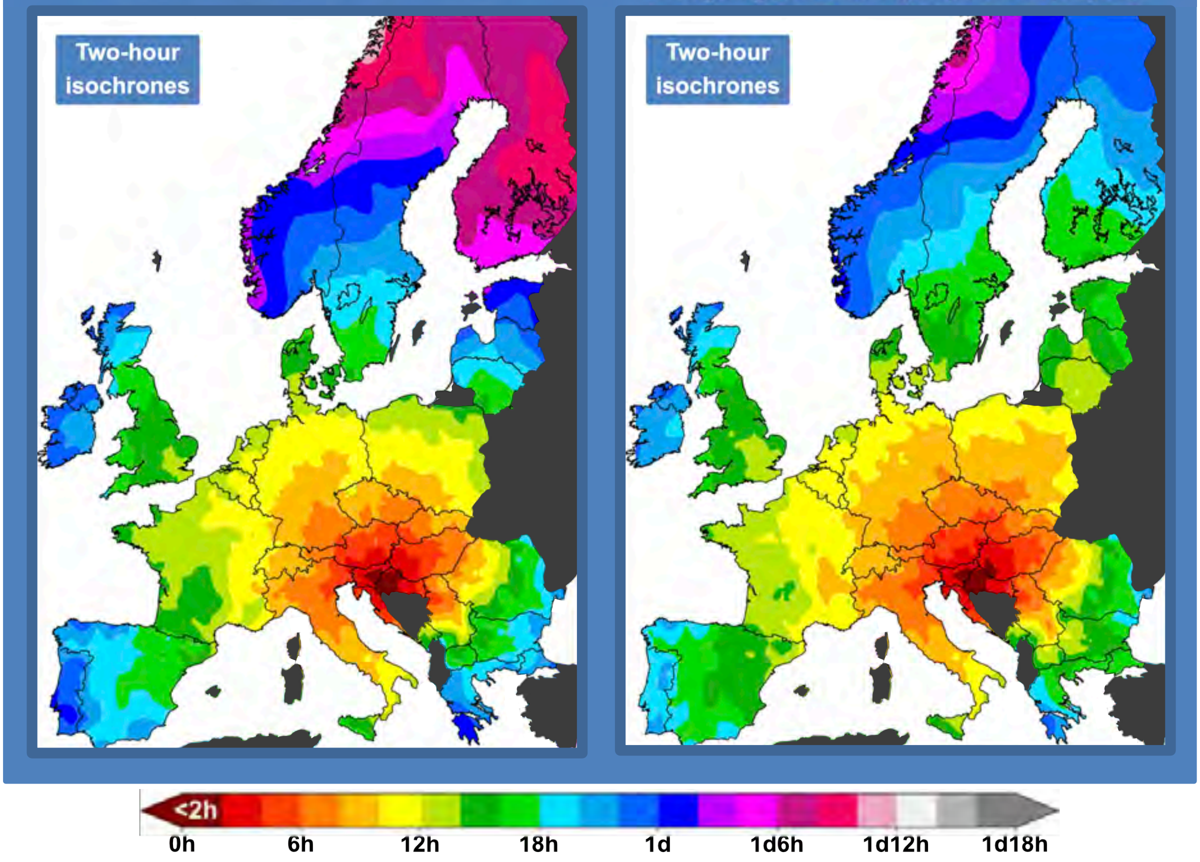
Public transit isochrones after implementation of a unified continental timetable and of ongoing pre-2050 high speed rail projects

ZAGREB

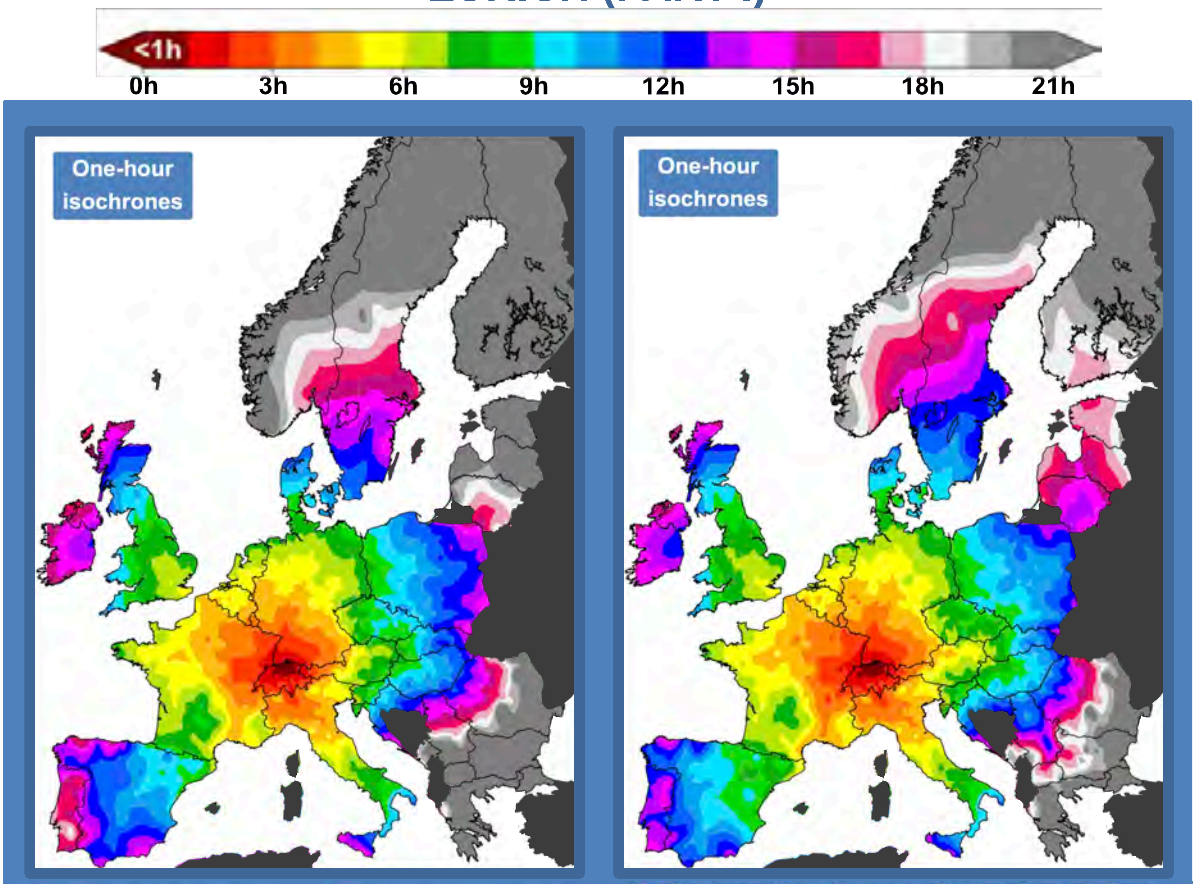


Public transit isochrones after implementation of a unified continental timetable

Public transit isochrones after implementation of a unified continental timetable and of ongoing pre-2050 high speed rail projects

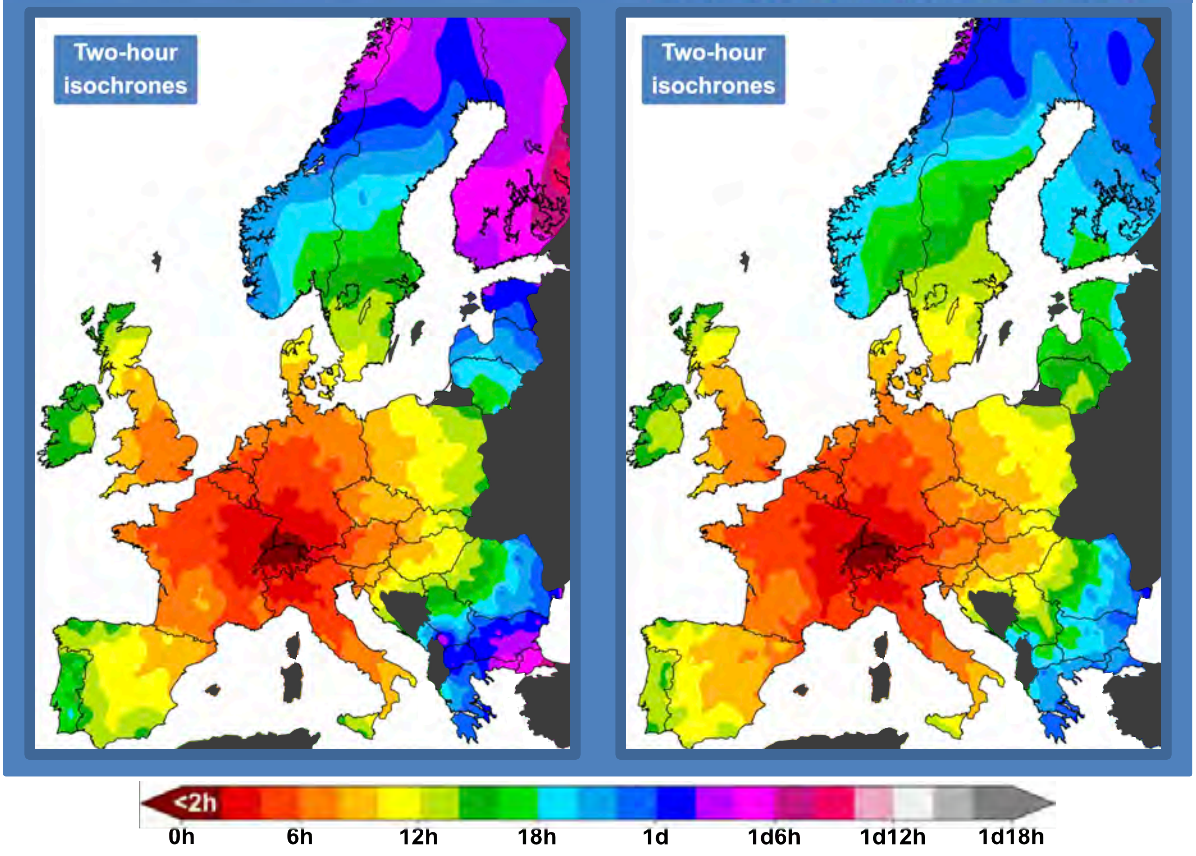


ZURICH (PART I)

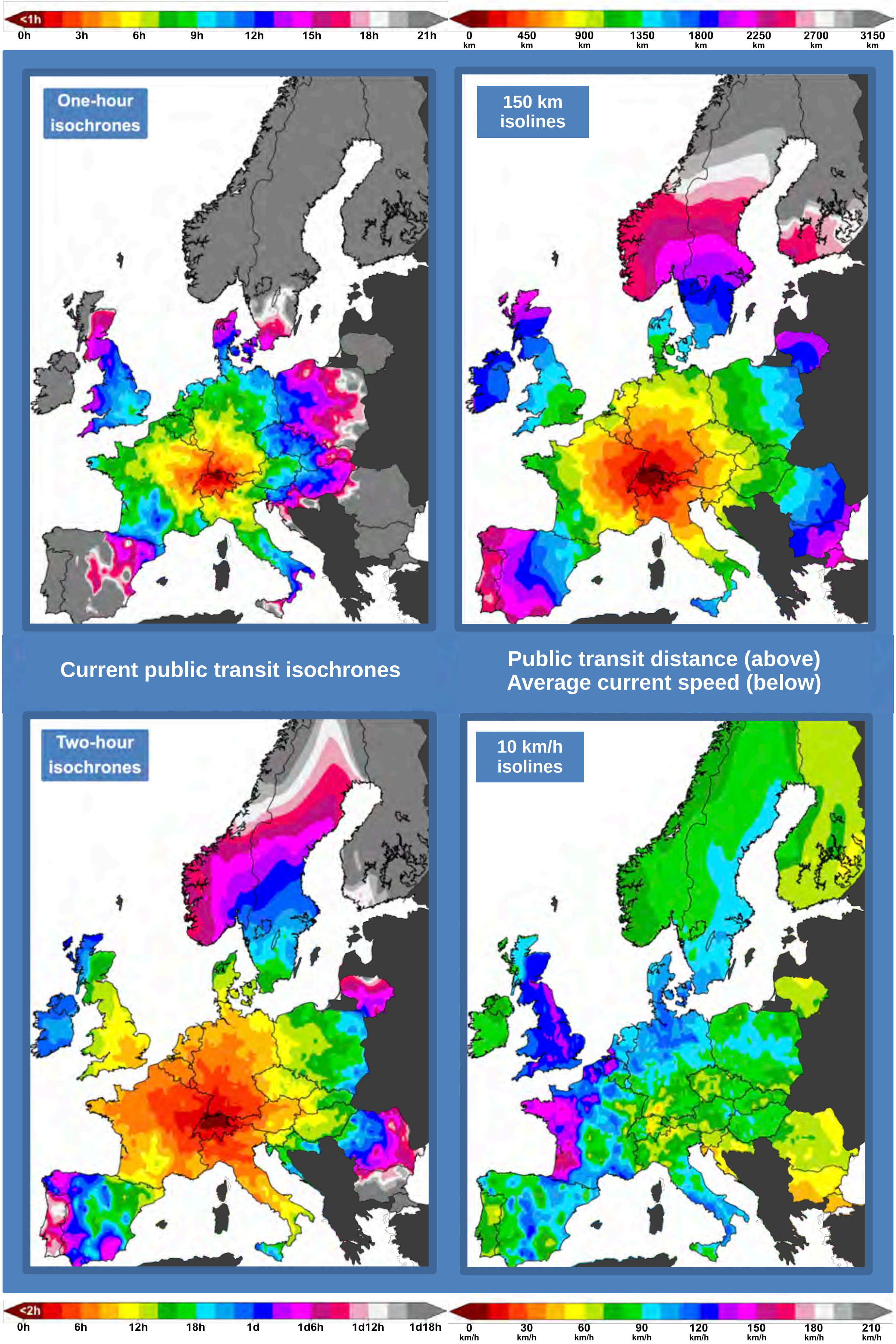


Public transit isochrones after implementation of a unified continental timetable

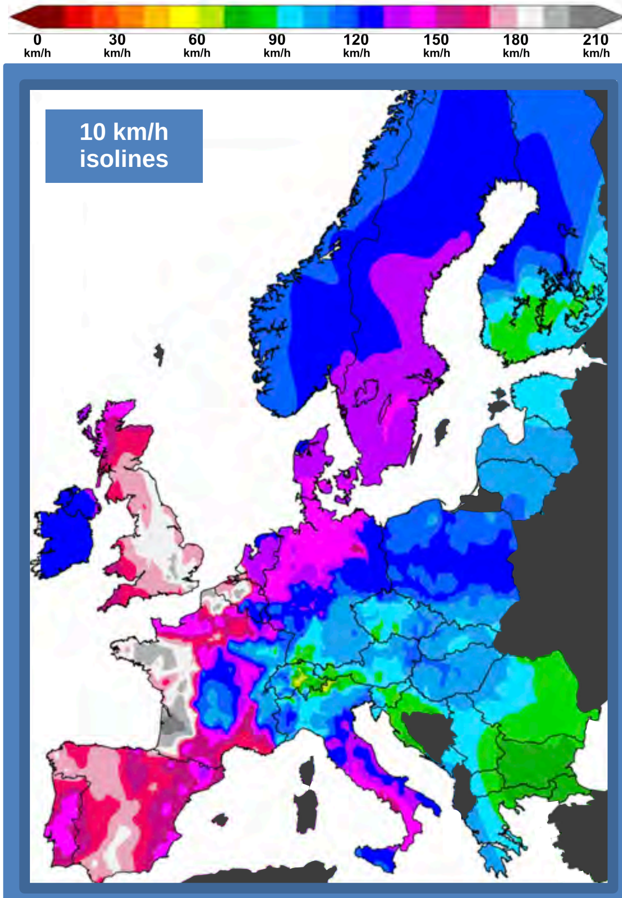
Public transit isochrones after implementation of a unified continental timetable and of ongoing pre-2050 high speed rail projects

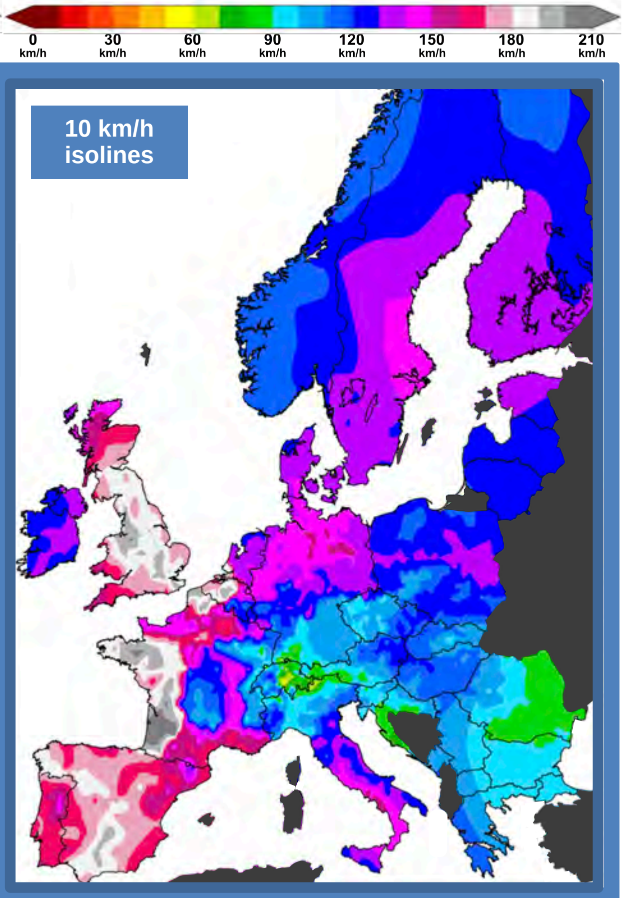


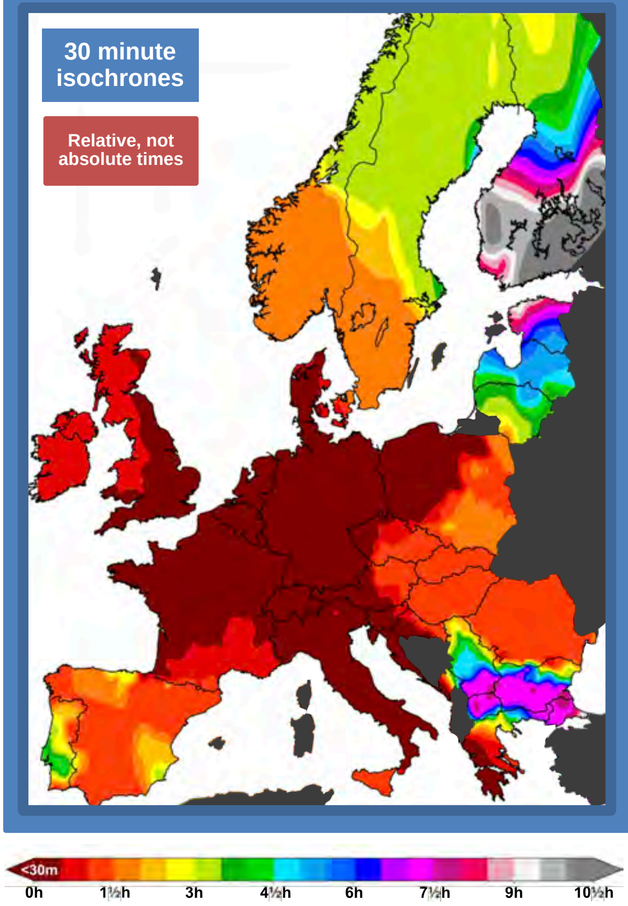
ZURICH (PART II)



ZURICH (PART III)





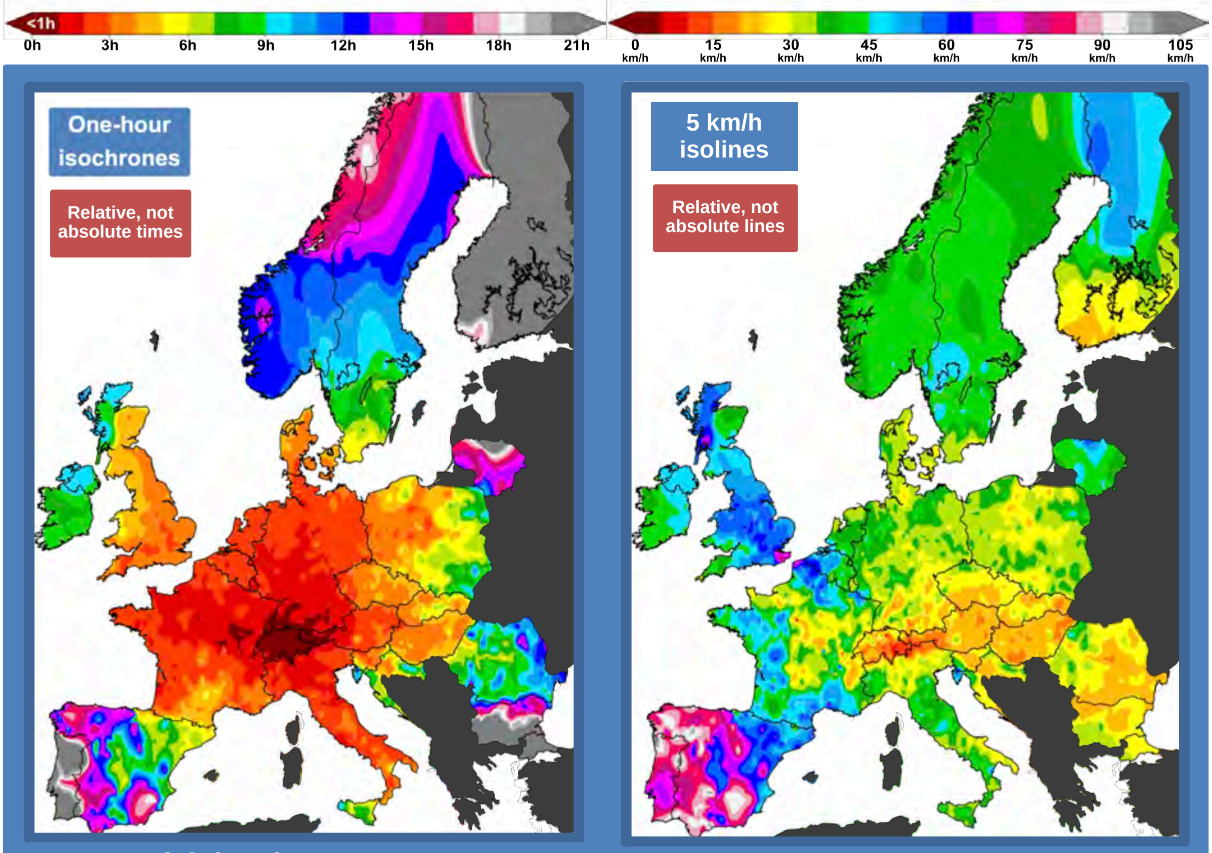


Potential average speeds today, post-optimisation (top left)

Potential average speeds in 2050, post-optimisation (top right)

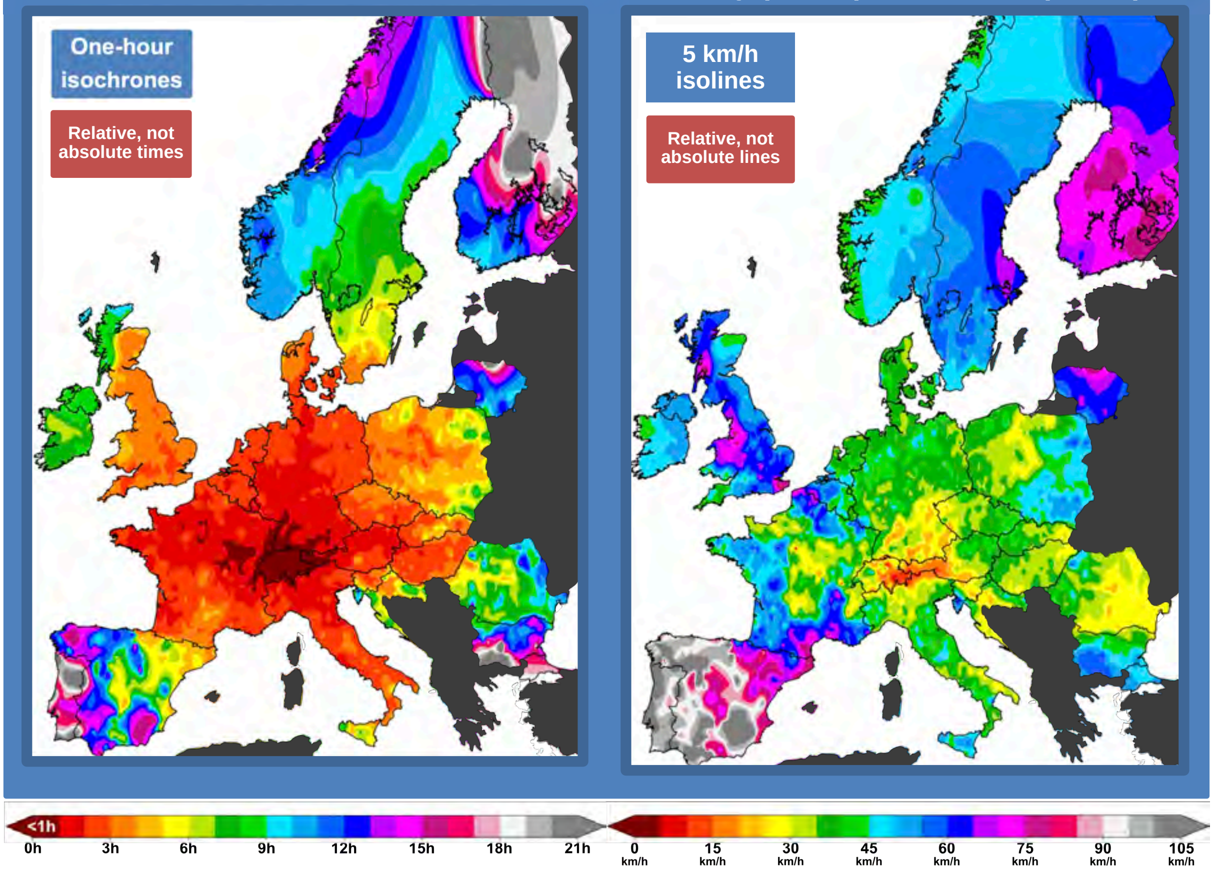
Time reduction expected by 2050 upon the construction of new infrastructure (bottom left)

ZURICH (PART IV)



Potential time improvement post-optimisation vs. current schedules today (above) and in 2050 (below)

Potential speed improvement post-optimisation vs. current speeds today (above) and in 2050 (below)



2. Tables

2.1. Corridor Tables

Table 5.2 Corridor 1: Comparison of current, future and potential travel times

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Narvik			Boden			Umeå			Gävle		
	Narvik	X											
5	Boden	393	393 0.0%	315 -19.8%	X								
5	Umeå	625	625 0.0%	498 -20.3%	194	194 0.0%	178 -8.2%	X					
5	Gävle	995	995 0.0%	773 -22.3%	551	551 0.0%	453 -17.8%	288	288 0.0%	270 -6.3%	X		
10	Stockholm	1097	1097 0.0%	854 -22.2%	634	634 0.0%	534 -15.8%	372	372 0.0%	351 -5.6%	81	81 0.0%	76 -6.2%
5	Malmö	1413	1304 -7.7%	1106 -21.7%	902	793 -12.1%	786 -12.9%	686	577 -15.9%	603 -12.1%	380	271 -28.7%	328 -13.7%
10	København	1461	1338 -8.4%	1134 -22.4%	955	832 -12.9%	814 -14.8%	733	610 -16.8%	631 -13.9%	433	310 -28.4%	356 -17.8%
5	Hamburg	1800	1550 -13.9%	1374 -23.7%	1384	1134 -18.1%	1054 -23.8%	1082	832 -23.1%	871 -19.5%	765	515 -32.7%	596 -22.1%
5	Hannover	1965	1696 -13.7%	1449 -26.3%	1536	1267 -17.5%	1129 -26.5%	1277	1008 -21.1%	946 -25.9%	868	599 -31.0%	671 -22.7%
5	Würzburg	2158	1889 -12.5%	1563 -27.6%	1708	1439 -15.7%	1243 -27.2%	1416	1147 -19.0%	1060 -25.1%	1050	781 -25.6%	785 -25.2%
5	Nürnburg	2215	1924 -13.1%	1616 -27.0%	1763	1472 -16.5%	1296 -26.5%	1480	1189 -19.7%	1113 -24.8%	1104	813 -26.4%	838 -24.1%
10	München	2305	2014 -12.6%	1682 -27.0%	1835	1544 -15.9%	1362 -25.8%	1549	1258 -18.8%	1179 -23.9%	1200	909 -24.3%	904 -24.7%
5	Innsbruck	2519	2179 -13.5%	1771 -29.7%	2046	1706 -16.6%	1451 -29.1%	1677	1337 -20.3%	1268 -24.4%	1383	1043 -24.6%	993 -28.2%
10	Verona	2739	2272 -17.1%	1949 -28.8%	2323	1856 -20.1%	1629 -29.9%	2002	1535 -23.3%	1446 -27.8%	1602	1135 -29.2%	1171 -26.9%
5	Bologna	2819	2352 -16.6%	2010 -28.7%	2397	1930 -19.5%	1690 -29.5%	2080	1613 -22.5%	1507 -27.5%	1680	1213 -27.8%	1232 -26.7%
5	Firenze	2805	2338 -16.6%	2048 -27.0%	2389	1922 -19.5%	1728 -27.7%	2123	1656 -22.0%	1545 -27.2%	1726	1259 -27.1%	1270 -26.4%
10	Roma	2910	2443 -16.0%	2136 -26.6%	2494	2027 -18.7%	1816 -27.2%	2168	1701 -21.5%	1633 -24.7%	1846	1379 -25.3%	1358 -26.4%
10	Napoli	3175	2708 -14.7%	2209 -30.4%	2584	2117 -18.1%	1889 -26.9%	2244	1777 -20.8%	1706 -24.0%	1847	1380 -25.3%	1431 -22.5%
5	Salerno	3267	2800 -14.3%	2223 -32.0%	2625	2158 -17.8%	1903 -27.5%	2439	1972 -19.1%	1720 -29.5%	1987	1520 -23.5%	1445 -27.3%
30	Villa San Giovanni	3578	3042 -15.0%	2400 -32.9%	2844	2308 -18.8%	2080 -26.9%	2622	2086 -20.4%	1897 -27.7%	2243	1707 -23.9%	1622 -27.7%
30	Messina	3605	3054 -15.3%	2460 -31.8%	2914	2363 -18.9%	2140 -26.6%	2857	2306 -19.3%	1957 -31.5%	2313	1762 -23.8%	1682 -27.3%
5	Palermo	3855	3304 -14.3%	2621 -32.0%	3439	2888 -16.0%	2301 -33.1%	3075	2524 -17.9%	2118 -31.1%	2637	2086 -20.9%	1843 -30.1%
	Trapani	4322	3771 -12.7%	2791 -35.4%	3906	3355 -14.1%	2471 -36.7%	3542	2991 -15.6%	2288 -35.4%	3104	2553 -17.8%	2013 -35.1%
		Narvik			Boden			Umeå			Gävle		
	AVERAGE		-11.3%	-27.1%		-13.9%	-24.5%		-16.2%	-22.6%		-21.2%	-23.1%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Stockholm			Malmö			København			Hamburg		
10	Stockholm	X											
5	Malmö	264	155 -41.3%	242 -8.3%	X								
10	København	311	180 -42.1%	270 -13.2%	39	25 -35.9%	23 -41.0%	X					
5	Hamburg	636	378 -40.6%	510 -19.8%	328	187 -43.0%	263 -19.8%	277	150 -45.8%	230 -17.0%	X		
5	Hannover	734	457 -37.7%	585 -20.3%	423	263 -37.8%	338 -20.1%	372	226 -39.2%	305 -18.0%	78	59 -24.4%	70 -10.3%
5	Würzburg	906	629 -30.6%	699 -22.8%	593	433 -27.0%	452 -23.8%	528	382 -27.7%	419 -20.6%	205	186 -9.3%	184 -10.2%
5	Nürnburg	961	662 -31.1%	752 -21.7%	650	468 -28.0%	505 -22.3%	592	424 -28.4%	472 -20.3%	262	221 -15.6%	237 -9.5%
10	München	1034	735 -28.9%	818 -20.9%	724	542 -25.1%	571 -21.1%	661	493 -25.4%	538 -18.6%	341	300 -12.0%	303 -11.1%
5	Innsbruck	1224	876 -28.4%	907 -25.9%	855	624 -27.0%	660 -22.8%	789	572 -27.5%	627 -20.5%	476	386 -18.9%	392 -17.6%
10	Verona	1476	1001 -32.2%	1085 -26.5%	1138	780 -31.5%	838 -26.4%	1154	810 -29.8%	805 -30.2%	696	479 -31.2%	570 -18.1%
5	Bologna	1552	1077 -30.6%	1146 -26.2%	1208	850 -29.6%	899 -25.6%	1224	880 -28.1%	866 -29.2%	793	576 -27.4%	631 -20.4%
5	Firenze	1587	1112 -29.9%	1184 -25.4%	1249	891 -28.7%	937 -25.0%	1265	921 -27.2%	904 -28.5%	843	626 -25.7%	669 -20.6%
10	Roma	1707	1232 -27.8%	1272 -25.5%	1294	936 -27.7%	1025 -20.8%	1385	1041 -24.8%	992 -28.4%	914	697 -23.7%	757 -17.2%
10	Napoli	1708	1233 -27.8%	1345 -21.3%	1370	1012 -26.1%	1098 -19.9%	1386	1042 -24.8%	1065 -23.2%	990	773 -21.9%	830 -16.2%
5	Salerno	1860	1385 -25.5%	1359 -26.9%	1547	1189 -23.1%	1112 -28.1%	1518	1174 -22.7%	1079 -28.9%	1059	842 -20.5%	844 -20.3%
30	Villa San Giovanni	2125	1581 -25.6%	1536 -27.7%	1835	1408 -23.3%	1289 -29.8%	1782	1369 -23.2%	1256 -29.5%	1371	1085 -20.9%	1021 -25.5%
30	Messina	2187	1628 -25.6%	1596 -27.0%	1940	1498 -22.8%	1349 -30.5%	1889	1461 -22.7%	1316 -30.3%	1465	1164 -20.5%	1081 -26.2%
5	Palermo	2677	2118 -20.9%	1757 -34.4%	2148	1706 -20.6%	1510 -29.7%	2095	1667 -20.4%	1477 -29.5%	1670	1369 -18.0%	1242 -25.6%
	Trapani	2941	2382 -19.0%	1927 -34.5%	2615	2173 -16.9%	1680 -35.8%	2562	2134 -16.7%	1647 -35.7%	2025	1724 -14.9%	1412 -30.3%
		Stockholm			Malmö			København			Hamburg		
	AVERAGE		-24.8%	-21.7%		-26.4%	-23.2%		-26.3%	-24.2%		-22.7%	-18.5%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Hannover			Würzburg			Nürnburg			München			Innsbruck		
5	Hannover	X														
5	Würzburg	122	122 0.0%	109 -10.7%	X											
5	Nürnburg	177	155 -12.4%	162 -8.5%	51	29 -43.1%	48 -5.9%	X								
10	München	254	232 -8.7%	228 -10.2%	118	96 -18.6%	114 -3.4%	62	62 0.0%	61 -1.6%	X					
5	Innsbruck	397	326 -17.9%	317 -20.2%	250	179 -28.4%	203 -18.8%	185	136 -26.5%	150 -18.9%	104	55 -47.1%	79 -24.0%	X		
10	Verona	619	421 -32.0%	495 -20.0%	461	263 -43.0%	381 -17.4%	401	225 -43.9%	328 -18.2%	322	146 -54.7%	257 -20.2%	212	85 -59.9%	173 -18.4%
5	Bologna	708	510 -28.0%	556 -21.5%	540	342 -36.7%	442 -18.1%	482	306 -36.5%	389 -19.3%	396	220 -44.4%	318 -19.7%	284	157 -44.7%	234 -17.6%
5	Firenze	781	583 -25.4%	594 -23.9%	597	399 -33.2%	480 -19.6%	539	363 -32.7%	427 -20.8%	450	274 -39.1%	356 -20.9%	335	208 -37.9%	272 -18.8%
10	Roma	832	634 -23.8%	682 -18.0%	692	494 -28.6%	568 -17.9%	629	453 -28.0%	515 -18.1%	546	370 -32.2%	444 -18.7%	441	314 -28.8%	360 -18.4%
10	Napoli	908	710 -21.8%	755 -16.9%	775	577 -25.5%	641 -17.3%	712	536 -24.7%	588 -17.4%	629	453 -28.0%	517 -17.8%	523	396 -24.3%	433 -17.2%
5	Salerno	977	779 -20.3%	769 -21.3%	808	610 -24.5%	655 -18.9%	745	569 -23.6%	602 -19.2%	662	486 -26.6%	531 -19.8%	537	410 -23.6%	447 -16.8%
30	Villa San Giovanni	1284	1017 -20.8%	946 -26.3%	1057	790 -25.3%	832 -21.3%	998	753 -24.5%	779 -21.9%	908	663 -27.0%	708 -22.0%	769	573 -25.5%	624 -18.9%
30	Messina	1362	1080 -20.7%	1006 -26.1%	1156	874 -24.4%	892 -22.8%	1059	799 -24.6%	839 -20.8%	961	701 -27.1%	768 -20.1%	841	630 -25.1%	684 -18.7%
5	Palermo	1586	1304 -17.8%	1167 -26.4%	1460	1178 -19.3%	1053 -27.9%	1401	1141 -18.6%	1000 -28.6%	1311	1051 -19.8%	929 -29.1%	1043	832 -20.2%	845 -19.0%
	Trapani	1941	1659 -14.5%	1337 -31.1%	1758	1476 -16.0%	1223 -30.4%	1699	1439 -15.3%	1170 -31.1%	1609	1349 -16.2%	1099 -31.7%	1498	1287 -14.1%	1015 -32.2%
		Hannover			Würzburg			Nürnburg			München			Innsbruck		
	AVERAGE		-22.1%	-20.5%		-24.3%	-19.7%		-24.2%	-19.4%		-25.1%	-19.7%		-27.3%	-21.6%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Verona			Bologna			Firenze			Roma			Napoli		
10	Verona	X														
5	Bologna	51	51 0.0%	51 0.0%	X											
5	Firenze	91	91 0.0%	89 -2.2%	33	33 0.0%	33 0.0%	X								
10	Roma	197	197 0.0%	177 -10.2%	123	123 0.0%	114 -7.3%	90	90 0.0%	83 -7.8%	X					
10	Napoli	278	278 0.0%	250 -10.1%	203	203 0.0%	187 -7.9%	177	177 0.0%	156 -11.9%	66	66 0.0%	63 -4.5%	X		
5	Salerno	292	292 0.0%	264 -9.6%	217	217 0.0%	201 -7.4%	205	205 0.0%	170 -17.1%	84	84 0.0%	77 -8.3%	34	34 0.0%	31 -8.8%
30	Villa San Giovanni	505	436 -13.7%	441 -12.7%	430	361 -16.0%	378 -12.1%	406	337 -17.0%	347 -14.5%	297	228 -23.2%	254 -14.5%	243	174 -28.4%	208 -14.4%
30	Messina	568	484 -14.8%	501 -11.8%	488	404 -17.2%	438 -10.2%	447	363 -18.8%	407 -8.9%	375	291 -22.4%	314 -16.3%	305	221 -27.5%	268 -12.1%
5	Palermo	761	677 -11.0%	662 -13.0%	686	602 -12.2%	599 -12.7%	679	595 -12.4%	568 -16.3%	553	469 -15.2%	475 -14.1%	486	402 -17.3%	429 -11.7%
	Trapani	1230	1146 -6.8%	832 -32.4%	1155	1071 -7.3%	769 -33.4%	1129	1045 -7.4%	738 -34.6%	1017	933 -8.3%	645 -36.6%	916	832 -9.2%	599 -34.6%
		Verona			Bologna			Firenze			Roma			Napoli		
	AVERAGE		-22.5%	-18.7%		-20.2%	-18.2%		-19.1%	-19.3%		-18.0%	-18.5%		-17.6%	-17.6%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Salerno			Villa San Giovanni			Messina			Palermo			Trapani		
5	Salerno	X														
30	Villa San Giovanni	199	130 -34.7%	172 -13.6%	X											
30	Messina	263	179 -31.9%	232 -11.8%	30	15 -50.0%	30 0.0%	X								
5	Palermo	449	365 -18.7%	393 -12.5%	208	193 -7.2%	191 -8.2%	164	164 0.0%	131 -20.1%	X					
	Trapani	873	789 -9.6%	563 -35.5%	515	500 -2.9%	361 -29.9%	462	462 0.0%	301 -34.8%	137	137 0.0%	165 20.4%	X		
		Salerno			Villa San Giovanni			Messina			Palermo			Trapani		
	AVERAGE		-17.3%	-20.0%		-22.1%	-20.8%		-21.5%	-21.2%		-15.4%	-21.1%		-11.6%	-31.2%

Table 12 Corridor 2: Comparison of current, future and potential travel times

	Times	Current	Future Non Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current
DWELL	Stations	Rostock			Berlin			Dresden			Ústí nad Labem			Praha			Brno			Břeclav		
	Rostock	X																				
5	Berlin	114	114	108	X																	
			0.0%	-5.3%																		
5	Dresden	246	214	208	112	80	95	X														
			-13.0%	-15.4%		-28.6%	-15.2%															
5	Ústí nad Labem	350	286	266	184	120	153	61	29	53	X											
			-18.3%	-24.0%		-34.8%	-16.8%		-52.5%	-13.1%												
10	Praha	423	317	337	257	151	224	134	60	124	71	29	66	X								
			-25.1%	-20.3%		-41.2%	-12.8%		-55.2%	-7.5%		-59.2%	-7.0%									
5	Brno	598	404	485	432	238	372	309	147	272	243	113	214	148	60	138	X					
			-32.4%	-18.9%		-44.9%	-13.9%		-52.4%	-12.0%		-53.5%	-11.9%		-59.5%	-6.8%						
5	Břeclav	630	427	519	465	262	406	342	171	306	275	136	248	179	82	172	29	20	29	X		
			-32.2%	-17.6%		-43.7%	-12.7%		-50.0%	-10.5%		-50.5%	-9.8%		-54.2%	-3.9%		-31.0%	0.0%			
5	Bratislava	699	496	573	534	331	460	412	241	360	344	205	302	253	156	226	98	89	83	59	59	49
			-29.0%	-18.0%		-38.0%	-13.9%		-41.5%	-12.6%		-40.4%	-12.2%		-38.3%	-10.7%		-9.2%	-15.3%		0.0%	-16.9%
10	Budapest	820	590	707	676	446	594	609	411	494	515	349	436	417	293	360	267	231	217	236	209	183
			-28.0%	-13.8%		-34.0%	-12.1%		-32.5%	-18.9%		-32.2%	-15.3%		-29.7%	-13.7%		-13.5%	-18.7%		-11.4%	-22.5%
35	Arad	1145	915	888	979	749	775	856	658	675	793	627	617	718	594	541	579	543	398	513	486	364
			-20.1%	-22.4%		-23.5%	-20.8%		-23.1%	-21.1%		-20.9%	-22.2%		-17.3%	-24.7%		-6.2%	-31.3%		-5.3%	-29.0%
5	Timisoara	1253	1023	998	1087	857	885	964	766	785	901	735	727	815	691	651	672	636	508	640	613	474
			-18.4%	-20.4%		-21.2%	-18.6%		-20.5%	-18.6%		-18.4%	-19.3%		-15.2%	-20.1%		-5.4%	-24.4%		-4.2%	-25.9%
5	Craiova	1652	1422	1360	1486	1256	1247	1363	1165	1147	1300	1134	1089	1269	1145	1013	1051	1015	870	1099	1072	836
			-13.9%	-17.7%		-15.5%	-16.1%		-14.5%	-15.8%		-12.8%	-16.2%		-9.8%	-20.2%		-3.4%	-17.2%		-2.5%	-23.9%
10	Sofia	2227	1997	1781	2076	1846	1668	2060	1862	1568	1932	1766	1510	1841	1717	1434	1686	1650	1291	1654	1627	1257
			-10.3%	-20.0%		-11.1%	-19.7%		-9.6%	-23.9%		-8.6%	-21.8%		-6.7%	-22.1%		-2.1%	-23.4%		-1.6%	-24.0%
10	Thessaloniki	2593	2363	2106	2442	2212	1993	2426	2228	1893	2298	2132	1835	2207	2083	1759	2052	2016	1616	2020	1993	1582
			-8.9%	-18.8%		-9.4%	-18.4%		-8.2%	-22.0%		-7.2%	-20.1%		-5.6%	-20.3%		-1.8%	-21.2%		-1.3%	-21.7%
10	Athens	3007	2777	2362	2856	2626	2249	2840	2642	2149	2712	2546	2091	2621	2497	2015	2466	2430	1872	2434	2407	1838
			-7.6%	-21.4%		-8.1%	-21.3%		-7.0%	-24.3%		-6.1%	-22.9%		-4.7%	-23.1%		-1.5%	-24.1%		-1.1%	-24.5%
	Patras	3187	2957	2540	3036	2806	2427	3020	2822	2327	2892	2726	2269	2801	2677	2193	2646	2610	2050	2614	2587	2016
			-7.2%	-20.3%		-7.6%	-20.1%		-6.6%	-22.9%		-5.7%	-21.5%		-4.4%	-21.7%		-1.4%	-22.5%		-1.0%	-22.9%
		Rostock			Berlin			Dresden			Ústí nad Labem			Praha			Brno			Břeclav		
	AVERAGE		-17.6%	-18.3%		-24.1%	-15.8%		-27.7%	-16.9%		-28.1%	-17.0%		-28.4%	-15.7%		-21.2%	-17.4%		-19.3%	-17.7%

	Times	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current
DWELL	Stations	Bratislava			Budapest			Arad			Timisoara			Craiova			Sofia			Thessaloniki			Athens			Patras		
	Rostock																											
5	Berlin																											
5	Dresden																											
5	Ústí nad Labem																											
10	Praha																											
5	Brno																											
5	Břeclav																											
5	Bratislava	X																										
10	Budapest	170	143	129	X																							
			-15.9%	-24.1%																								
35	Arad	443	416	294	257	257	171	X																				
			-6.1%	-33.6%		0.0%	-33.5%																					
5	Timisoara	571	544	404	346	346	281	81	81	75	X																	
			-4.7%	-29.2%		0.0%	-18.8%		0.0%	-7.4%																		
5	Craiova	948	921	766	763	763	643	477	477	437	390	390	357	X														
			-2.8%	-19.2%		0.0%	-15.7%		0.0%	-8.4%		0.0%	-8.5%															
10	Sofia	1645	1618	1187	1350	1350	901	1030	1030	858	942	942	778	516	516	416	X											
			-1.6%	-27.8%		0.0%	-33.3%		0.0%	-16.7%		0.0%	-17.4%		0.0%	-19.4%												
10	Thessaloniki	2011	1984	1512	1716	1716	1226	1396	1396	1183	1308	1308	1103	882	882	741	320	320	315	X								
			-1.3%	-24.8%		0.0%	-28.6%		0.0%	-15.3%		0.0%	-15.7%		0.0%	-16.0%		0.0%	-1.6%									
10	Athens	2425	2398	1768	2130	2130	1482	1810	1810	1439	1722	1722	1359	1296	1296	997	760	760	571	293	293	246	X					
			-1.1%	-27.1%		0.0%	-30.4%		0.0%	-20.5%		0.0%	-21.1%		0.0%	-23.1%		0.0%	-24.9%		0.0%	-16.0%						
	Patras	2605	2578	1946	2310	2310	1660	1990	1990	1617	1902	1902	1537	1476	1476	1175	920	920	749	652	652	424	174	174	168	X		
			-1.0%	-25.3%		0.0%	-28.1%		0.0%	-18.7%		0.0%	-19.2%		0.0%	-20.4%		0.0%	-18.6%		0.0%	-35.0%		0.0%	-3.4%			
		Bratislava			Budapest			Arad			Timisoara			Craiova			Sofia			Thessaloniki			Athens			Patras		
	AVERAGE		-15.4%	-20.7%		-13.2%	-21.8%		-8.2%	-21.7%		-7.2%	-19.0%		-5.0%	-17.2%		-3.5%	-21.0%		-2.9%	-19.7%		-2.5%	-21.9%		-2.3%	-21.4%

Table 13 Corridor 3: Comparison of current, future and potential travel times

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Paris			Strasbourg			Stuttgart			Ulm			Augsburg			München			Linz			Wien			Budapest		
	Paris	X																										
5	Strasbourg	106	106 0.0%	105 -0.9%	X																							
10	Stuttgart	192	192 0.0%	184 -4.2%	82	82 0.0%	74 -9.8%	X																				
5	Ulm	252	237 -6.0%	235 -6.7%	136	121 -11.0%	125 -8.1%	42	27 -35.7%	41 -2.4%	X																	
5	Augsburg	295	265 -10.2%	278 -5.8%	179	149 -16.8%	168 -6.1%	85	55 -35.3%	84 -1.2%	41	26 -36.6%	38 -7.3%	X														
10	München	327	297 -9.2%	308 -5.8%	211	181 -14.2%	198 -6.2%	117	87 -25.6%	114 -2.6%	73	58 -20.5%	68 -6.8%	29	29 0.0%	25 -13.8%	X											
5	Linz	508	386 -24.0%	464 -8.7%	393	271 -31.0%	354 -9.9%	298	176 -40.9%	270 -9.4%	254	147 -42.1%	224 -11.8%	207	115 -44.4%	181 -12.6%	172	80 -53.5%	146 -15.1%	X								
5	Wien	585	458 -21.7%	538 -8.0%	470	343 -27.0%	428 -8.9%	375	248 -33.9%	344 -8.3%	331	219 -33.8%	298 -10.0%	284	187 -34.2%	255 -10.2%	249	150 -39.8%	220 -11.6%	75	70 -6.7%	69 -8.0%	X					
30	Budapest	753	609 -19.1%	685 -9.0%	638	494 -22.6%	575 -9.9%	543	399 -26.5%	491 -9.6%	499	370 -25.9%	445 -10.8%	451	337 -25.3%	402 -10.9%	412	296 -28.2%	367 -10.9%	242	220 -9.1%	216 -10.7%	157	140 -10.8%	142 -9.6%	X		
5	Novi Sad	1497	888 -40.7%	1089 -27.3%	1394	785 -43.7%	979 -29.8%	1213	604 -50.2%	895 -26.2%	1137	543 -52.2%	849 -25.3%	1096	517 -52.8%	806 -26.5%	1066	485 -54.5%	771 -27.7%	828	341 -58.8%	620 -25.1%	745	263 -64.7%	546 -26.7%	589	124 -78.9%	374 -36.5%
5	Belgrade	1543	934 -39.5%	1129 -26.8%	1440	831 -42.3%	1019 -29.2%	1259	650 -48.4%	935 -25.7%	1183	589 -50.2%	889 -24.9%	1142	563 -50.7%	846 -25.9%	1112	531 -52.2%	811 -27.1%	874	387 -55.7%	660 -24.5%	791	309 -60.9%	586 -25.9%	635	160 -74.8%	414 -34.8%
25	Niš	1903	1028 -46.0%	1384 -27.3%	1800	925 -48.6%	1274 -29.2%	1619	744 -54.0%	1190 -26.5%	1543	683 -55.7%	1144 -25.9%	1502	657 -56.3%	1101 -26.7%	1472	625 -57.5%	1066 -27.6%	1234	481 -61.0%	915 -25.9%	1151	403 -65.0%	841 -26.9%	995	254 -74.5%	669 -32.8%
5	Sofia	2146	1271 -40.8%	1673 -22.0%	2514	1639 -34.8%	1563 -37.8%	1933	1058 -45.3%	1479 -23.5%	1889	1029 -45.5%	1433 -24.1%	1846	1001 -45.8%	1390 -24.7%	1802	955 -47.0%	1355 -24.8%	1633	880 -46.1%	1204 -26.3%	1550	802 -48.3%	1130 -27.1%	1350	609 -54.9%	958 -29.0%
5	Plovdiv	2533	1658 -34.5%	1818 -28.2%	2418	1543 -36.2%	1708 -29.4%	2323	1448 -37.7%	1624 -30.1%	2279	1419 -37.7%	1578 -30.8%	2235	1390 -37.8%	1535 -31.3%	2194	1347 -38.6%	1500 -31.6%	2009	1256 -37.5%	1349 -32.9%	1907	1159 -39.2%	1275 -33.1%	1700	959 -43.6%	1103 -35.1%
5	Dimitrovgrad	2478	1603 -35.3%	1871 -24.5%	2363	1488 -37.0%	1761 -25.5%	2268	1393 -38.6%	1677 -26.1%	2411	1551 -35.7%	1631 -32.4%	2180	1335 -38.8%	1588 -27.2%	2139	1292 -39.6%	1553 -27.4%	1949	1196 -38.6%	1402 -28.1%	1847	1099 -40.5%	1328 -28.1%	1640	899 -45.2%	1156 -29.5%
20	Svilengrad	2593	1718 -33.7%	1919 -26.0%	3050	2175 -28.7%	1809 -40.7%	2529	1654 -34.6%	1725 -31.8%	2339	1479 -36.8%	1679 -28.2%	2539	1694 -33.3%	1636 -35.6%	2254	1407 -37.6%	1601 -29.0%	2083	1330 -36.1%	1450 -30.4%	1968	1220 -38.0%	1376 -30.1%	1761	1020 -42.1%	1204 -31.6%
40	Edirne	3403	2463 -27.6%	1973 -42.0%	3232	2292 -29.1%	1863 -42.4%	2571	1631 -36.6%	1779 -30.8%	2527	1602 -36.6%	1733 -31.4%	2483	1573 -36.6%	1690 -31.9%	2679	1767 -34.0%	1655 -38.2%	2252	1434 -36.3%	1504 -33.2%	2150	1337 -37.8%	1430 -33.5%	1943	1137 -41.5%	1258 -35.3%
	Istanbul	3736	2650 -29.1%	2231 -40.3%	3524	2438 -30.8%	2121 -39.8%	2923	1837 -37.2%	2037 -30.3%	2761	1690 -38.8%	1991 -27.9%	2766	1710 -38.2%	1948 -29.6%	2711	1653 -39.0%	1913 -29.4%	2803	1525 -45.6%	1762 -37.1%	2442	1483 -39.3%	1688 -30.9%	2235	1283 -42.6%	1516 -32.2%
		Paris			Strasbourg			Stuttgart			Ulm			Augsburg			München			Linz			Wien			Budapest		
	AVERAGE		-24.5%	-18.4%		-26.7%	-21.4%		-34.1%	-17.5%		-35.3%	-18.5%		-34.9%	-19.2%		-34.8%	-19.7%		-39.3%	-20.6%		-37.7%	-19.8%		-39.1%	-22.2%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Novi Sad			Belgrade			Niš			Sofia			Plovdiv			Dimitrovgrad			Svilengrad			Edirne			Istanbul		
	Paris																											
5	Strasbourg																											
10	Stuttgart																											
5	Ulm																											
5	Augsburg																											
10	München																											
5	Linz																											
5	Wien																											
30	Budapest																											
5	Novi Sad	X																										
5	Belgrade	36	36 0.0%	35 -2.8%	X																							
25	Niš	396	130 -67.2%	290 -26.8%	341	75 -78.0%	250 -26.7%	X																				
5	Sofia	1884	455 -75.8%	579 -69.3%	1930	400 -79.3%	539 -72.1%	270	270 0.0%	264 -2.2%	X																	
5	Plovdiv	2263	750 -66.9%	724 -68.0%	2309	779 -66.3%	684 -70.4%	452	452 0.0%	409 -9.5%	152	152 0.0%	140 -7.9%	X														
5	Dimitrovgrad	2165	652 -69.9%	777 -64.1%	2211	681 -69.2%	737 -66.7%	511	511 0.0%	462 -9.6%	211	211 0.0%	193 -8.5%	55	55 0.0%	48 -12.7%	X											
20	Svilengrad	2293	780 -66.0%	825 -64.0%	2339	809 -65.4%	785 -66.4%	582	582 0.0%	510 -12.4%	282	282 0.0%	241 -14.5%	110	110 0.0%	96 -12.7%	43	43 0.0%	43 0.0%	X								
40	Edirne	2388	810 -66.1%	879 -63.2%	2434	839 -65.5%	839 -65.5%	718	653 -9.1%	564 -21.4%	418	418 0.0%	295 -29.4%	228	228 0.0%	150 -34.2%	148	148 0.0%	97 -34.5%	95	30 -68.4%	34 -64.2%	X					
	Istanbul	2619	895 -65.8%	1137 -56.6%	2665	924 -65.3%	1097 -58.8%	949	738 -22.2%	822 -13.4%	649	503 -22.5%	553 -14.8%	459	313 -31.8%	408 -11.1%	379	233 -38.5%	355 -6.3%	326	180 -44.8%	292 -10.4%	226	80 -64.6%	218 -3.5%	X		
		Novi Sad			Belgrade			Niš			Sofia			Plovdiv			Dimitrovgrad			Svilengrad			Edirne			Istanbul		
	AVERAGE		-57.3%	-39.2%		-56.7%	-39.7%		-40.9%	-21.8%		-34.5%	-27.0%		-29.9%	-29.9%		-31.0%	-26.5%		-33.3%	-31.1%		-34.7%	-37.3%		-40.9%	-27.8%

Table 14 Corridor 4: Comparison of current, future and potential travel times

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Cádiz			Sevilla			Córdoba			Madrid		
	Cádiz	X											
5	Sevilla	83	83 0.0%	76 -8.4%	X								
5	Córdoba	137	137 0.0%	122 -10.9%	42	42 0.0%	41 -2.4%	X					
10	Madrid	255	255 0.0%	229 -10.2%	153	153 0.0%	148 -3.3%	106	106 0.0%	102 -3.8%	X		
5	Zaragoza	343	343 0.0%	314 -8.5%	234	234 0.0%	233 -0.4%	179	179 0.0%	165 -7.8%	75	75 0.0%	75 0.0%
5	Lleida	392	392 0.0%	359 -8.4%	277	277 0.0%	273 -1.4%	220	220 0.0%	210 -4.5%	119	119 0.0%	115 -3.4%
5	Tarragona	402	402 0.0%	388 -3.5%	303	303 0.0%	275 -9.2%	246	246 0.0%	230 -6.5%	124	124 0.0%	120 -3.2%
5	Barcelona	423	423 0.0%	366 -13.5%	318	318 0.0%	285 -10.4%	273	273 0.0%	239 -12.5%	150	150 0.0%	149 -0.7%
5	Perpignan	551	551 0.0%	446 -19.1%	443	443 0.0%	365 -17.6%	388	388 0.0%	319 -17.8%	248	248 0.0%	229 -7.7%
5	Montpellier	653	593 -9.2%	528 -19.1%	547	487 -11.0%	447 -18.3%	492	432 -12.2%	401 -18.5%	365	305 -16.4%	311 -14.8%
10	Lyon	1563	1503 -3.8%	612 -60.8%	768	708 -7.8%	531 -30.9%	719	659 -8.3%	485 -32.5%	542	482 -11.1%	395 -27.1%
5	Torino	1704	1523 -10.6%	803 -52.9%	1539	1358 -11.8%	722 -53.1%	1490	1309 -12.1%	676 -54.6%	906	725 -20.0%	586 -35.3%
10	Milano	1625	1444 -11.1%	851 -47.6%	1460	1279 -12.4%	770 -47.3%	1419	1238 -12.8%	724 -49.0%	920	739 -19.7%	634 -31.1%
5	Verona	1763	1569 -11.0%	927 -47.4%	1598	1404 -12.1%	846 -47.1%	1554	1360 -12.5%	800 -48.5%	1117	923 -17.4%	710 -36.4%
10	Venezia	1959	1760 -10.2%	983 -49.8%	1686	1487 -11.8%	902 -46.5%	1616	1417 -12.3%	856 -47.0%	1363	1164 -14.6%	766 -43.8%
10	Trieste	2100	1901 -9.5%	1074 -48.9%	1827	1628 -10.9%	993 -45.6%	1771	1572 -11.2%	947 -46.5%	1498	1299 -13.3%	857 -42.8%
5	Ljubljana	2035	1836 -9.8%	1214 -40.3%	1762	1563 -11.3%	1133 -35.7%	1706	1507 -11.7%	1087 -36.3%	1530	1331 -13.0%	997 -34.8%
5	Zagreb	2300	2101 -8.7%	1321 -42.6%	2027	1828 -9.8%	1240 -38.8%	1971	1772 -10.1%	1194 -39.4%	1679	1480 -11.9%	1104 -34.2%
10	Budapest	2070	1811 -12.5%	1555 -24.9%	1797	1538 -14.4%	1474 -18.0%	1801	1542 -14.4%	1428 -20.7%	1560	1317 -15.6%	1316 -15.6%
5	Debrecen	2225	1966 -11.6%	1703 -23.5%	1952	1693 -13.3%	1622 -16.9%	1961	1702 -13.2%	1576 -19.6%	1747	1504 -13.9%	1464 -16.2%
65	Záhony	2347	2088 -11.0%	1787 -23.9%	2074	1815 -12.5%	1706 -17.7%	2078	1819 -12.5%	1660 -20.1%	1877	1634 -12.9%	1548 -17.5%
	Chop	2703	2444 -9.6%	1869 -30.9%	2191	1932 -11.8%	1788 -18.4%	2135	1876 -12.1%	1742 -18.4%	1888	1710 -9.4%	1630 -13.7%
		Cádiz			Sevilla			Córdoba			Madrid		
	AVERAGE		-6.1%	-28.3%		-7.2%	-23.2%		-7.4%	-24.6%		-9.0%	-18.8%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Zaragoza			Lleida			Tarragona			Barcelona		
	Cádiz												
5	Sevilla												
5	Córdoba												
10	Madrid												
5	Zaragoza	X											
5	Lleida	40	40 0.0%	40 0.0%	X								
5	Tarragona	57	57 0.0%	57 0.0%	24	24 0.0%	24 0.0%	X					
5	Barcelona	82	82 0.0%	82 0.0%	59	59 0.0%	54 -8.5%	32	32 0.0%	30 -6.3%	X		
5	Perpignan	184	184 0.0%	162 -12.0%	165	165 0.0%	134 -18.8%	123	123 0.0%	110 -10.6%	80	80 0.0%	75 -6.3%
5	Montpellier	288	228 -20.8%	244 -15.3%	266	206 -22.6%	216 -18.8%	227	167 -26.4%	192 -15.4%	182	122 -33.0%	157 -13.7%
10	Lyon	504	444 -11.9%	328 -34.9%	462	402 -13.0%	300 -35.1%	429	369 -14.0%	276 -35.7%	374	314 -16.0%	241 -35.6%
5	Torino	918	737 -19.7%	519 -43.5%	826	645 -21.9%	491 -40.6%	795	614 -22.8%	467 -41.3%	738	557 -24.5%	432 -41.5%
10	Milano	838	657 -21.6%	567 -32.3%	819	638 -22.1%	539 -34.2%	792	611 -22.9%	515 -35.0%	734	553 -24.7%	480 -34.6%
5	Verona	1328	1134 -14.6%	643 -51.6%	1037	843 -18.7%	615 -40.7%	1006	812 -19.3%	591 -41.3%	958	764 -20.3%	556 -42.0%
10	Venezia	1355	1156 -14.7%	699 -48.4%	1283	1084 -15.5%	671 -47.7%	1252	1053 -15.9%	647 -48.3%	1195	996 -16.7%	565 -52.7%
10	Trieste	1502	1303 -13.2%	790 -47.4%	1418	1219 -14.0%	762 -46.3%	1393	1194 -14.3%	738 -47.0%	1336	1137 -14.9%	656 -50.9%
5	Ljubljana	1508	1309 -13.2%	930 -38.3%	1450	1251 -13.7%	902 -37.8%	1419	1220 -14.0%	878 -38.1%	1362	1163 -14.6%	796 -41.6%
5	Zagreb	1540	1341 -12.9%	1037 -32.7%	1521	1322 -13.1%	1009 -33.7%	1568	1369 -12.7%	985 -37.2%	1511	1312 -13.2%	903 -40.2%
10	Budapest	1478	1254 -15.2%	1236 -16.4%	1459	1200 -17.8%	1191 -18.4%	1432	1173 -18.1%	1162 -18.9%	1374	1164 -15.3%	1127 -18.0%
5	Debrecen	1657	1433 -13.5%	1384 -16.5%	1614	1355 -16.0%	1339 -17.0%	1587	1328 -16.3%	1310 -17.5%	1585	1375 -13.2%	1275 -19.6%
65	Záhony	1755	1531 -12.8%	1468 -16.4%	1715	1456 -15.1%	1423 -17.0%	1709	1450 -15.2%	1394 -18.4%	1630	1420 -12.9%	1359 -16.6%
	Chop	2081	1857 -10.8%	1550 -25.5%	1841	1582 -14.1%	1505 -18.3%	1760	1501 -14.7%	1476 -16.1%	1753	1543 -12.0%	1441 -17.8%
		Zaragoza			Lleida			Tarragona			Barcelona		
	AVERAGE		-9.3%	-21.3%		-10.4%	-21.4%		-10.8%	-21.4%		-11.0%	-23.0%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Perpignan			Montpellier			Lyon			Torino			Milano		
	Cádiz															
5	Sevilla															
5	Córdoba															
10	Madrid															
5	Zaragoza															
5	Lleida															
5	Tarragona															
5	Barcelona															
5	Perpignan	X														
5	Montpellier	104	44 -57.7%	77 -26.0%	X											
10	Lyon	259	199 -23.2%	161 -37.8%	138	138 0.0%	79 -42.8%	X								
5	Torino	637	456 -28.4%	352 -44.7%	534	413 -22.7%	270 -49.4%	211	90 -57.3%	181 -14.2%	X					
10	Milano	642	461 -28.2%	400 -37.7%	630	509 -19.2%	318 -49.5%	561	440 -21.6%	229 -59.2%	50	50 0.0%	43 -14.0%	X		
5	Verona	806	612 -24.1%	476 -40.9%	745	611 -18.0%	394 -47.1%	678	544 -19.8%	305 -55.0%	122	109 -10.7%	119 -2.5%	73	60 -17.8%	66 -9.6%
10	Venezia	868	669 -22.9%	532 -38.7%	811	672 -17.1%	450 -44.5%	740	601 -18.8%	361 -51.2%	179	161 -10.1%	175 -2.2%	135	117 -13.3%	122 -9.6%
10	Trieste	979	780 -20.3%	623 -36.4%	934	795 -14.9%	541 -42.1%	885	746 -15.7%	452 -48.9%	288	270 -6.3%	266 -7.6%	248	230 -7.3%	213 -14.1%
5	Ljubljana	1270	1071 -15.7%	763 -39.9%	1005	866 -13.8%	681 -32.2%	1176	1037 -11.8%	592 -49.7%	550	532 -3.3%	406 -26.2%	462	444 -3.9%	353 -23.6%
5	Zagreb	1419	1220 -14.0%	870 -38.7%	1307	1168 -10.6%	788 -39.7%	1227	1088 -11.3%	699 -43.0%	785	767 -2.3%	513 -34.6%	702	684 -2.6%	460 -34.5%
10	Budapest	1282	1065 -16.9%	1047 -18.3%	1047	992 -5.3%	965 -7.8%	985	786 -20.2%	876 -11.1%	838	760 -9.3%	690 -17.7%	755	677 -10.3%	637 -15.6%
5	Debrecen	1436	1219 -15.1%	1195 -16.8%	1381	1326 -4.0%	1113 -19.4%	1317	1118 -15.1%	1024 -22.2%	1013	935 -7.7%	838 -17.3%	938	860 -8.3%	785 -16.3%
65	Záhony	1617	1400 -13.4%	1279 -20.9%	1406	1351 -3.9%	1197 -14.9%	1404	1205 -14.2%	1108 -21.1%	1240	1162 -6.3%	922 -25.6%	1085	1007 -7.2%	869 -19.9%
	Chop	1604	1452 -9.5%	1361 -15.1%	1549	1494 -3.6%	1279 -17.4%	1485	1286 -13.4%	1190 -19.9%	1286	1208 -6.1%	1004 -21.9%	1196	1118 -6.5%	951 -20.5%
		Perpignan			Montpellier			Lyon			Torino			Milano		
	AVERAGE		-13.8%	-24.8%		-16.3%	-27.0%		-15.6%	-36.6%		-14.9%	-30.5%		-14.0%	-30.2%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Verona			Venezia			Trieste			Ljubljana			Zagreb		
	Cádiz															
5	Sevilla															
5	Córdoba															
10	Madrid															
5	Zaragoza															
5	Lleida															
5	Tarragona															
5	Barcelona															
5	Perpignan															
5	Montpellier															
10	Lyon															
5	Torino															
10	Milano															
5	Verona	X														
10	Venezia	55	50 -9.1%	51 -7.3%	X											
10	Trieste	164	159 -3.0%	142 -13.4%	95	95 0.0%	81 -14.7%	X								
5	Ljubljana	382	377 -1.3%	282 -26.2%	293	293 0.0%	221 -24.6%	161	161 0.0%	130 -19.3%	X					
5	Zagreb	613	608 -0.8%	389 -36.5%	605	605 0.0%	328 -45.8%	475	475 0.0%	237 -50.1%	131	131 0.0%	102 -22.1%	X		
10	Budapest	660	595 -9.8%	566 -14.2%	636	576 -9.4%	505 -20.6%	647	587 -9.3%	519 -19.8%	487	427 -12.3%	384 -21.1%	404	344 -14.9%	277 -31.4%
5	Debrecen	832	767 -7.8%	714 -14.2%	828	768 -7.2%	653 -21.1%	813	753 -7.4%	667 -18.0%	637	577 -9.4%	532 -16.5%	594	534 -10.1%	425 -28.5%
65	Záhony	930	865 -7.0%	798 -14.2%	965	905 -6.2%	737 -23.6%	914	854 -6.6%	751 -17.8%	709	649 -8.5%	616 -13.1%	716	656 -8.4%	509 -28.9%
	Chop	999	934 -6.5%	880 -11.9%	1005	945 -6.0%	819 -18.5%	976	916 -6.1%	833 -14.7%	749	753 0.5%	698 -6.8%	894	834 -6.7%	591 -33.9%
		Verona			Venezia			Trieste			Ljubljana			Zagreb		
	AVERAGE		-12.5%	-30.9%		-11.0%	-33.7%		-9.4%	-33.0%		-8.6%	-29.7%		-8.3%	-36.5%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Budapest			Debrecen			Záhony			Chop		
	Cádiz												
5	Sevilla												
5	Córdoba												
10	Madrid												
5	Zaragoza												
5	Lleida												
5	Tarragona												
5	Barcelona												
5	Perpignan												
5	Montpellier												
10	Lyon												
5	Torino												
10	Milano												
5	Verona												
10	Venezia												
10	Trieste												
5	Ljubljana												
5	Zagreb												
10	Budapest	X											
5	Debrecen	163	163 0.0%	138 -15.3%	X								
65	Záhony	236	236 0.0%	222 -5.9%	84	84 0.0%	79 -6.0%	X					
	Chop	275	275 0.0%	249 -9.5%	159	159 0.0%	154 -3.1%	17	17 0.0%	17 0.0%	X		
		Budapest			Debrecen			Záhony			Chop		
	AVERAGE		-11.5%	-17.1%		-9.7%	-17.2%		-8.9%	-17.1%		-7.5%	-16.8%

Table 15 Corridor 5: Comparison of current, future and potential travel times

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Luleå			Haparanda			Tornio			Oulu			Tampere		
	Luleå	X														
10	Haparanda	113	113 0.0%	104 -8.0%	X											
5	Tornio	182	133 -26.9%	124 -31.9%	60	10 -83.3%	10 -83.3%	X								
5	Oulu	302	229 -24.2%	212 -29.8%	156	111 -28.8%	98 -37.2%	96	96 0.0%	83 -13.5%	X					
5	Tampere	533	457 -14.3%	424 -20.5%	553	339 -38.7%	310 -43.9%	493	324 -34.3%	295 -40.2%	223	223 0.0%	207 -7.2%	X		
10	Helsinki	637	522 -18.1%	517 -18.8%	651	404 -37.9%	403 -38.1%	591	389 -34.2%	388 -34.3%	324	288 -11.1%	300 -7.4%	94	60 -36.2%	88 -6.4%
5	Tallinn	797	582 -27.0%	671 -15.8%	811	459 -43.4%	557 -31.3%	751	439 -41.5%	542 -27.8%	484	333 -31.2%	454 -6.2%	254	100 -60.6%	242 -4.7%
5	Riga	1423	664 -53.3%	1003 -29.5%	1437	546 -62.0%	889 -38.1%	1377	531 -61.4%	874 -36.5%	1110	430 -61.3%	786 -29.2%	880	202 -77.0%	574 -34.8%
5	Panevėžys	1357	721 -46.9%	1172 -13.6%	1371	603 -56.0%	1058 -22.8%	1311	588 -55.1%	1043 -20.4%	1044	487 -53.4%	955 -8.5%	814	259 -68.2%	743 -8.7%
5	Kaunas	1441	760 -47.3%	1222 -15.2%	1455	642 -55.9%	1108 -23.8%	1395	627 -55.1%	1093 -21.6%	1128	526 -53.4%	1005 -10.9%	898	298 -66.8%	793 -11.7%
5	Bialystok	2089	863 -58.7%	1442 -31.0%	2103	745 -64.6%	1328 -36.9%	2043	730 -64.3%	1313 -35.7%	1776	629 -64.6%	1225 -31.0%	1546	401 -74.1%	1013 -34.5%
10	Warszawa	1979	969 -51.0%	1550 -21.7%	2041	851 -58.3%	1436 -29.6%	2101	836 -60.2%	1421 -32.4%	1947	735 -62.2%	1333 -31.5%	1717	507 -70.5%	1121 -34.7%
5	Łódź	2012	1044 -48.1%	1625 -19.2%	2074	921 -55.6%	1511 -27.1%	2134	901 -57.8%	1496 -29.9%	2192	795 -63.7%	1408 -35.8%	1962	562 -71.4%	1196 -39.0%
5	Poznań	1824	1104 -39.5%	1344 -26.3%	1880	986 -47.6%	1402 -25.4%	1940	971 -49.9%	1412 -27.2%	2360	870 -63.1%	1482 -37.2%	2130	642 -69.9%	1270 -40.4%
5	Frankfurt (Oder)	1698	1220 -28.2%	1247 -26.6%	1760	1102 -37.4%	1305 -25.9%	1820	1087 -40.3%	1315 -27.7%	2294	986 -57.0%	1398 -39.1%	2032	758 -62.7%	1372 -32.5%
10	Berlin	1621	1280 -21.0%	1201 -25.9%	1683	1162 -31.0%	1259 -25.2%	1743	1147 -34.2%	1269 -27.2%	2039	1046 -48.7%	1352 -33.7%	1823	818 -55.1%	1423 -21.9%
5	Hannover	1570	1420 -9.6%	1172 -25.4%	1640	1297 -20.9%	1230 -25.0%	1700	1277 -24.9%	1240 -27.1%	2006	1171 -41.6%	1323 -34.0%	1798	938 -47.8%	1406 -21.8%
5	Bielefeld	1672	1426 -14.7%	1219 -27.1%	1734	1308 -24.6%	1277 -26.4%	1794	1293 -27.9%	1287 -28.3%	2094	1192 -43.1%	1370 -34.6%	1837	964 -47.5%	1453 -20.9%
5	Hamm	1690	1454 -14.0%	1224 -27.6%	1760	1336 -24.1%	1282 -27.2%	1820	1321 -27.4%	1292 -29.0%	2104	1220 -42.0%	1375 -34.6%	1834	992 -45.9%	1458 -20.5%
5	Dortmund	1685	1474 -12.5%	1238 -26.5%	1747	1356 -22.4%	1296 -25.8%	1807	1341 -25.8%	1306 -27.7%	2100	1240 -41.0%	1389 -33.9%	1823	1012 -44.5%	1472 -19.3%
5	Düsseldorf	1738	1526 -12.2%	1266 -27.2%	1800	1408 -21.8%	1324 -26.4%	1860	1393 -25.1%	1334 -28.3%	2159	1292 -40.2%	1417 -34.4%	2006	1064 -47.0%	1500 -25.2%
5	Köln	1759	1553 -11.7%	1285 -26.9%	1821	1435 -21.2%	1343 -26.2%	1881	1420 -24.5%	1353 -28.1%	2174	1319 -39.3%	1436 -33.9%	1984	1091 -45.0%	1519 -23.4%
5	Aachen	1839	1592 -13.4%	1322 -28.1%	1901	1474 -22.5%	1380 -27.4%	1961	1459 -25.6%	1390 -29.1%	2203	1358 -38.4%	1473 -33.1%	2019	1130 -44.0%	1556 -22.9%
5	Liège	1877	1616 -13.9%	1346 -28.3%	1939	1498 -22.7%	1404 -27.6%	1999	1483 -25.8%	1414 -29.3%	2486	1382 -44.4%	1497 -39.8%	2145	1154 -46.2%	1580 -26.3%
10	Brussel	1925	1668 -13.4%	1394 -27.6%	1987	1550 -22.0%	1452 -26.9%	2047	1535 -25.0%	1462 -28.6%	2477	1434 -42.1%	1545 -37.6%	2190	1206 -44.9%	1628 -25.7%
5	Gent	1971	1736 -11.9%	1431 -27.4%	2033	1613 -20.7%	1489 -26.8%	2093	1593 -23.9%	1499 -28.4%	2543	1487 -41.5%	1582 -37.8%	2239	1254 -44.0%	1665 -25.6%
5	Brugge	2002	1733 -13.4%	1458 -27.2%	2064	1615 -21.8%	1516 -26.6%	2124	1600 -24.7%	1526 -28.2%	2616	1499 -42.7%	1609 -38.5%	2283	1271 -44.3%	1692 -25.9%
	Oostende	2028	1751 -13.7%	1474 -27.3%	2090	1633 -21.9%	1532 -26.7%	2150	1618 -24.7%	1542 -28.3%	2629	1517 -42.3%	1625 -38.2%	2296	1289 -43.9%	1708 -25.6%
		Luleå			Haparanda			Tornio			Oulu			Tampere		
	AVERAGE		-24.4%	-24.5%		-35.8%	-30.2%		-37.2%	-30.7%		-41.5%	-29.2%		-49.8%	-24.6%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Helsinki			Tallinn			Riga			Panevėžys			Kaunas		
	Luleå															
10	Haparanda															
5	Tornio															
5	Oulu															
5	Tampere															
10	Helsinki	X														
5	Tallinn	150	30 -80.0%	144 -4.0%	X											
5	Riga	776	137 -82.3%	476 -38.7%	358	102 -71.5%	327 -8.7%	X								
5	Panevėžys	710	194 -72.7%	645 -9.2%	579	159 -72.5%	496 -14.3%	216	55 -74.5%	164 -24.1%	X					
5	Kaunas	794	233 -70.7%	695 -12.5%	768	198 -74.2%	546 -28.9%	252	94 -62.7%	214 -15.1%	184	37 -79.9%	140 -23.9%	X		
5	Bialystok	1442	336 -76.7%	915 -36.5%	1063	301 -71.7%	766 -27.9%	547	197 -64.0%	434 -20.7%	620	140 -77.4%	360 -41.9%	290	103 -64.5%	215 -25.9%
10	Warszawa	1613	442 -72.6%	1023 -36.6%	1191	407 -65.8%	874 -26.6%	675	303 -55.1%	542 -19.7%	786	246 -68.7%	468 -40.5%	452	207 -54.2%	323 -28.5%
5	Łódź	1858	492 -73.5%	1098 -40.9%	1280	452 -64.7%	949 -25.9%	764	348 -54.5%	617 -19.2%	883	299 -66.1%	543 -38.5%	557	268 -51.9%	398 -28.5%
5	Poznań	2026	577 -71.5%	1172 -42.2%	1479	542 -63.4%	1023 -30.8%	963	438 -54.5%	691 -28.2%	1103	410 -62.8%	617 -44.1%	740	342 -53.8%	472 -36.2%
5	Frankfurt (Oder)	1965	693 -64.7%	1274 -35.2%	1595	658 -58.7%	1125 -29.5%	1079	554 -48.7%	793 -26.5%	1415	722 -49.0%	719 -49.2%	1084	686 -36.7%	574 -47.0%
10	Berlin	1771	753 -57.5%	1325 -25.2%	1655	718 -56.6%	1176 -28.9%	1139	614 -46.1%	844 -25.9%	1544	851 -44.9%	770 -50.1%	1038	640 -38.3%	625 -39.8%
5	Hannover	1739	868 -50.1%	1419 -18.4%	1765	828 -53.1%	1273 -27.9%	1249	724 -42.0%	941 -24.7%	1763	1070 -39.3%	867 -50.8%	1257	859 -31.7%	722 -42.6%
5	Bielefeld	1871	899 -52.0%	1471 -21.4%	1819	864 -52.5%	1325 -27.2%	1303	760 -41.7%	993 -23.8%	1752	1041 -40.6%	919 -47.5%	1246	830 -33.4%	774 -37.9%
5	Hamm	1934	927 -52.1%	1501 -22.4%	1849	892 -51.8%	1355 -26.7%	1333	788 -40.9%	1023 -23.3%	1843	1130 -38.7%	949 -48.5%	1337	919 -31.3%	804 -39.9%
5	Dortmund	1899	947 -50.1%	1520 -20.0%	1869	912 -51.2%	1374 -26.5%	1353	808 -40.3%	1042 -23.0%	1866	1153 -38.2%	968 -48.1%	1360	942 -30.7%	823 -39.5%
5	Düsseldorf	1960	999 -49.0%	1562 -20.3%	1921	964 -49.8%	1416 -26.3%	1405	860 -38.8%	1084 -22.8%	1924	1211 -37.1%	1010 -47.5%	1418	1000 -29.5%	865 -39.0%
5	Köln	1931	1026 -46.9%	1572 -18.6%	1948	991 -49.1%	1426 -26.8%	1432	887 -38.1%	1094 -23.6%	1854	1141 -38.5%	1020 -45.0%	1357	939 -30.8%	875 -35.5%
5	Aachen	1986	1065 -46.4%	1609 -19.0%	1987	1030 -48.2%	1463 -26.4%	1471	926 -37.0%	1131 -23.1%	1941	1228 -36.7%	1057 -45.5%	1618	1200 -25.8%	912 -43.6%
5	Liège	2010	1089 -45.8%	1633 -18.8%	2011	1054 -47.6%	1487 -26.1%	1495	950 -36.5%	1155 -22.7%	2008	1295 -35.5%	1081 -46.2%	1686	1268 -24.8%	936 -44.5%
10	Brussel	2062	1141 -44.7%	1681 -18.5%	2063	1106 -46.4%	1535 -25.6%	1547	1002 -35.2%	1203 -22.2%	2059	1346 -34.6%	1129 -45.2%	1582	1164 -26.4%	984 -37.8%
5	Gent	2100	1184 -43.6%	1718 -18.2%	2101	1144 -45.5%	1572 -25.2%	1585	1040 -34.4%	1240 -21.8%	2271	1558 -31.4%	1166 -48.7%	1782	1364 -23.5%	1021 -42.7%
5	Brugge	2127	1206 -43.3%	1745 -18.0%	2128	1171 -45.0%	1599 -24.9%	1612	1067 -33.8%	1267 -21.4%	2142	1429 -33.3%	1193 -44.3%	1812	1394 -23.1%	1048 -42.2%
	Oostende	2140	1224 -42.8%	1761 -17.7%	2146	1189 -44.6%	1615 -24.7%	1630	1085 -33.4%	1283 -21.3%	2161	1448 -33.0%	1209 -44.1%	1834	1416 -22.8%	1064 -42.0%
		Helsinki			Tallinn			Riga			Panevėžys			Kaunas		
	AVERAGE		-52.8%	-22.9%		-54.4%	-23.2%		-51.2%	-24.8%		-51.3%	-36.0%		-44.4%	-31.7%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Bialystok			Warszawa			Łódź			Poznań			Frankfurt (Oder)		
	Luleå															
10	Haparanda															
5	Tornio															
5	Oulu															
5	Tampere															
10	Helsinki															
5	Tallinn															
5	Riga															
5	Panevėžys															
5	Kaunas															
5	Bialystok	X														
10	Warszawa	123	104 -15.4%	103 -16.3%	X											
5	Łódź	220	157 -28.6%	178 -19.1%	79	35 -55.7%	65 -17.7%	X								
5	Poznań	287	115 -59.9%	252 -12.2%	148	120 -18.9%	139 -6.1%	194	85 -56.2%	141 -27.3%	X					
5	Frankfurt (Oder)	425	253 -40.5%	354 -16.7%	264	236 -10.6%	241 -8.7%	340	231 -32.1%	243 -28.5%	111	111 0.0%	97 -12.6%	X		
10	Berlin	590	418 -29.2%	405 -31.4%	321	293 -8.7%	292 -9.0%	379	270 -28.8%	294 -22.4%	249	249 0.0%	148 -40.6%	55	55 0.0%	46 -16.4%
5	Hannover	615	528 -14.1%	502 -18.4%	444	416 -6.3%	389 -12.4%	599	490 -18.2%	391 -34.7%	283	283 0.0%	245 -13.4%	178	178 0.0%	143 -19.7%
5	Bielefeld	679	574 -15.5%	554 -18.4%	514	468 -8.9%	441 -14.2%	559	432 -22.7%	443 -20.8%	345	327 -5.2%	297 -13.9%	236	218 -7.6%	195 -17.4%
5	Hamm	697	590 -15.4%	584 -16.2%	545	497 -8.8%	471 -13.6%	592	463 -21.8%	473 -20.1%	376	356 -5.3%	327 -13.0%	269	249 -7.4%	225 -16.4%
5	Dortmund	726	619 -14.7%	603 -16.9%	554	506 -8.7%	490 -11.6%	633	504 -20.4%	492 -22.3%	408	388 -4.9%	346 -15.2%	293	273 -6.8%	244 -16.7%
5	Düsseldorf	774	667 -13.8%	645 -16.7%	622	574 -7.7%	532 -14.5%	672	543 -19.2%	534 -20.5%	468	448 -4.3%	388 -17.1%	349	329 -5.7%	286 -18.1%
5	Köln	782	675 -13.7%	655 -16.2%	636	588 -7.5%	542 -14.8%	696	567 -18.5%	544 -21.8%	499	479 -4.0%	398 -20.2%	329	309 -6.1%	296 -10.0%
5	Aachen	871	764 -12.3%	692 -20.6%	742	694 -6.5%	579 -22.0%	738	609 -17.5%	581 -21.3%	541	521 -3.7%	435 -19.6%	406	386 -4.9%	333 -18.0%
5	Liège	938	831 -11.4%	716 -23.7%	719	671 -6.7%	603 -16.1%	762	633 -16.9%	605 -20.6%	553	533 -3.6%	459 -17.0%	437	417 -4.6%	357 -18.3%
10	Brussel	989	882 -10.8%	764 -22.8%	778	730 -6.2%	651 -16.3%	813	684 -15.9%	653 -19.7%	602	582 -3.3%	507 -15.8%	486	466 -4.1%	405 -16.7%
5	Gent	1201	1094 -8.9%	801 -33.3%	814	766 -5.9%	688 -15.5%	878	749 -14.7%	690 -21.4%	640	620 -3.1%	544 -15.0%	531	511 -3.8%	442 -16.8%
5	Brugge	1072	965 -10.0%	828 -22.8%	845	797 -5.7%	715 -15.4%	903	774 -14.3%	717 -20.6%	679	659 -2.9%	571 -15.9%	559	539 -3.6%	469 -16.1%
	Oostende	1091	984 -9.8%	844 -22.6%	861	813 -5.6%	731 -15.1%	919	790 -14.0%	733 -20.2%	708	688 -2.8%	587 -17.1%	575	555 -3.5%	485 -15.7%
		Bialystok			Warszawa			Łódź			Poznań			Frankfurt (Oder)		
	AVERAGE		-37.2%	-24.7%		-30.1%	-20.0%		-37.9%	-25.3%		-27.9%	-23.3%		-23.1%	-23.0%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Berlin			Hannover			Bielefeld			Hamm			Dortmund		
	Luleå															
10	Haparanda															
5	Tornio															
5	Oulu															
5	Tampere															
10	Helsinki															
5	Tallinn															
5	Riga															
5	Panevėžys															
5	Kaunas															
5	Bialystok															
10	Warszawa															
5	Łódź															
5	Poznań															
5	Frankfurt (Oder)															
10	Berlin	X														
5	Hannover	100	100 0.0%	87 -13.0%	X											
5	Bielefeld	153	135 -11.8%	139 -9.2%	49	31 -36.7%	47 -4.1%	X								
5	Hamm	182	162 -11.0%	169 -7.1%	76	56 -26.3%	76 0.0%	25	23 -8.0%	25 0.0%	X					
5	Dortmund	207	187 -9.7%	188 -9.2%	99	79 -20.2%	95 -4.0%	48	46 -4.2%	44 -8.3%	15	15 0.0%	14 -6.7%	X		
5	Düsseldorf	262	242 -7.6%	230 -12.2%	151	131 -13.2%	137 -9.3%	104	102 -1.9%	86 -17.3%	70	70 0.0%	51 -27.1%	47	47 0.0%	37 -21.3%
5	Köln	246	226 -8.1%	240 -2.4%	153	133 -13.1%	147 -3.9%	107	105 -1.9%	96 -10.3%	96	96 0.0%	66 -31.3%	70	70 0.0%	61 -12.9%
5	Aachen	316	296 -6.3%	277 -12.3%	216	196 -9.3%	184 -14.8%	177	175 -1.1%	133 -24.9%	159	159 0.0%	103 -35.2%	127	127 0.0%	98 -22.8%
5	Liège	347	327 -5.8%	301 -13.3%	244	224 -8.2%	208 -14.8%	191	189 -1.0%	157 -17.8%	173	173 0.0%	127 -26.6%	147	147 0.0%	122 -17.0%
10	Brussel	398	378 -5.0%	349 -12.3%	293	273 -6.8%	256 -12.6%	242	240 -0.8%	205 -15.3%	219	219 0.0%	175 -20.1%	197	197 0.0%	170 -13.7%
5	Gent	442	422 -4.5%	386 -12.7%	332	312 -6.0%	293 -11.7%	280	278 -0.7%	242 -13.6%	266	266 0.0%	212 -20.3%	244	244 0.0%	207 -15.2%
5	Brugge	473	453 -4.2%	413 -12.7%	370	350 -5.4%	320 -13.5%	312	310 -0.6%	269 -13.8%	294	294 0.0%	239 -18.7%	273	273 0.0%	234 -14.3%
	Oostende	480	460 -4.2%	429 -10.6%	381	361 -5.2%	336 -11.8%	339	337 -0.6%	285 -15.9%	316	316 0.0%	255 -19.3%	293	293 0.0%	250 -14.7%
		Berlin			Hannover			Bielefeld			Hamm			Dortmund		
	AVERAGE		-21.4%	-20.4%		-20.4%	-18.9%		-18.8%	-19.6%		-17.5%	-21.9%		-16.5%	-19.7%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Düsseldorf			Köln			Aachen			Liège		
	Luleå												
10	Haparanda												
5	Tornio												
5	Oulu												
5	Tampere												
10	Helsinki												
5	Tallinn												
5	Riga												
5	Panevėžys												
5	Kaunas												
5	Bialystok												
10	Warszawa												
5	Łódź												
5	Poznań												
5	Frankfurt (Oder)												
10	Berlin												
5	Hannover												
5	Bielefeld												
5	Hamm												
5	Dortmund												
5	Düsseldorf	X											
5	Köln	22	22 0.0%	19 -13.6%	X								
5	Aachen	65	65 0.0%	51 -21.5%	34	34 0.0%	32 -5.9%	X					
5	Liège	86	86 0.0%	75 -12.8%	61	61 0.0%	56 -8.2%	19	19 0.0%	19 0.0%	X		
10	Brussel	135	135 0.0%	123 -8.9%	110	110 0.0%	104 -5.5%	68	68 0.0%	67 -1.5%	47	47 0.0%	43 -8.5%
5	Gent	187	187 0.0%	160 -14.4%	148	148 0.0%	141 -4.7%	116	116 0.0%	104 -10.3%	85	85 0.0%	80 -5.9%
5	Brugge	212	212 0.0%	187 -11.8%	186	186 0.0%	168 -9.7%	145	145 0.0%	131 -9.7%	121	121 0.0%	107 -11.6%
	Oostende	240	240 0.0%	203 -15.4%	201	201 0.0%	184 -8.5%	160	160 0.0%	147 -8.1%	135	135 0.0%	123 -8.9%
		Düsseldorf			Köln			Aachen			Liège		
	AVERAGE		-15.7%	-21.1%		-15.5%	-18.1%		-14.8%	-21.0%		-14.9%	-20.4%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Brussel			Gent			Brugge			Oostende		
	Luleå												
10	Haparanda												
5	Tornio												
5	Oulu												
5	Tampere												
10	Helsinki												
5	Tallinn												
5	Riga												
5	Panevėžys												
5	Kaunas												
5	Bialystok												
10	Warszawa												
5	Łódź												
5	Poznań												
5	Frankfurt (Oder)												
10	Berlin												
5	Hannover												
5	Bielefeld												
5	Hamm												
5	Dortmund												
5	Düsseldorf												
5	Köln												
5	Aachen												
5	Liège												
10	Brussel	X											
5	Gent	28	28 0.0%	27 -3.6%	X								
5	Brugge	54	54 0.0%	54 0.0%	22	22 0.0%	22 0.0%	X					
	Oostende	70	70 0.0%	70 0.0%	38	38 0.0%	38 0.0%	13	13 0.0%	11 -15.4%	X		
		Brussel			Gent			Brugge			Oostende		
	AVERAGE		-14.4%	-18.1%		-13.6%	-19.1%		-13.8%	-19.2%		-13.7%	-19.1%

Table 16 Corridor 6: Comparison of current, future and potential travel times

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Groningen			Lelystad			Amsterdam			Rotterdam			Brussel			Lille			London			Birmingham			Crewe			Carlisle			Edinburgh			Stirling			Perth			Inverness			Thurso		
	Groningen	X																																												
5	Lelystad	83	58	78	X																																									
			-30.1%	-6.0%																																										
10	Amsterdam	123	98	115	34	34	32	X																																						
			-20.3%	-6.5%		0.0%	-5.9%																																							
5	Rotterdam	155	130	131	71	71	70	39	39	33	X																																			
			-16.1%	-15.5%		0.0%	-1.4%		0.0%	-15.4%																																				
5	Brussel	229	204	201	145	145	140	112	112	103	70	70	65	X																																
			-10.9%	-12.2%		0.0%	-3.4%		0.0%	-8.0%		0.0%	-7.1%																																	
5	Lille	293	268	240	196	196	179	161	161	142	118	118	104	35	35	34	X																													
			-8.5%	-18.1%		0.0%	-8.7%		0.0%	-11.8%		0.0%	-11.9%		0.0%	-2.9%																														
35	London	385	360	321	300	300	260	239	239	223	196	196	185	116	116	115	81	81	81	X																										
			-6.5%	-16.6%		0.0%	-13.3%		0.0%	-6.7%		0.0%	-5.6%		0.0%	-0.9%		0.0%	0.0%																											
5	Birmingham	551	490	427	465	429	366	371	335	329	328	292	291	237	201	221	199	163	187	85	49	71	X																							
			-11.1%	-22.5%		-7.7%	-21.3%		-9.7%	-11.3%		-11.0%	-11.3%		-15.2%	-6.8%		-18.1%	-6.0%		-42.4%	-16.5%																								
5	Crewe	558	497	444	443	407	383	383	347	346	333	297	308	249	213	238	212	176	204	99	55	88	53	53	45	X																				
			-10.9%	-20.4%		-8.1%	-13.5%		-9.4%	-9.7%		-10.8%	-7.5%		-14.5%	-4.4%		-17.0%	-3.8%		-44.4%	-11.1%		0.0%	-15.1%																					
5	Carlisle	694	633	545	598	562	484	483	447	447	440	404	409	352	316	339	312	276	305	197	153	189	173	173	146	110	110	96	X																	
			-8.8%	-21.5%		-6.0%	-19.1%		-7.5%	-7.5%		-8.2%	-7.0%		-10.2%	-3.7%		-11.5%	-2.2%		-22.3%	-4.1%		0.0%	-15.6%		0.0%	-12.7%																		
10	Edinburgh	746	685	616	661	625	555	603	567	518	507	471	480	419	383	410	379	343	376	266	222	260	245	245	217	182	182	167	67	67	66	X														
			-8.2%	-17.4%		-5.4%	-16.0%		-6.0%	-14.1%		-7.1%	-5.3%		-8.6%	-2.1%		-9.5%	-0.8%		-16.5%	-2.3%		0.0%	-11.4%		0.0%	-8.2%		0.0%	-1.5%															
5	Stirling	787	726	655	672	636	594	640	604	557	569	533	519	481	445	449	444	408	415	317	273	299	298	298	256	232	232	206	118	118	105	38	38	29	X											
			-7.8%	-16.8%		-5.4%	-11.6%		-5.6%	-13.0%		-6.3%	-8.8%		-7.5%	-6.7%		-8.1%	-6.5%		-13.9%	-5.7%		0.0%	-14.1%		0.0%	-11.2%		0.0%	-11.0%		0.0%	-23.7%												
5	Perth	804	743	688	707	671	627	675	639	590	617	581	552	522	486	482	483	447	448	360	316	332	343	343	289	276	276	239	154	154	138	80	80	62	30	30	28	X								
			-7.6%	-14.4%		-5.1%	-11.3%		-5.3%	-12.6%		-5.8%	-10.5%		-6.9%	-7.7%		-7.5%	-7.2%		-12.2%	-7.8%		0.0%	-15.7%		0.0%	-13.4%		0.0%	-10.4%		0.0%	-22.5%		0.0%	-6.7%									
10	Inverness	928	867	802	831	795	741	829	793	704	776	740	666	642	606	596	603	567	562	469	425	446	455	455	403	425	425	353	278	278	252	187	187	176	148	148	142	119	119	109	X					
			-6.6%	-13.6%		-4.3%	-10.8%		-4.3%	-15.1%		-4.6%	-14.2%		-5.6%	-7.2%		-6.0%	-6.8%		-9.4%	-4.9%		0.0%	-11.4%		0.0%	-16.9%		0.0%	-9.4%		0.0%	-5.9%		0.0%	-4.1%		0.0%	-8.4%						
	Thurso	1419	1358	1008	1304	1268	947	1302	1266	910	1305	1269	872	924	888	802	885	849	768	740	696	652	733	733	609	647	647	559	545	545	458	452	452	382	403	403	348	359	359	315	222	222	196	X		
			-4.3%	-29.0%		-2.8%	-27.4%		-2.8%	-30.1%		-2.8%	-33.2%		-3.9%	-13.2%		-4.1%	-13.2%		-5.9%	-11.9%		0.0%	-16.9%		0.0%	-13.6%		0.0%	-16.0%		0.0%	-15.5%		0.0%	-13.6%		0.0%	-12.3%		0.0%	-11.7%			
		Groningen			Lelystad			Amsterdam			Rotterdam			Brussel			Lille			London			Birmingham			Crewe			Carlisle			Edinburgh			Stirling			Perth			Inverness			Thurso		
	AVERAGE		-11.3%	-16.5%		-5.4%	-12.1%		-5.1%	-12.0%		-5.2%	-11.1%		-5.9%	-6.2%		-6.4%	-7.1%		-12.4%	-7.7%		-8.2%	-14.0%		-8.2%	-11.5%		-5.3%	-10.1%		-4.4%	-10.5%		-3.9%	-11.0%		-3.6%	-11.5%		-2.9%	-10.0%		-1.9%	-18.4%

Table 17 Corridor 7: Comparison of current, future and potential travel times

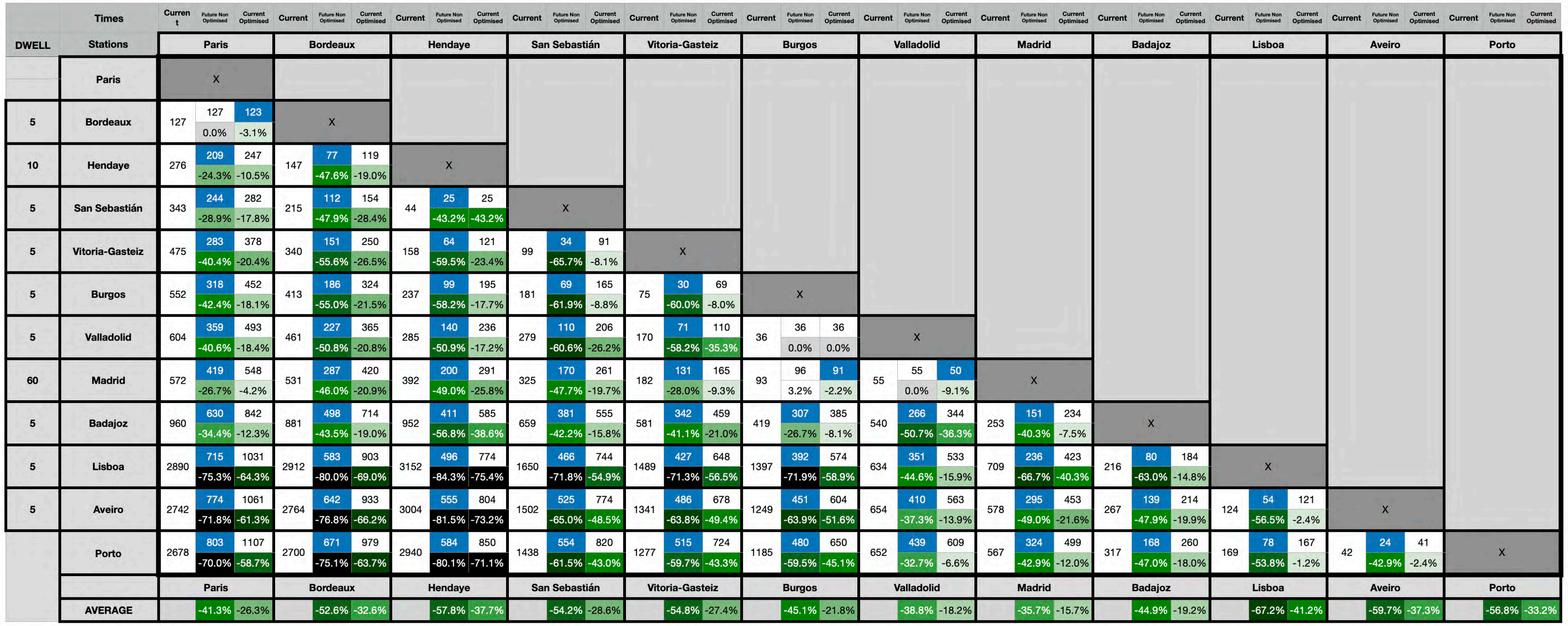
	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Amsterdam			Utrecht			Düsseldorf			Köln			Frankfurt			Mannheim			Karlsruhe		
	Amsterdam	X																				
5	Utrecht	24	24 0.0%	23 -4.2%	X																	
5	Düsseldorf	129	129 0.0%	119 -7.8%	91	91 0.0%	91 0.0%	X														
5	Köln	148	148 0.0%	143 -3.4%	118	118 0.0%	110 -6.8%	22	22 0.0%	19 -13.6%	X											
10	Frankfurt	231	231 0.0%	202 -12.6%	205	205 0.0%	169 -17.6%	86	86 0.0%	78 -9.3%	65	65 0.0%	54 -16.9%	X								
5	Mannheim	255	246 -3.5%	222 -12.9%	229	220 -3.9%	189 -17.5%	113	104 -8.0%	98 -13.3%	88	88 0.0%	74 -15.9%	38	29 -23.7%	28 -26.3%	X					
5	Karlsruhe	290	281 -3.1%	249 -14.1%	264	255 -3.4%	216 -18.2%	142	133 -6.3%	125 -12.0%	122	122 0.0%	101 -17.2%	61	52 -14.8%	55 -9.8%	26	26 0.0%	22 -15.4%	X		
10	Basel	399	369 -7.5%	343 -14.0%	373	343 -8.0%	310 -16.9%	244	214 -12.3%	219 -10.2%	231	210 -9.1%	195 -15.6%	166	136 -18.1%	149 -10.2%	128	107 -16.4%	116 -9.4%	103	82 -20.4%	89 -13.6%
10	Zurich	472	442 -6.4%	406 -14.0%	446	416 -6.7%	373 -16.4%	311	281 -9.6%	282 -9.3%	304	283 -6.9%	258 -15.1%	233	203 -12.9%	212 -9.0%	196	175 -10.7%	179 -8.7%	170	149 -12.4%	152 -10.6%
5	Lugano	624	594 -4.8%	499 -20.0%	597	567 -5.0%	466 -21.9%	442	412 -6.8%	375 -15.2%	433	412 -4.8%	351 -18.9%	364	334 -8.2%	305 -16.2%	327	306 -6.4%	272 -16.8%	301	280 -7.0%	245 -18.6%
10	Milano	691	661 -4.3%	562 -18.7%	664	634 -4.5%	529 -20.3%	510	480 -5.9%	438 -14.1%	500	479 -4.2%	414 -17.2%	448	418 -6.7%	368 -17.9%	415	394 -5.1%	335 -19.3%	389	368 -5.4%	308 -20.8%
10	Genova	833	604 -27.5%	654 -21.5%	811	756 -6.8%	621 -23.4%	657	602 -8.4%	530 -19.3%	615	569 -7.5%	506 -17.7%	566	511 -9.7%	460 -18.7%	520	474 -8.8%	427 -17.9%	491	445 -9.4%	400 -18.5%
	Ventimiglia	669	479 -28.4%	561 -16.1%	681	626 -8.1%	512 -24.8%	731	676 -7.5%	624 -14.6%	688	642 -6.7%	510 -25.9%	730	675 -7.5%	554 -24.1%	685	639 -6.7%	521 -23.9%	651	605 -7.1%	494 -24.1%
		Amsterdam			Utrecht			Düsseldorf			Köln			Frankfurt			Mannheim			Karlsruhe		
	AVERAGE		-7.1%	-13.3%		-3.9%	-15.7%		-5.4%	-11.6%		-3.3%	-15.4%		-8.5%	-15.7%		-7.8%	-16.4%		-7.4%	-16.1%

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Basel			Zurich			Lugano			Milano			Genova			Ventimiglia		
	Amsterdam																		
5	Utrecht																		
5	Düsseldorf																		
5	Köln																		
10	Frankfurt																		
5	Mannheim																		
5	Karlsruhe																		
10	Basel	X																	
10	Zurich	53	53 0.0%	53 0.0%	X														
5	Lugano	188	188 0.0%	146 -22.3%	113	113 0.0%	101 -10.6%	X											
10	Milano	252	252 0.0%	209 -17.1%	248	248 0.0%	164 -33.9%	75	75 0.0%	58 -22.7%	X								
10	Genova	374	349 -6.7%	301 -19.5%	339	314 -7.4%	256 -24.5%	202	177 -12.4%	150 -25.7%	90	65 -27.8%	82 -8.9%	X					
	Ventimiglia	498	473 -5.0%	395 -20.7%	437	412 -5.7%	350 -19.9%	330	305 -7.6%	244 -26.1%	224	199 -11.2%	176 -21.4%	115	115 0.0%	84 -27.0%	X		
		Basel			Zurich			Lugano			Milano			Genova			Ventimiglia		
	AVERAGE		-8.6%	-14.1%		-6.6%	-14.3%		-5.3%	-19.6%		-6.3%	-19.3%		-11.0%	-20.2%		-8.5%	-22.4%

Table 18 Corridor 8: Comparison of current, future and potential travel times

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	**Stations**	**Ventimiglia**			**Nice**			**Marseille**			**Lyon**			**Mulhouse**			**Strasbourg**			**Metz**			**Luxembourg**			**Brussel**			**Amsterdam**		
	Ventimiglia		X																												
5	**Nice**	50	50	30		X																									
			0.0%	-40.0%																											
10	**Marseille**	222	144	162	148	70	127		X																						
			-35.1%	-27.0%		-52.7%	-14.2%																								
5	**Lyon**	340	262	258	264	186	223	100	100	86		X																			
			-22.9%	-24.1%		-29.5%	-15.5%		0.0%	-14.0%																					
10	**Mulhouse**	535	386	405	451	302	370	278	207	233	166	95	142		X																
			-27.9%	-24.3%		-33.0%	-18.0%		-25.5%	-16.2%		-42.8%	-14.5%																		
5	**Strasbourg**	599	450	458	531	382	423	331	260	286	219	138	195	53	53	43		X													
			-24.9%	-23.5%		-28.1%	-20.3%		-21.5%	-13.6%		-37.0%	-11.0%		0.0%	-18.9%															
5	**Metz**	574	425	510	481	332	475	359	288	338	266	185	247	104	104	95	47	47	47		X										
			-26.0%	-11.1%		-31.0%	-1.2%		-19.8%	-5.8%		-30.5%	-7.1%		0.0%	-8.7%		0.0%	0.0%												
10	**Luxembourg**	638	489	440	555	406	512	409	338	375	330	249	284	150	150	132	93	93	84	41	41	32		X							
			-23.4%	-31.0%		-26.8%	-7.7%		-17.4%	-8.3%		-24.5%	-13.9%		0.0%	-12.0%		0.0%	-9.7%		0.0%	-22.0%									
10	**Brussel**	538	460	453	462	384	418	328	328	281	221	221	190	282	241	217	224	183	169	228	187	203	196	155	161		X				
			-14.5%	-15.8%		-16.9%	-9.5%		0.0%	-14.3%		0.0%	-14.0%		-14.5%	-23.0%		-18.3%	-24.6%		-18.0%	-11.0%		-20.9%	-17.9%						
	Amsterdam	669	479	561	580	502	526	448	448	389	366	366	298	407	366	325	355	314	277	318	277	311	328	287	269	112	112	98		X	
			-28.4%	-16.1%		-13.4%	-9.3%		0.0%	-13.2%		0.0%	-18.6%		-10.1%	-20.1%		-11.5%	-22.0%		-12.9%	-2.2%		-12.5%	-18.0%		0.0%	-12.5%			
		Ventimiglia			**Nice**			**Marseille**			**Lyon**			**Mulhouse**			**Strasbourg**			**Metz**			**Luxembourg**			**Brussel**			**Amsterdam**		
	AVERAGE		-22.6%	-23.7%		-25.7%	-15.1%		-19.1%	-14.1%		-20.8%	-14.8%		-17.1%	-17.3%		-15.7%	-15.9%		-15.3%	-7.7%		-13.9%	-15.6%		-11.5%	-15.8%		-9.9%	-14.7%

Table 19 Corridor 9: Comparison of current, future and potential travel times



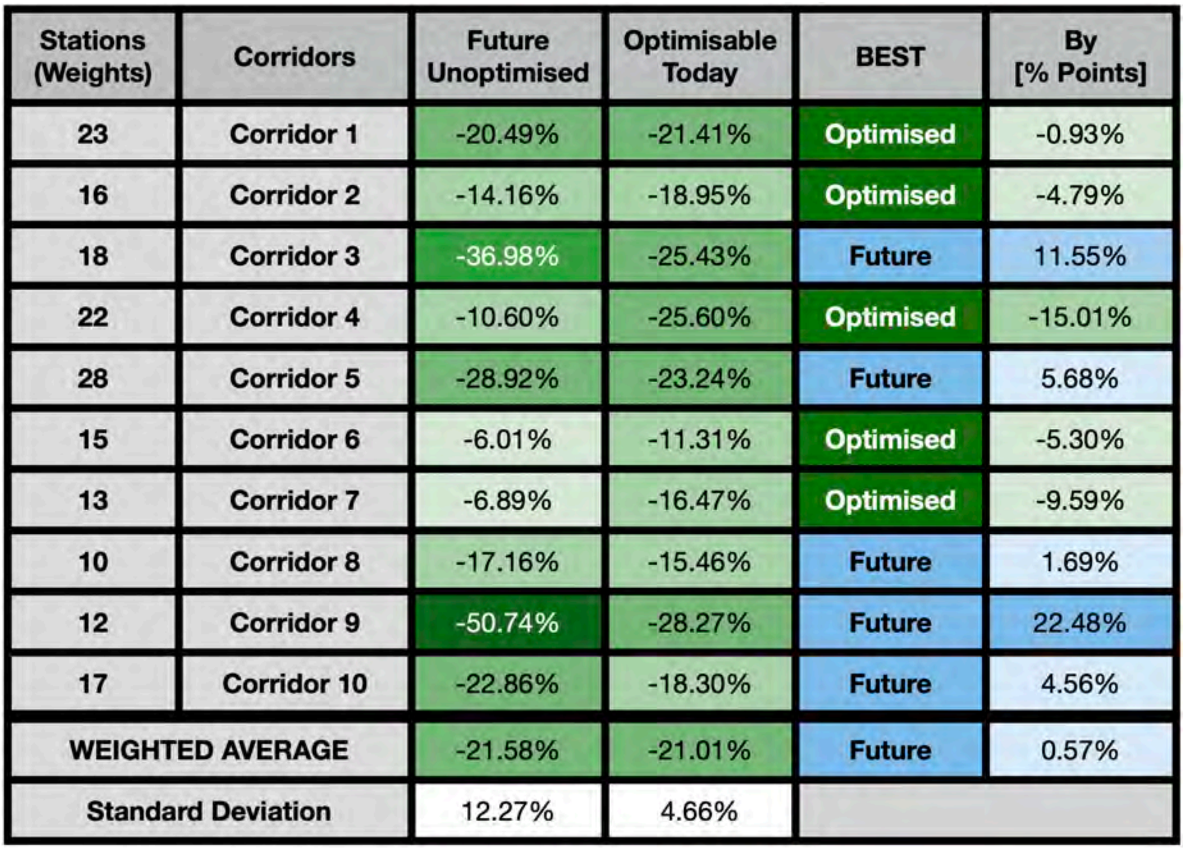
	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Paris			Bordeaux			Hendaye			San Sebastián			Vitoria-Gasteiz			Burgos			Valladolid			Madrid			Badajoz			Lisboa			Aveiro			Porto		
	Paris	X																																			
5	Bordeaux	127	127	123	X																																
			0.0%	-3.1%																																	
10	Hendaye	276	209	247	147	77	119	X																													
			-24.3%	-10.5%		-47.6%	-19.0%																														
5	San Sebastián	343	244	282	215	112	154	44	25	25	X																										
			-28.9%	-17.8%		-47.9%	-28.4%		-43.2%	-43.2%																											
5	Vitoria-Gasteiz	475	283	378	340	151	250	158	64	121	99	34	91	X																							
			-40.4%	-20.4%		-55.6%	-26.5%		-59.5%	-23.4%		-65.7%	-8.1%																								
5	Burgos	552	318	452	413	186	324	237	99	195	181	69	165	75	30	69	X																				
			-42.4%	-18.1%		-55.0%	-21.5%		-58.2%	-17.7%		-61.9%	-8.8%		-60.0%	-8.0%																					
5	Valladolid	604	359	493	461	227	365	285	140	236	279	110	206	170	71	110	36	36	36	X																	
			-40.6%	-18.4%		-50.8%	-20.8%		-50.9%	-17.2%		-60.6%	-26.2%		-58.2%	-35.3%		0.0%	0.0%																		
60	Madrid	572	419	548	531	287	420	392	200	291	325	170	261	182	131	165	93	96	91	55	55	50	X														
			-26.7%	-4.2%		-46.0%	-20.9%		-49.0%	-25.8%		-47.7%	-19.7%		-28.0%	-9.3%		3.2%	-2.2%		0.0%	-9.1%															
5	Badajoz	960	630	842	881	498	714	952	411	585	659	381	555	581	342	459	419	307	385	540	266	344	253	151	234	X											
			-34.4%	-12.3%		-43.5%	-19.0%		-56.8%	-38.6%		-42.2%	-15.8%		-41.1%	-21.0%		-26.7%	-8.1%		-50.7%	-36.3%		-40.3%	-7.5%												
5	Lisboa	2890	715	1031	2912	583	903	3152	496	774	1650	466	744	1489	427	648	1397	392	574	634	351	533	709	236	423	216	80	184	X								
			-75.3%	-64.3%		-80.0%	-69.0%		-84.3%	-75.4%		-71.8%	-54.9%		-71.3%	-56.5%		-71.9%	-58.9%		-44.6%	-15.9%		-66.7%	-40.3%		-63.0%	-14.8%									
5	Aveiro	2742	774	1061	2764	642	933	3004	555	804	1502	525	774	1341	486	678	1249	451	604	654	410	563	578	295	453	267	139	214	124	54	121	X					
			-71.8%	-61.3%		-76.8%	-66.2%		-81.5%	-73.2%		-65.0%	-48.5%		-63.8%	-49.4%		-63.9%	-51.6%		-37.3%	-13.9%		-49.0%	-21.6%		-47.9%	-19.9%		-56.5%	-2.4%						
	Porto	2678	803	1107	2700	671	979	2940	584	850	1438	554	820	1277	515	724	1185	480	650	652	439	609	567	324	499	317	168	260	169	78	167	42	24	41	X		
			-70.0%	-58.7%		-75.1%	-63.7%		-80.1%	-71.1%		-61.5%	-43.0%		-59.7%	-43.3%		-59.5%	-45.1%		-32.7%	-6.6%		-42.9%	-12.0%		-47.0%	-18.0%		-53.8%	-1.2%		-42.9%	-2.4%			
		Paris			Bordeaux			Hendaye			San Sebastián			Vitoria-Gasteiz			Burgos			Valladolid			Madrid			Badajoz			Lisboa			Aveiro			Porto		
	AVERAGE		-41.3%	-26.3%		-52.6%	-32.6%		-57.8%	-37.7%		-54.2%	-28.6%		-54.8%	-27.4%		-45.1%	-21.8%		-38.8%	-18.2%		-35.7%	-15.7%		-44.9%	-19.2%		-67.2%	-41.2%		-59.7%	-37.3%		-56.8%	-33.2%

Table 20 Corridor 10: Comparison of current, future and potential travel times

	Times	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised	Current	Future Non Optimised	Current Optimised
DWELL	Stations	Lecce			Bari			Ancona			Bologna			Padova			Venezia			Udine			Klagenfurt			Graz			Wien			Brno			Ostrava			Katowice			Łódź			Warszawa			Gdańsk			Gdynia		
	Lecce	X																																																		
5	Bari	80	80 0.0%	71 -11.3%	X																																															
5	Ancona	313	293 -6.4%	281 -10.2%	230	210 -8.7%	205 -10.9%	X																																										
5	Bologna	425	405 -4.7%	370 -12.9%	340	320 -5.9%	294 -13.5%	106	106 0.0%	84 -20.8%	X																																							
5	Padova	511	491 -3.9%	426 -16.6%	421	401 -4.8%	350 -16.9%	188	188 0.0%	140 -25.5%	59	59 0.0%	51 -13.6%	X																																		
10	Venezia	533	513 -3.8%	443 -16.9%	446	426 -4.5%	367 -17.7%	206	206 0.0%	157 -23.8%	75	75 0.0%	68 -9.3%	14	14 0.0%	12 -14.3%	X																															
5	Udine	644	624 -3.1%	520 -19.3%	561	541 -3.6%	444 -20.9%	322	322 0.0%	234 -27.3%	184	184 0.0%	145 -21.2%	119	119 0.0%	89 -25.2%	88	88 0.0%	67 -23.9%	X																												
5	Klagenfurt	757	737 -2.6%	620 -18.1%	667	647 -3.0%	544 -18.4%	432	432 0.0%	334 -22.7%	317	317 0.0%	245 -22.7%	242	242 0.0%	189 -21.9%	209	209 0.0%	167 -20.1%	111	111 0.0%	95 -14.4%	X																									
5	Graz	922	787 -14.6%	770 -16.5%	832	697 -16.2%	694 -16.6%	597	482 -19.3%	484 -18.9%	463	367 -20.7%	395 -14.7%	405	292 -27.9%	339 -16.3%	374	259 -30.7%	317 -15.2%	276	161 -41.7%	245 -11.2%	132	45 -65.9%	145 9.8%	X																								
10	Wien	996	907 -8.9%	840 -15.7%	906	817 -9.8%	764 -15.7%	715	602 -15.8%	554 -22.5%	556	487 -12.4%	465 -16.4%	479	412 -14.0%	409 -14.6%	448	379 -15.4%	387 -13.6%	350	281 -19.7%	315 -10.0%	228	165 -27.6%	215 -5.7%	155	115 -25.8%	138 -11.0%	X																						
5	Brno	1219	1003 -17.7%	933 -23.5%	1086	913 -15.9%	857 -21.1%	834	698 -16.3%	647 -22.4%	656	583 -11.1%	558 -14.9%	614	508 -17.3%	502 -18.2%	568	475 -16.4%	480 -15.5%	472	377 -20.1%	408 -13.6%	356	261 -26.7%	308 -13.5%	250	211 -15.6%	231 -7.6%	86	86 0.0%	83 -3.5%	X																				
5	Ostrava	1311	1068 -18.5%	1002 -23.6%	1228	978 -20.4%	926 -24.6%	943	763 -19.1%	716 -24.1%	773	648 -16.2%	627 -18.9%	701	573 -18.3%	571 -18.5%	655	540 -17.6%	549 -16.2%	559	442 -20.9%	477 -14.7%	444	326 -26.6%	377 -15.1%	337	276 -18.1%	300 -11.0%	173	151 -12.7%	152 -12.1%	136	60 -55.9%	110 -19.1%	X																	
5	Katowice	1486	1103 -25.8%	1084 -27.1%	1402	1013 -27.7%	1008 -28.1%	1063	798 -24.9%	798 -24.9%	889	683 -23.2%	709 -20.2%	821	608 -25.9%	653 -20.5%	775	575 -25.8%	631 -18.6%	679	477 -29.7%	559 -17.7%	556	361 -35.1%	459 -17.4%	447	311 -30.4%	382 -14.5%	282	186 -34.0%	228 -19.1%	267	95 -64.4%	192 -28.1%	93	30 -67.7%	77 -17.2%	X														
5	Łódź	1656	1163 -29.8%	1228 -25.8%	1573	1073 -31.8%	1152 -26.8%	1334	858 -35.7%	942 -29.4%	1210	743 -38.6%	853 -29.5%	1107	668 -39.7%	797 -28.0%	1042	635 -39.1%	775 -25.6%	921	537 -41.7%	703 -23.7%	774	421 -45.6%	603 -22.1%	668	371 -44.5%	526 -21.3%	504	246 -51.2%	372 -26.2%	490	155 -68.4%	336 -31.4%	322	90 -72.0%	221 -31.4%	167	55 -67.1%	139 -16.8%	X											
5	Warszawa	1624	1203 -25.9%	1223 -24.7%	1540	1113 -27.7%	1147 -25.5%	1302	898 -31.0%	937 -28.0%	1152	783 -32.0%	848 -26.4%	1049	708 -32.5%	792 -24.5%	982	675 -31.3%	770 -21.6%	860	577 -32.9%	698 -18.8%	715	461 -35.5%	598 -16.4%	608	411 -32.4%	521 -14.3%	444	286 -35.6%	367 -17.3%	431	195 -54.8%	331 -23.2%	264	130 -50.8%	216 -18.2%	145	95 -34.5%	134 -7.6%	78	35 -55.1%	65 -16.7%	X								
5	Gdańsk	1653	1358 -17.8%	1372 -17.0%	1569	1268 -19.2%	1296 -17.4%	1331	1053 -20.9%	1086 -18.4%	1187	938 -21.0%	997 -16.0%	1162	863 -25.7%	941 -19.0%	1160	830 -28.4%	919 -20.8%	1070	732 -31.6%	847 -20.8%	898	616 -31.4%	747 -16.8%	800	566 -29.3%	670 -16.3%	627	441 -29.7%	516 -17.7%	596	350 -41.3%	480 -19.5%	450	285 -36.7%	365 -18.9%	313	250 -20.1%	283 -9.6%	249	206 -17.3%	214 -14.1%	150	150 0.0%	144 -4.0%	X					
	Gdynia	1682	1384 -17.7%	1393 -17.2%	1598	1294 -19.0%	1317 -17.6%	1360	1079 -20.7%	1107 -18.6%	1215	964 -20.7%	1018 -16.2%	1190	889 -25.3%	962 -19.2%	1189	856 -28.0%	940 -20.9%	1099	758 -31.0%	868 -21.0%	925	642 -30.6%	768 -17.0%	829	592 -28.6%	691 -16.6%	656	467 -28.8%	537 -18.1%	622	376 -39.5%	501 -19.5%	478	311 -34.9%	386 -19.2%	359	276 -23.1%	304 -15.3%	276	233 -15.6%	235 -14.9%	175	175 0.0%	165 -5.7%	21	21 0.0%	16 -23.8%	X		
		Lecce			Bari			Ancona			Bologna			Padova			Venezia			Udine			Klagenfurt			Graz			Wien			Brno			Ostrava			Katowice			Łódź			Warszawa			Gdańsk			Gdynia		
	AVERAGE		-12.6%	-18.5%		-13.6%	-18.9%		-13.7%	-21.8%		-12.9%	-18.0%		-14.7%	-19.6%		-15.1%	-18.4%		-17.3%	-19.0%		-20.7%	-15.8%		-28.9%	-13.3%		-21.3%	-15.0%		-30.1%	-18.4%		-31.6%	-18.9%		-35.0%	-18.9%		-43.3%	-24.0%		-32.0%	-18.3%		-23.1%	-16.9%		-22.7%	-17.6%

2.2. Corridor Table Results

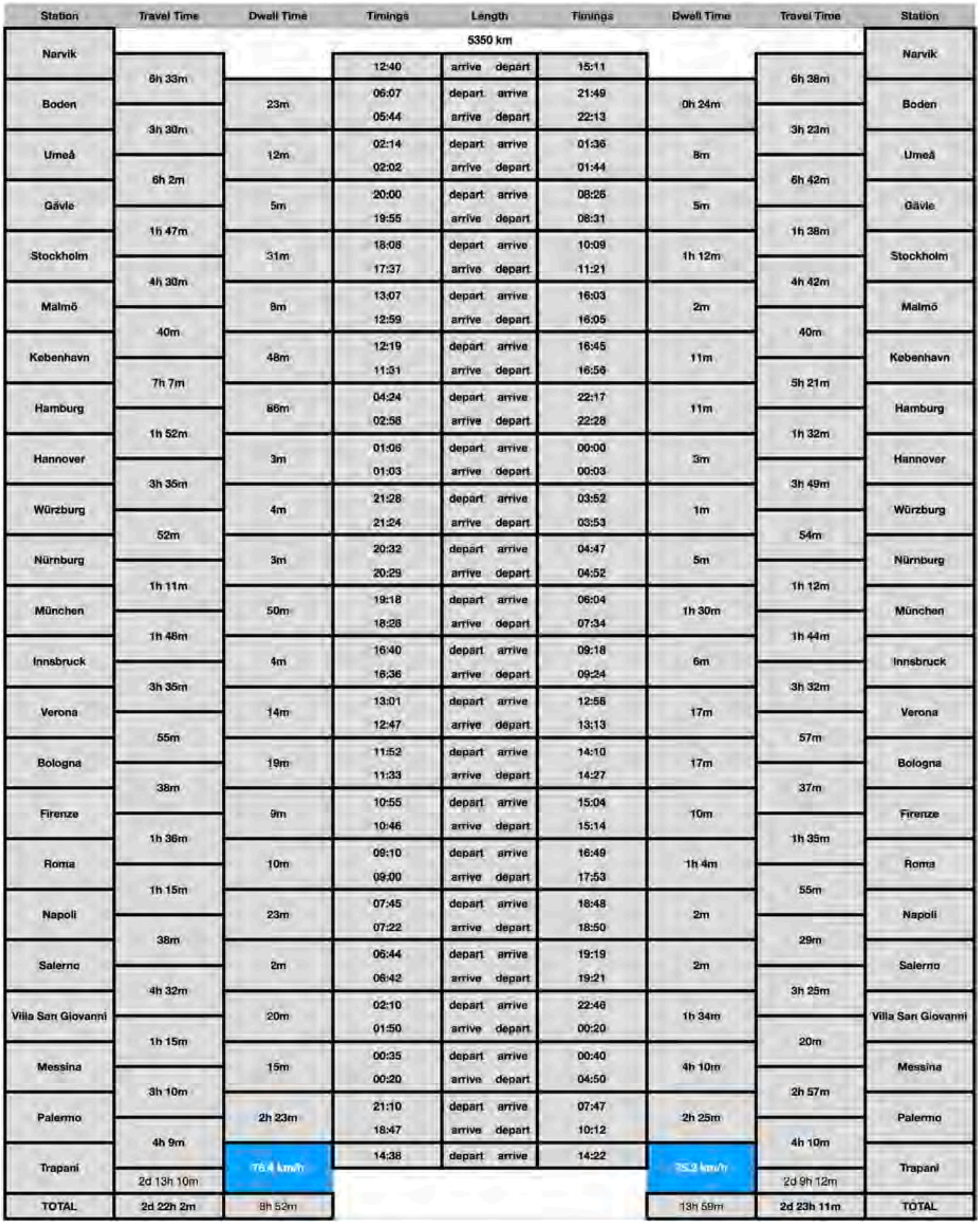
Table 9.2 Average potential travel time improvement between corridor stations



Stations (Weights)	Corridors	Future Unoptimised	Optimisable Today	BEST	By [% Points]
23	**Corridor 1**	-20.49%	-21.41%	**Optimised**	-0.93%
16	**Corridor 2**	-14.16%	-18.95%	**Optimised**	-4.79%
18	**Corridor 3**	-36.98%	-25.43%	**Future**	11.55%
22	**Corridor 4**	-10.60%	-25.60%	**Optimised**	-15.01%
28	**Corridor 5**	-28.92%	-23.24%	**Future**	5.68%
15	**Corridor 6**	-6.01%	-11.31%	**Optimised**	-5.30%
13	**Corridor 7**	-6.89%	-16.47%	**Optimised**	-9.59%
10	**Corridor 8**	-17.16%	-15.46%	**Future**	1.69%
12	**Corridor 9**	-50.74%	-28.27%	**Future**	22.48%
17	**Corridor 10**	-22.86%	-18.30%	**Future**	4.56%
WEIGHTED AVERAGE		-21.58%	-21.01%	**Future**	0.57%
Standard Deviation		12.27%	4.66%		

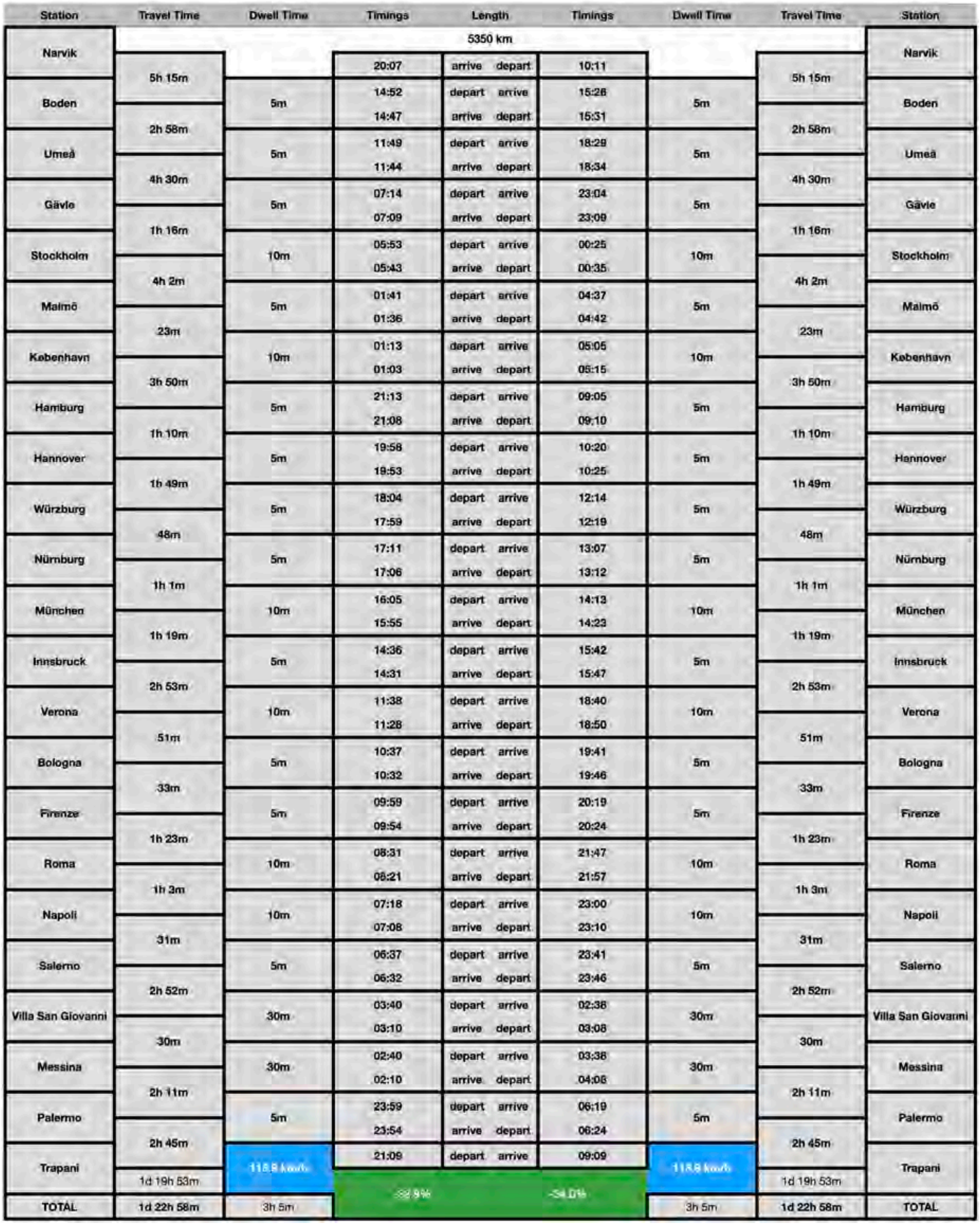
2.3. Corridor Timetables

Table 21 Corridor 1: Current Timetable



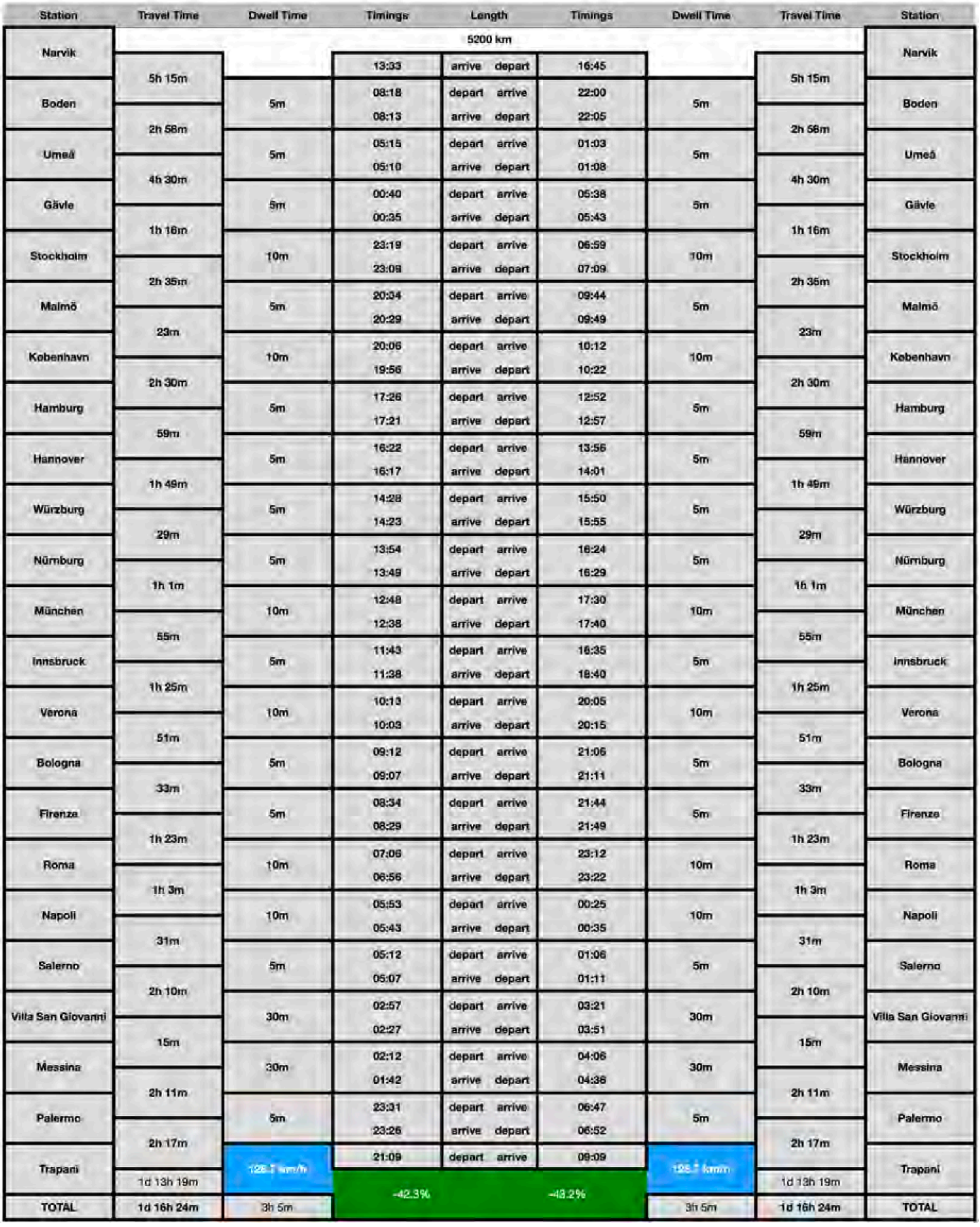
Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				5350 km				
Narvik			12:40	arrive depart	15:11			Narvik
	6h 33m						6h 38m	
Boden		23m	06:07 05:44	depart arrive arrive depart	21:49 22:13	0h 24m		Boden
	3h 30m						3h 23m	
Umeå		12m	02:14 02:02	depart arrive arrive depart	01:36 01:44	8m		Umeå
	6h 2m						6h 42m	
Gävle		5m	20:00 19:55	depart arrive arrive depart	08:26 08:31	5m		Gävle
	1h 47m						1h 38m	
Stockholm		31m	18:08 17:37	depart arrive arrive depart	10:09 11:21	1h 12m		Stockholm
	4h 30m						4h 42m	
Malmö		8m	13:07 12:59	depart arrive arrive depart	16:03 16:05	2m		Malmö
	40m						40m	
København		48m	12:19 11:31	depart arrive arrive depart	16:45 16:56	11m		København
	7h 7m						5h 21m	
Hamburg		86m	04:24 02:58	depart arrive arrive depart	22:17 22:28	11m		Hamburg
	1h 52m						1h 32m	
Hannover		3m	01:06 01:03	depart arrive arrive depart	00:00 00:03	3m		Hannover
	3h 35m						3h 49m	
Würzburg		4m	21:28 21:24	depart arrive arrive depart	03:52 03:53	1m		Würzburg
	52m						54m	
Nürnburg		3m	20:32 20:29	depart arrive arrive depart	04:47 04:52	5m		Nürnburg
	1h 11m						1h 12m	
München		50m	19:18 18:28	depart arrive arrive depart	06:04 07:34	1h 30m		München
	1h 48m						1h 44m	
Innsbruck		4m	16:40 16:36	depart arrive arrive depart	09:18 09:24	6m		Innsbruck
	3h 35m						3h 32m	
Verona		14m	13:01 12:47	depart arrive arrive depart	12:56 13:13	17m		Verona
	55m						57m	
Bologna		19m	11:52 11:33	depart arrive arrive depart	14:10 14:27	17m		Bologna
	38m						37m	
Firenze		9m	10:55 10:46	depart arrive arrive depart	15:04 15:14	10m		Firenze
	1h 36m						1h 35m	
Roma		10m	09:10 09:00	depart arrive arrive depart	16:49 17:53	1h 4m		Roma
	1h 15m						55m	
Napoli		23m	07:45 07:22	depart arrive arrive depart	18:48 18:50	2m		Napoli
	38m						29m	
Salerno		2m	06:44 06:42	depart arrive arrive depart	19:19 19:21	2m		Salerno
	4h 32m						3h 25m	
Villa San Giovanni		20m	02:10 01:50	depart arrive arrive depart	22:46 00:20	1h 34m		Villa San Giovanni
	1h 15m						20m	
Messina		15m	00:35 00:20	depart arrive arrive depart	00:40 04:50	4h 10m		Messina
	3h 10m						2h 57m	
Palermo		2h 23m	21:10 18:47	depart arrive arrive depart	07:47 10:12	2h 25m		Palermo
	4h 9m						4h 10m	
Trapani	2d 13h 10m	76.4 km/h	14:38	depart arrive	14:22	75.2 km/h	2d 9h 12m	Trapani
TOTAL	2d 22h 2m	8h 52m				13h 59m	2d 23h 11m	TOTAL

Table 22 Corridor 1: Optimised Timetable



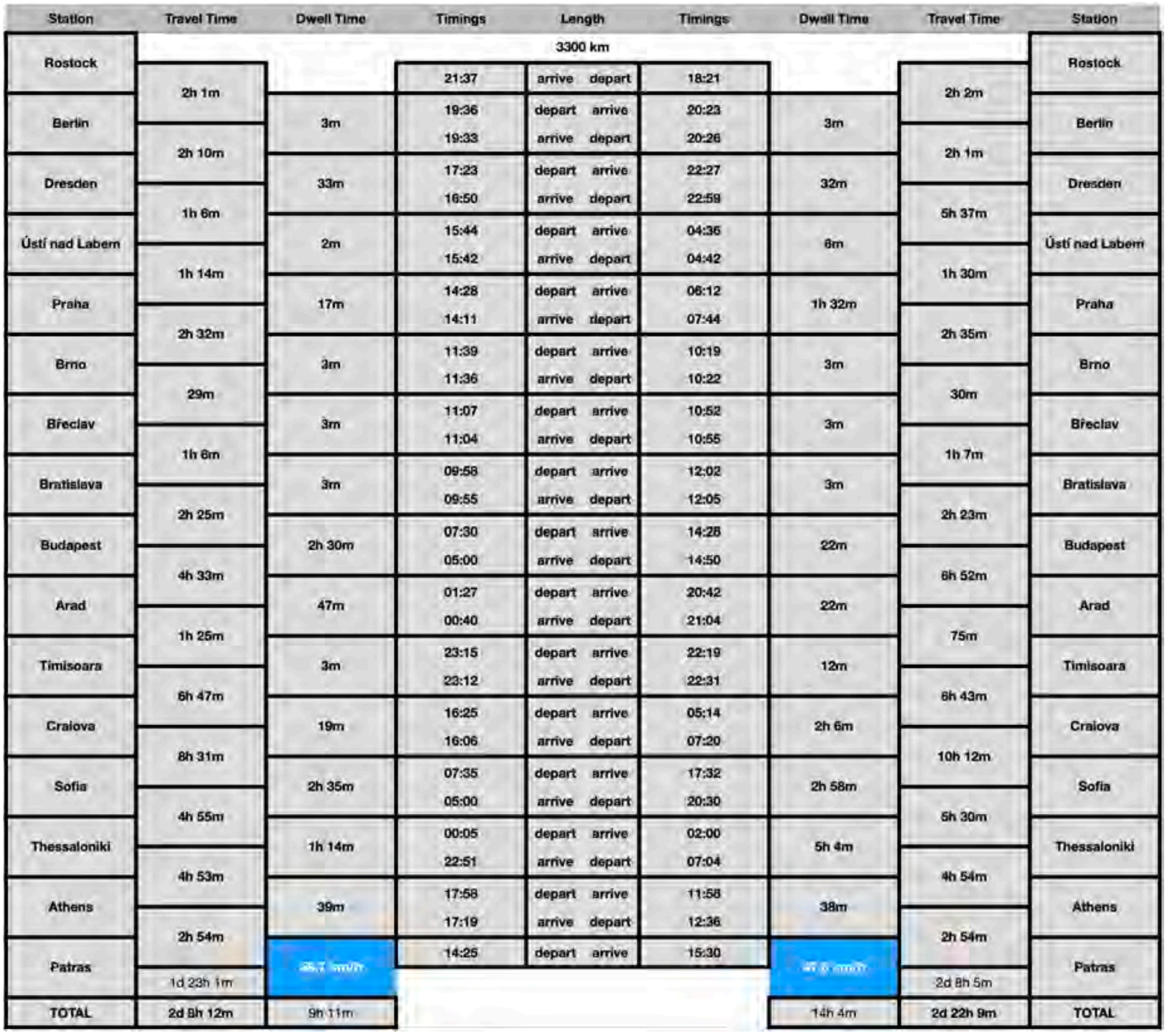
Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				5350 km				
Narvik			20:07	arrive depart	10:11			Narvik
	5h 15m						5h 15m	
Boden		5m	14:52 14:47	depart arrive arrive depart	15:26 15:31	5m		Boden
	2h 58m						2h 58m	
Umeå		5m	11:49 11:44	depart arrive arrive depart	18:29 18:34	5m		Umeå
	4h 30m						4h 30m	
Gävle		5m	07:14 07:09	depart arrive arrive depart	23:04 23:09	5m		Gävle
	1h 16m						1h 16m	
Stockholm		10m	05:53 05:43	depart arrive arrive depart	00:25 00:35	10m		Stockholm
	4h 2m						4h 2m	
Malmö		5m	01:41 01:36	depart arrive arrive depart	04:37 04:42	5m		Malmö
	23m						23m	
København		10m	01:13 01:03	depart arrive arrive depart	05:05 05:15	10m		København
	3h 50m						3h 50m	
Hamburg		5m	21:13 21:08	depart arrive arrive depart	09:05 09:10	5m		Hamburg
	1h 10m						1h 10m	
Hannover		5m	19:58 19:53	depart arrive arrive depart	10:20 10:25	5m		Hannover
	1h 49m						1h 49m	
Würzburg		5m	18:04 17:59	depart arrive arrive depart	12:14 12:19	5m		Würzburg
	48m						48m	
Nürnburg		5m	17:11 17:06	depart arrive arrive depart	13:07 13:12	5m		Nürnburg
	1h 1m						1h 1m	
München		10m	16:05 15:55	depart arrive arrive depart	14:13 14:23	10m		München
	1h 19m						1h 19m	
Innsbruck		5m	14:36 14:31	depart arrive arrive depart	15:42 15:47	5m		Innsbruck
	2h 53m						2h 53m	
Verona		10m	11:38 11:28	depart arrive arrive depart	18:40 18:50	10m		Verona
	51m						51m	
Bologna		5m	10:37 10:32	depart arrive arrive depart	19:41 19:46	5m		Bologna
	33m						33m	
Firenze		5m	09:59 09:54	depart arrive arrive depart	20:19 20:24	5m		Firenze
	1h 23m						1h 23m	
Roma		10m	08:31 08:21	depart arrive arrive depart	21:47 21:57	10m		Roma
	1h 3m						1h 3m	
Napoli		10m	07:18 07:08	depart arrive arrive depart	23:00 23:10	10m		Napoli
	31m						31m	
Salerno		5m	06:37 06:32	depart arrive arrive depart	23:41 23:46	5m		Salerno
	2h 52m						2h 52m	
Villa San Giovanni		30m	03:40 03:10	depart arrive arrive depart	02:38 03:08	30m		Villa San Giovanni
	30m						30m	
Messina		30m	02:40 02:10	depart arrive arrive depart	03:38 04:08	30m		Messina
	2h 11m						2h 11m	
Palermo		5m	23:59 23:54	depart arrive arrive depart	06:19 06:24	5m		Palermo
	2h 45m						2h 45m	
Trapani	1d 19h 53m	115.9 km/h	21:09	depart arrive	09:09	115.8 km/h	1d 19h 53m	Trapani
TOTAL	1d 22h 58m	3h 5m	-32.9%		-34.0%	3h 5m	1d 22h 58m	TOTAL

Table 23 Corridor 1: Optimised Future Timetable



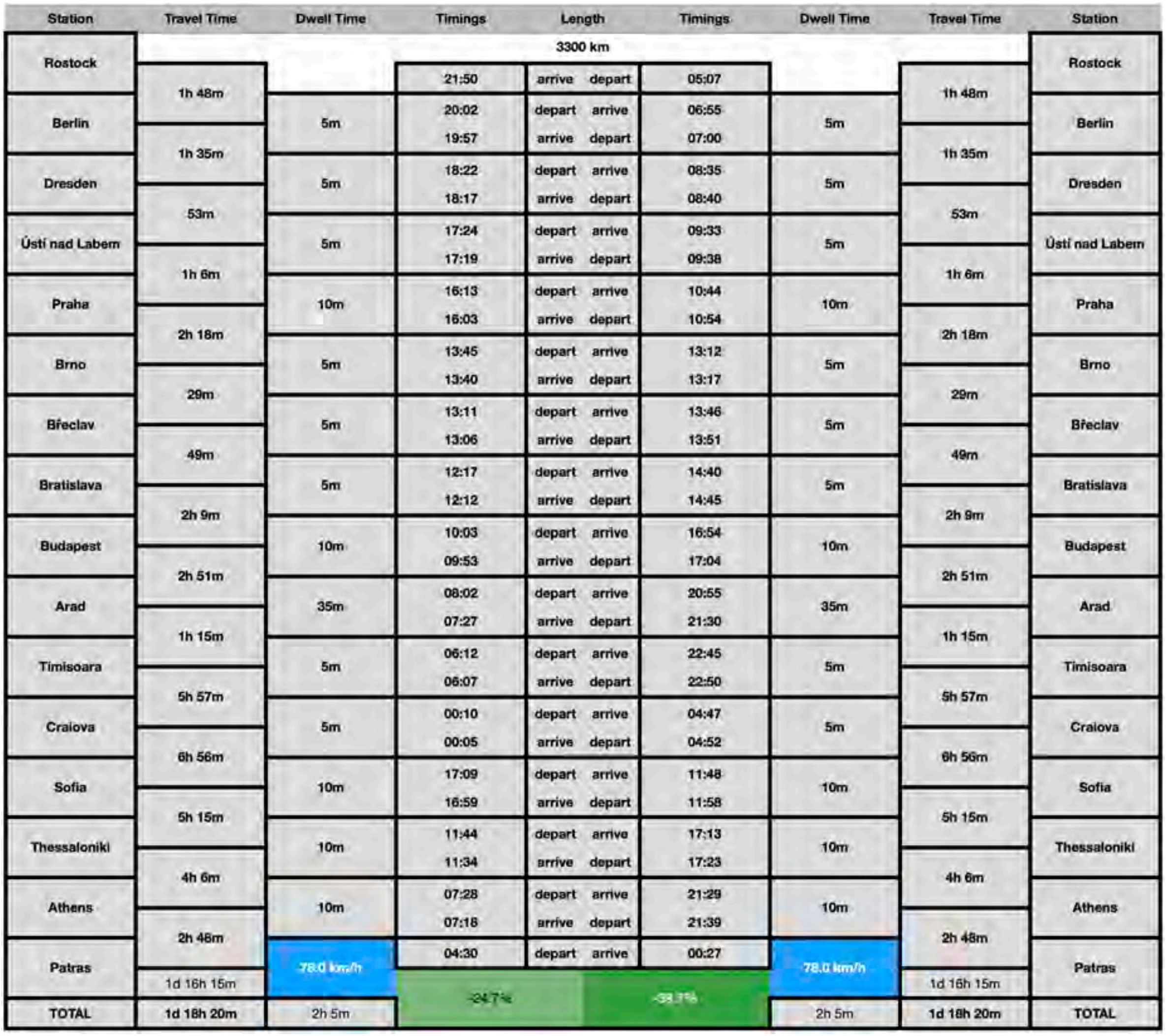
Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				5200 km				
Narvik			13:33	arrive depart	16:45			Narvik
	5h 15m						5h 15m	
Boden		5m	08:18 08:13	depart arrive arrive depart	22:00 22:05	5m		Boden
	2h 58m						2h 56m	
Umeå		5m	05:15 05:10	depart arrive arrive depart	01:03 01:08	5m		Umeå
	4h 30m						4h 30m	
Gävle		5m	00:40 00:35	depart arrive arrive depart	05:38 05:43	5m		Gävle
	1h 16m						1h 16m	
Stockholm		10m	23:19 23:09	depart arrive arrive depart	06:59 07:09	10m		Stockholm
	2h 35m						2h 35m	
Malmö		5m	20:34 20:29	depart arrive arrive depart	09:44 09:49	5m		Malmö
	23m						23m	
København		10m	20:06 19:56	depart arrive arrive depart	10:12 10:22	10m		København
	2h 30m						2h 30m	
Hamburg		5m	17:26 17:21	depart arrive arrive depart	12:52 12:57	5m		Hamburg
	59m						59m	
Hannover		5m	16:22 16:17	depart arrive arrive depart	13:56 14:01	5m		Hannover
	1h 49m						1h 49m	
Würzburg		5m	14:28 14:23	depart arrive arrive depart	15:50 15:55	5m		Würzburg
	29m						29m	
Nürnburg		5m	13:54 13:49	depart arrive arrive depart	16:24 16:29	5m		Nürnburg
	1h 1m						1h 1m	
München		10m	12:48 12:38	depart arrive arrive depart	17:30 17:40	10m		München
	55m						55m	
Innsbruck		5m	11:43 11:38	depart arrive arrive depart	18:35 18:40	5m		Innsbruck
	1h 25m						1h 25m	
Verona		10m	10:13 10:03	depart arrive arrive depart	20:05 20:15	10m		Verona
	51m						51m	
Bologna		5m	09:12 09:07	depart arrive arrive depart	21:06 21:11	5m		Bologna
	33m						33m	
Firenze		5m	08:34 08:29	depart arrive arrive depart	21:44 21:49	5m		Firenze
	1h 23m						1h 23m	
Roma		10m	07:06 06:56	depart arrive arrive depart	23:12 23:22	10m		Roma
	1h 3m						1h 3m	
Napoli		10m	05:53 05:43	depart arrive arrive depart	00:25 00:35	10m		Napoli
	31m						31m	
Salerno		5m	05:12 05:07	depart arrive arrive depart	01:06 01:11	5m		Salerno
	2h 10m						2h 10m	
Villa San Giovanni		30m	02:57 02:27	depart arrive arrive depart	03:21 03:51	30m		Villa San Giovanni
	15m						15m	
Messina		30m	02:12 01:42	depart arrive arrive depart	04:06 04:36	30m		Messina
	2h 11m						2h 11m	
Palermo		5m	23:31 23:26	depart arrive arrive depart	06:47 06:52	5m		Palermo
	2h 17m						2h 17m	
Trapani		128.7 km/h	21:09	depart arrive	09:09	128.7 km/h		Trapani
	1d 13h 19m		-42.3%		-43.2%		1d 13h 19m	
TOTAL	1d 16h 24m	3h 5m				3h 5m	1d 16h 24m	TOTAL

Table 24 Corridor 2: Current Timetable



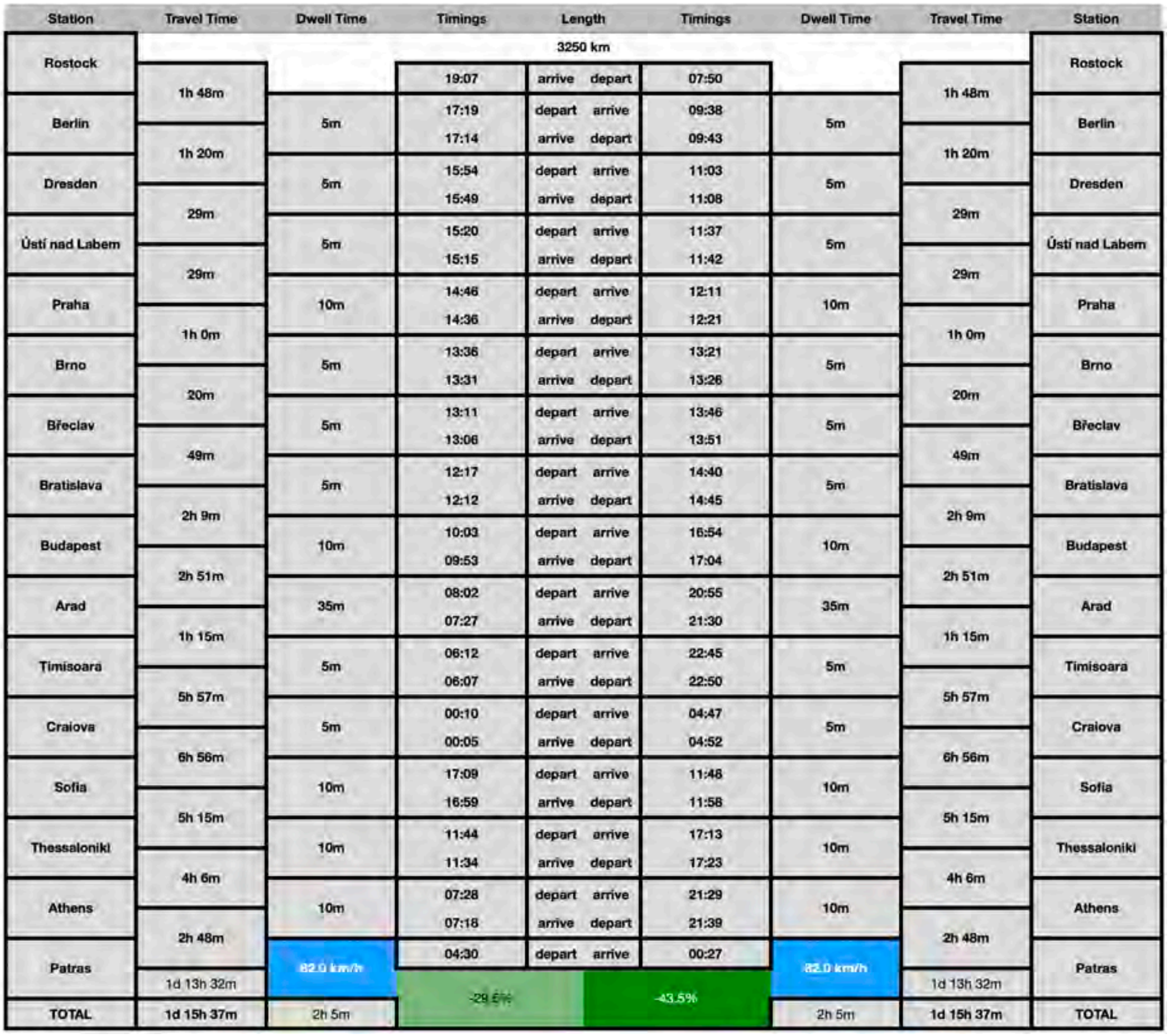
Station	Travel Time	Dwell Time	Timings	Length		Timings	Dwell Time	Travel Time	Station
				3300 km					
Rostock			21:37	arrive	depart	18:21			Rostock
	2h 1m							2h 2m	
Berlin		3m	19:36	depart	arrive	20:23	3m		Berlin
			19:33	arrive	depart	20:26			
	2h 10m							2h 1m	
Dresden		33m	17:23	depart	arrive	22:27	32m		Dresden
			16:50	arrive	depart	22:59			
	1h 6m							5h 37m	
Ústí nad Labem		2m	15:44	depart	arrive	04:36	6m		Ústí nad Labem
			15:42	arrive	depart	04:42			
	1h 14m							1h 30m	
Praha		17m	14:28	depart	arrive	06:12	1h 32m		Praha
			14:11	arrive	depart	07:44			
	2h 32m							2h 35m	
Brno		3m	11:39	depart	arrive	10:19	3m		Brno
			11:36	arrive	depart	10:22			
	29m							30m	
Břeclav		3m	11:07	depart	arrive	10:52	3m		Břeclav
			11:04	arrive	depart	10:55			
	1h 6m							1h 7m	
Bratislava		3m	09:58	depart	arrive	12:02	3m		Bratislava
			09:55	arrive	depart	12:05			
	2h 25m							2h 23m	
Budapest		2h 30m	07:30	depart	arrive	14:28	22m		Budapest
			05:00	arrive	depart	14:50			
	4h 33m							6h 52m	
Arad		47m	01:27	depart	arrive	20:42	22m		Arad
			00:40	arrive	depart	21:04			
	1h 25m							75m	
Timisoara		3m	23:15	depart	arrive	22:19	12m		Timisoara
			23:12	arrive	depart	22:31			
	6h 47m							6h 43m	
Craiova		19m	16:25	depart	arrive	05:14	2h 6m		Craiova
			16:06	arrive	depart	07:20			
	8h 31m							10h 12m	
Sofia		2h 35m	07:35	depart	arrive	17:32	2h 58m		Sofia
			05:00	arrive	depart	20:30			
	4h 55m							5h 30m	
Thessaloniki		1h 14m	00:05	depart	arrive	02:00	5h 4m		Thessaloniki
			22:51	arrive	depart	07:04			
	4h 53m							4h 54m	
Athens		39m	17:58	depart	arrive	11:58	38m		Athens
			17:19	arrive	depart	12:36			
	2h 54m							2h 54m	
Patras		58.7 km/h	14:25	depart	arrive	15:30	47.0 km/h		Patras
	1d 23h 1m							2d 8h 5m	
TOTAL	2d 8h 12m	9h 11m					14h 4m	2d 22h 9m	TOTAL

Table 25 Corridor 2: Optimised Timetable



Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				3300 km				
Rostock			21:50	arrive depart	05:07			Rostock
	1h 48m						1h 48m	
Berlin		5m	20:02 19:57	depart arrive arrive depart	06:55 07:00	5m		Berlin
	1h 35m						1h 35m	
Dresden		5m	18:22 18:17	depart arrive arrive depart	08:35 08:40	5m		Dresden
	53m						53m	
Ústí nad Labem		5m	17:24 17:19	depart arrive arrive depart	09:33 09:38	5m		Ústí nad Labem
	1h 6m						1h 6m	
Praha		10m	16:13 16:03	depart arrive arrive depart	10:44 10:54	10m		Praha
	2h 18m						2h 18m	
Brno		5m	13:45 13:40	depart arrive arrive depart	13:12 13:17	5m		Brno
	29m						29m	
Břeclav		5m	13:11 13:06	depart arrive arrive depart	13:46 13:51	5m		Břeclav
	49m						49m	
Bratislava		5m	12:17 12:12	depart arrive arrive depart	14:40 14:45	5m		Bratislava
	2h 9m						2h 9m	
Budapest		10m	10:03 09:53	depart arrive arrive depart	16:54 17:04	10m		Budapest
	2h 51m						2h 51m	
Arad		35m	08:02 07:27	depart arrive arrive depart	20:55 21:30	35m		Arad
	1h 15m						1h 15m	
Timisoara		5m	06:12 06:07	depart arrive arrive depart	22:45 22:50	5m		Timisoara
	5h 57m						5h 57m	
Craiova		5m	00:10 00:05	depart arrive arrive depart	04:47 04:52	5m		Craiova
	6h 56m						6h 56m	
Sofia		10m	17:09 16:59	depart arrive arrive depart	11:48 11:58	10m		Sofia
	5h 15m						5h 15m	
Thessaloniki		10m	11:44 11:34	depart arrive arrive depart	17:13 17:23	10m		Thessaloniki
	4h 6m						4h 6m	
Athens		10m	07:28 07:18	depart arrive arrive depart	21:29 21:39	10m		Athens
	2h 46m						2h 48m	
Patras		78.0 km/h	04:30	depart arrive	00:27	78.0 km/h		Patras
	1d 16h 15m		-24.7%		-38.1%		1d 16h 15m	
TOTAL	1d 18h 20m	2h 5m				2h 5m	1d 18h 20m	TOTAL

Table 26 Corridor 2: Optimised Future Timetable



Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				3250 km				
Rostock			19:07	arrive depart	07:50			Rostock
	1h 48m						1h 48m	
Berlin		5m	17:19 17:14	depart arrive arrive depart	09:38 09:43	5m		Berlin
	1h 20m						1h 20m	
Dresden		5m	15:54 15:49	depart arrive arrive depart	11:03 11:08	5m		Dresden
	29m						29m	
Ústí nad Labem		5m	15:20 15:15	depart arrive arrive depart	11:37 11:42	5m		Ústí nad Labem
	29m						29m	
Praha		10m	14:46 14:36	depart arrive arrive depart	12:11 12:21	10m		Praha
	1h 0m						1h 0m	
Brno		5m	13:36 13:31	depart arrive arrive depart	13:21 13:26	5m		Brno
	20m						20m	
Břeclav		5m	13:11 13:06	depart arrive arrive depart	13:46 13:51	5m		Břeclav
	49m						49m	
Bratislava		5m	12:17 12:12	depart arrive arrive depart	14:40 14:45	5m		Bratislava
	2h 9m						2h 9m	
Budapest		10m	10:03 09:53	depart arrive arrive depart	16:54 17:04	10m		Budapest
	2h 51m						2h 51m	
Arad		35m	08:02 07:27	depart arrive arrive depart	20:55 21:30	35m		Arad
	1h 15m						1h 15m	
Timisoara		5m	06:12 06:07	depart arrive arrive depart	22:45 22:50	5m		Timisoara
	5h 57m						5h 57m	
Craiova		5m	00:10 00:05	depart arrive arrive depart	04:47 04:52	5m		Craiova
	6h 56m						6h 56m	
Sofia		10m	17:09 16:59	depart arrive arrive depart	11:48 11:58	10m		Sofia
	5h 15m						5h 15m	
Thessaloniki		10m	11:44 11:34	depart arrive arrive depart	17:13 17:23	10m		Thessaloniki
	4h 6m						4h 6m	
Athens		10m	07:28 07:18	depart arrive arrive depart	21:29 21:39	10m		Athens
	2h 48m						2h 48m	
Patras		82.0 km/h	04:30	depart arrive	00:27	82.0 km/h		Patras
	1d 13h 32m		-29.6%		-43.5%		1d 13h 32m	
TOTAL	1d 15h 37m	2h 5m				2h 5m	1d 15h 37m	TOTAL

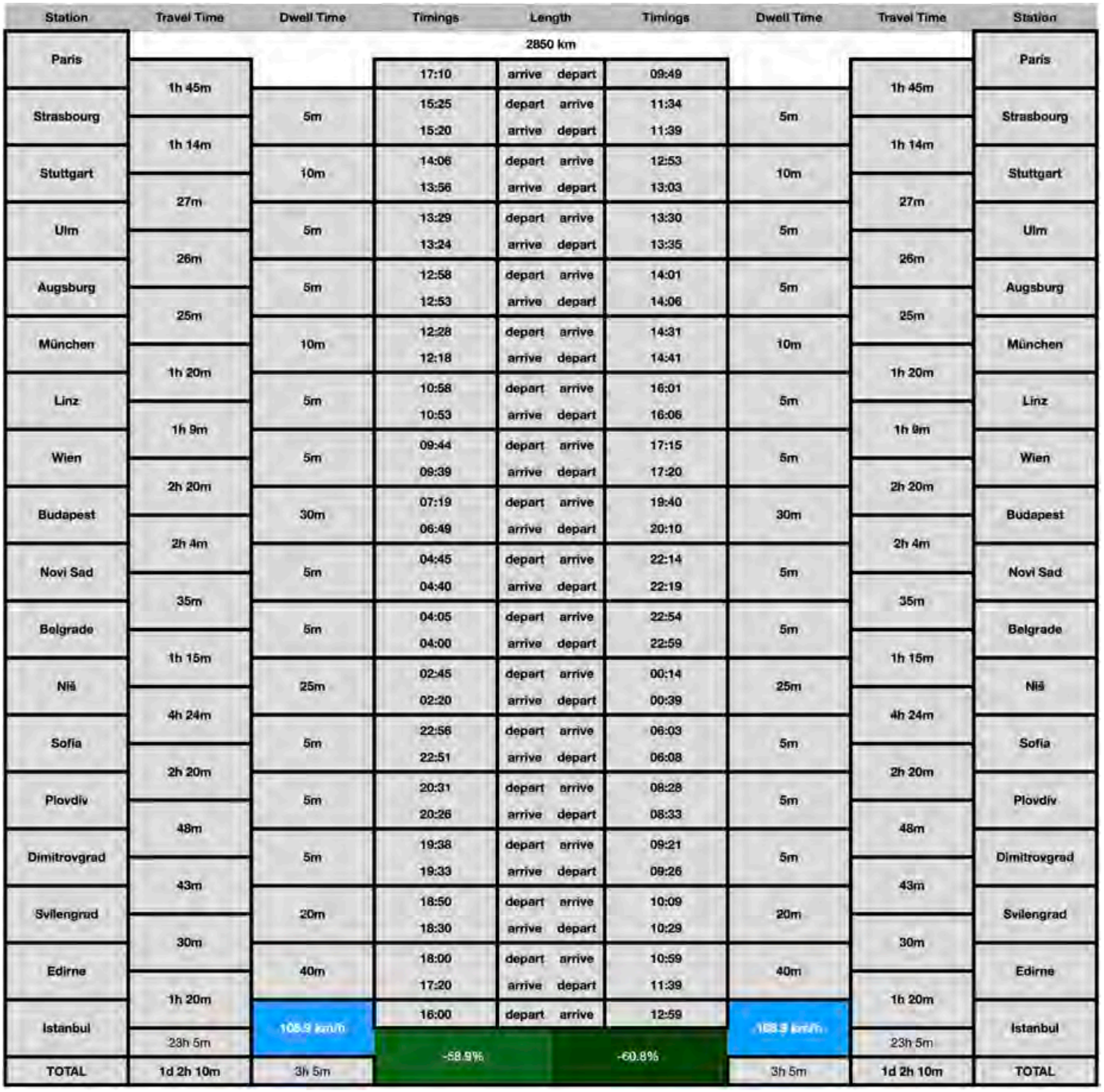
Table 6.2 Corridor 3: Current Timetable

Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				3050 km				
Paris			10:38	arrive depart	10:52			Paris
	1h 46m						1h 46m	
Strasbourg		5m	08:52 08:47	depart arrive arrive depart	12:38 12:42	4m		Strasbourg
	2h 48m						1h 22m	
Stuttgart		51m	05:59 05:08	depart arrive arrive depart	14:04 14:51	47m		Stuttgart
	58m						43m	
Ulm		2m	04:10 04:08	depart arrive arrive depart	15:34 15:36	2m		Ulm
	39m						41m	
Augsburg		2m	03:29 03:27	depart arrive arrive depart	16:17 16:19	2m		Augsburg
	35m						30m	
München		6m	02:52 02:46	depart arrive arrive depart	16:49 17:30	41m		München
	3h 16m						2h 45m	
Linz		2m	23:30 23:28	depart arrive arrive depart	20:15 20:17	2m		Linz
	1h 33m						1h 15m	
Wien		35m	21:55 21:20	depart arrive arrive depart	21:32 21:40	8m		Wien
	2h 40m						2h 42m	
Budapest		31m	18:40 18:09	depart arrive arrive depart	00:22 05:50	5h 28m		Budapest
	9h 14m						13h 6m	
Novi Sad		10m	08:55 08:45	depart arrive arrive depart	18:56 19:00	4m		Novi Sad
	36m						36m	
Belgrade		54m	08:09 07:15	depart arrive arrive depart	19:36 21:30	1h 54m		Belgrade
	3h 15m						4h 19m	
Niš		10h 0m	04:00 18:00	depart arrive arrive depart	01:49 04:40	2h 51m		Niš
	3h 0m						4h 10m	
Sofia		1h 10m	16:00 14:50	depart arrive arrive depart	09:50 10:30	40m		Sofia
	2h 59m						2h 37m	
Plovdiv		4m	11:51 11:47	depart arrive arrive depart	13:07 13:12	5m		Plovdiv
	58m						58m	
Dimitrovgrad		1h 34m	10:49 09:15	depart arrive arrive depart	14:10 16:08	1h 58m		Dimitrovgrad
	55m						54m	
Svilengrad		5h 39m	08:20 02:41	depart arrive arrive depart	17:02 01:25	8h 23m		Svilengrad
	1h 49m						1h 16m	
Edirne		22m	00:52 00:30	depart arrive arrive depart	02:43 02:48	5m		Edirne
	4h 30m						3h 46m	
Istanbul	1d 17h 31m	47.9 km/h	20:00	depart arrive	06:34	45.7 km/h	1d 19h 28m	Istanbul
TOTAL	2d 15h 38m	22h 7m				23h 14m	2d 18h 42m	TOTAL

Table 7.2 Corridor 3: Optimised Timetable

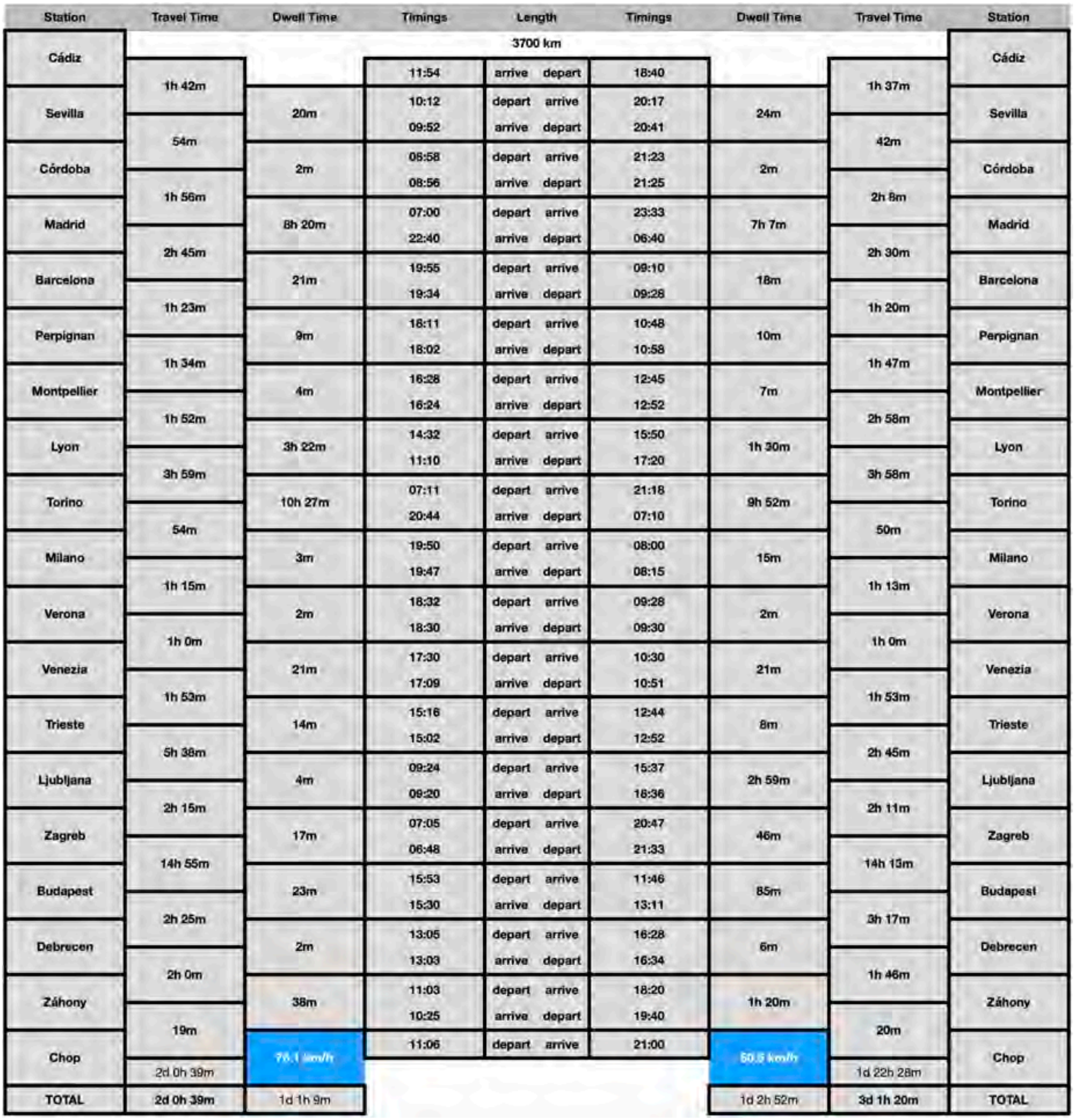
Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				3050 km				
Paris			17:01	arrive depart	10:19			Paris
	1h 45m						1h 45m	
Strasbourg		5m	15:16 15:11	depart arrive arrive depart	12:04 12:09	5m		Strasbourg
	1h 14m						1h 14m	
Stuttgart		10m	13:57 13:47	depart arrive arrive depart	13:23 13:33	10m		Stuttgart
	41m						41m	
Ulm		5m	13:06 13:01	depart arrive arrive depart	14:14 14:19	5m		Ulm
	38m						38m	
Augsburg		5m	12:23 12:18	depart arrive arrive depart	14:57 15:02	5m		Augsburg
	25m						25m	
München		10m	11:53 11:43	depart arrive arrive depart	15:27 15:37	10m		München
	2h 26m						2h 26m	
Linz		5m	09:17 09:12	depart arrive arrive depart	18:03 18:08	5m		Linz
	1h 9m						1h 9m	
Wien		5m	08:03 07:58	depart arrive arrive depart	19:17 19:22	5m		Wien
	2h 22m						2h 22m	
Budapest		30m	05:36 05:06	depart arrive arrive depart	21:44 22:14	30m		Budapest
	6h 14m						6h 14m	
Novi Sad		5m	22:52 22:47	depart arrive arrive depart	04:28 04:33	5m		Novi Sad
	35m						35m	
Belgrade		5m	22:12 22:07	depart arrive arrive depart	05:08 05:13	5m		Belgrade
	4h 10m						4h 10m	
Niš		25m	17:57 17:32	depart arrive arrive depart	09:23 09:48	25m		Niš
	4h 24m						4h 24m	
Sofia		5m	14:08 14:03	depart arrive arrive depart	15:12 15:17	5m		Sofia
	2h 20m						2h 20m	
Plovdiv		5m	11:43 11:38	depart arrive arrive depart	17:37 17:42	5m		Plovdiv
	48m						48m	
Dimitrovgrad		5m	10:50 10:45	depart arrive arrive depart	18:30 18:35	5m		Dimitrovgrad
	43m						43m	
Svilengrad		20m	10:02 09:42	depart arrive arrive depart	19:18 19:38	20m		Svilengrad
	34m						34m	
Edirne		40m	09:08 08:28	depart arrive arrive depart	20:12 20:52	40m		Edirne
	3h 38m						3h 38m	
Istanbul	1d 10h 6m	82.0 km/h	04:50	depart arrive	00:30	82.0 km/h	1d 10h 6m	Istanbul
TOTAL	1d 13h 11m	3h 5m	-41.6%		-44.3%	3h 5m	1d 13h 11m	TOTAL

Table 8.2 Corridor 3: Optimised Future Timetable



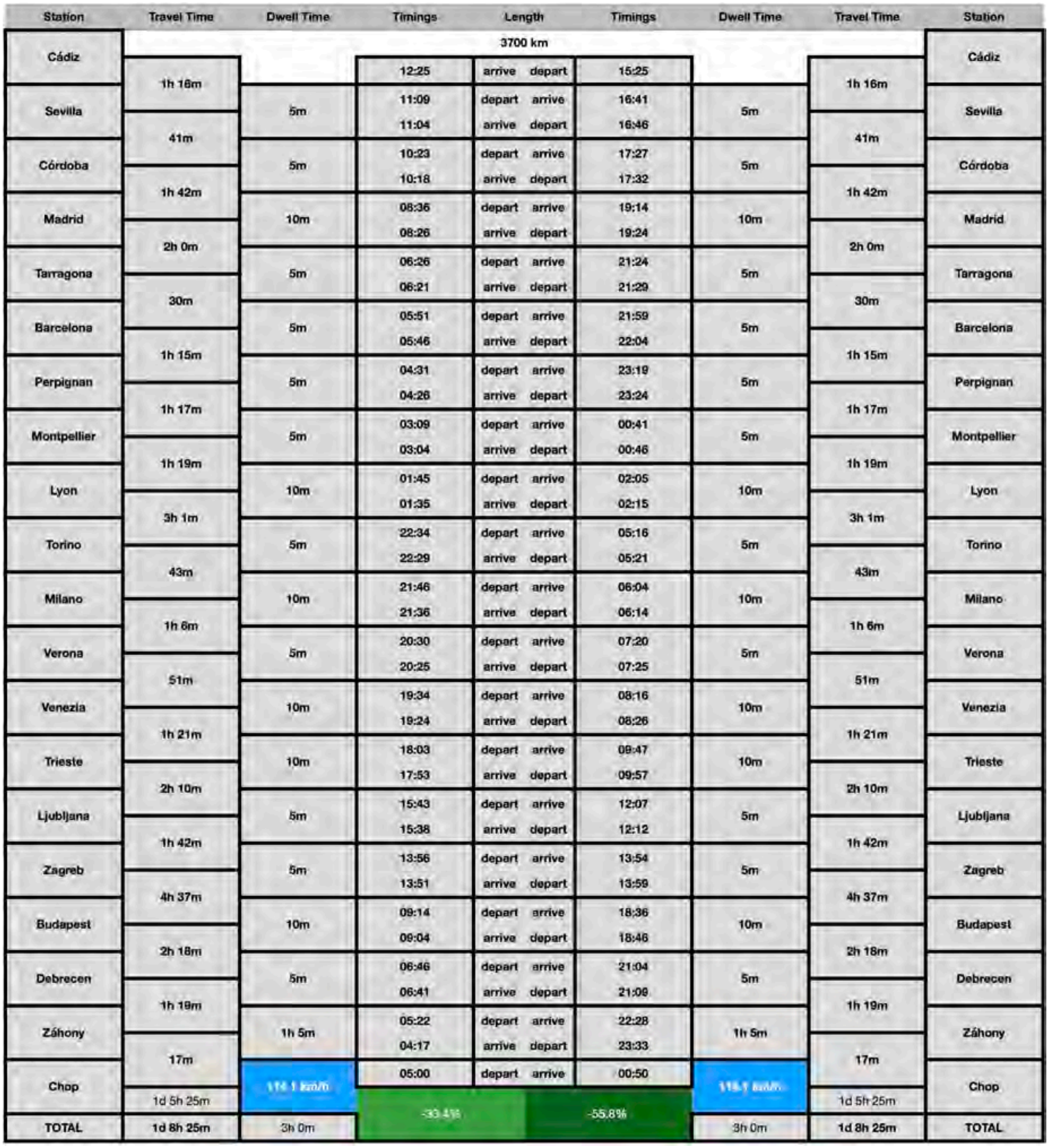
Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				2850 km				
Paris			17:10	arrive depart	09:49			Paris
	1h 45m						1h 45m	
Strasbourg		5m	15:25 15:20	depart arrive arrive depart	11:34 11:39	5m		Strasbourg
	1h 14m						1h 14m	
Stuttgart		10m	14:06 13:56	depart arrive arrive depart	12:53 13:03	10m		Stuttgart
	27m						27m	
Ulm		5m	13:29 13:24	depart arrive arrive depart	13:30 13:35	5m		Ulm
	26m						26m	
Augsburg		5m	12:58 12:53	depart arrive arrive depart	14:01 14:06	5m		Augsburg
	25m						25m	
München		10m	12:28 12:18	depart arrive arrive depart	14:31 14:41	10m		München
	1h 20m						1h 20m	
Linz		5m	10:58 10:53	depart arrive arrive depart	16:01 16:06	5m		Linz
	1h 9m						1h 9m	
Wien		5m	09:44 09:39	depart arrive arrive depart	17:15 17:20	5m		Wien
	2h 20m						2h 20m	
Budapest		30m	07:19 06:49	depart arrive arrive depart	19:40 20:10	30m		Budapest
	2h 4m						2h 4m	
Novi Sad		5m	04:45 04:40	depart arrive arrive depart	22:14 22:19	5m		Novi Sad
	35m						35m	
Belgrade		5m	04:05 04:00	depart arrive arrive depart	22:54 22:59	5m		Belgrade
	1h 15m						1h 15m	
Niš		25m	02:45 02:20	depart arrive arrive depart	00:14 00:39	25m		Niš
	4h 24m						4h 24m	
Sofia		5m	22:56 22:51	depart arrive arrive depart	06:03 06:08	5m		Sofia
	2h 20m						2h 20m	
Plovdiv		5m	20:31 20:26	depart arrive arrive depart	08:28 08:33	5m		Plovdiv
	48m						48m	
Dimitrovgrad		5m	19:38 19:33	depart arrive arrive depart	09:21 09:26	5m		Dimitrovgrad
	43m						43m	
Svilengrad		20m	18:50 18:30	depart arrive arrive depart	10:09 10:29	20m		Svilengrad
	30m						30m	
Edirne		40m	18:00 17:20	depart arrive arrive depart	10:59 11:39	40m		Edirne
	1h 20m						1h 20m	
Istanbul		108.9 km/h	16:00	depart arrive	12:59	108.9 km/h		Istanbul
	23h 5m		-58.9%		-60.8%		23h 5m	
TOTAL	1d 2h 10m	3h 5m				3h 5m	1d 2h 10m	TOTAL

Table 27 Corridor 4: Current Timetable



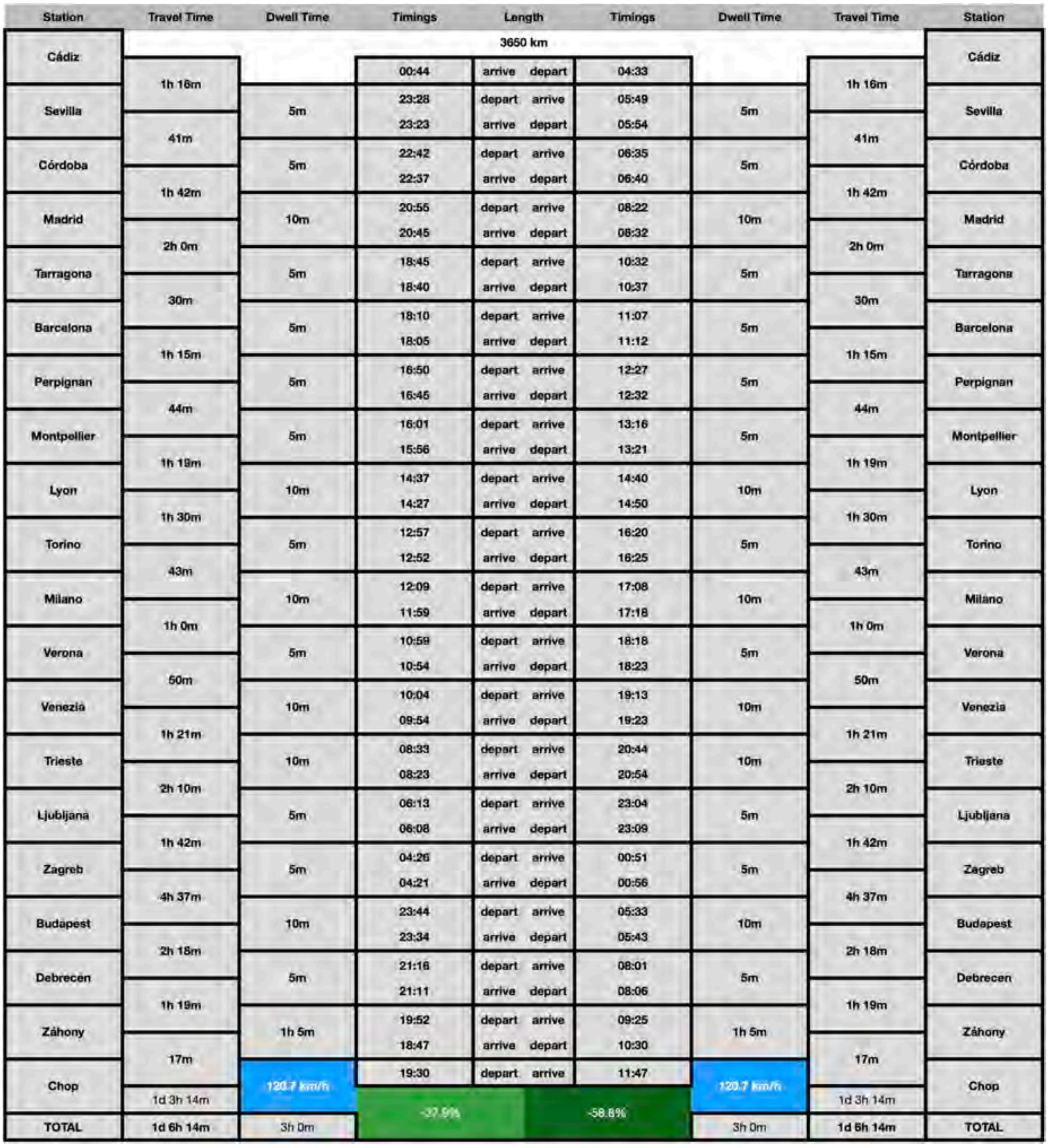
Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				3700 km				
Cádiz			11:54	arrive depart	18:40			Cádiz
	1h 42m						1h 37m	
Sevilla		20m	10:12 09:52	depart arrive arrive depart	20:17 20:41	24m		Sevilla
	54m						42m	
Córdoba		2m	08:58 08:56	depart arrive arrive depart	21:23 21:25	2m		Córdoba
	1h 56m						2h 8m	
Madrid		8h 20m	07:00 22:40	depart arrive arrive depart	23:33 06:40	7h 7m		Madrid
	2h 45m						2h 30m	
Barcelona		21m	19:55 19:34	depart arrive arrive depart	09:10 09:28	18m		Barcelona
	1h 23m						1h 20m	
Perpignan		9m	18:11 18:02	depart arrive arrive depart	10:48 10:58	10m		Perpignan
	1h 34m						1h 47m	
Montpellier		4m	16:28 16:24	depart arrive arrive depart	12:45 12:52	7m		Montpellier
	1h 52m						2h 58m	
Lyon		3h 22m	14:32 11:10	depart arrive arrive depart	15:50 17:20	1h 30m		Lyon
	3h 59m						3h 58m	
Torino		10h 27m	07:11 20:44	depart arrive arrive depart	21:18 07:10	9h 52m		Torino
	54m						50m	
Milano		3m	19:50 19:47	depart arrive arrive depart	08:00 08:15	15m		Milano
	1h 15m						1h 13m	
Verona		2m	18:32 18:30	depart arrive arrive depart	09:28 09:30	2m		Verona
	1h 0m						1h 0m	
Venezia		21m	17:30 17:09	depart arrive arrive depart	10:30 10:51	21m		Venezia
	1h 53m						1h 53m	
Trieste		14m	15:16 15:02	depart arrive arrive depart	12:44 12:52	8m		Trieste
	5h 38m						2h 45m	
Ljubljana		4m	09:24 09:20	depart arrive arrive depart	15:37 18:36	2h 59m		Ljubljana
	2h 15m						2h 11m	
Zagreb		17m	07:05 06:48	depart arrive arrive depart	20:47 21:33	46m		Zagreb
	14h 55m						14h 13m	
Budapest		23m	15:53 15:30	depart arrive arrive depart	11:46 13:11	85m		Budapest
	2h 25m						3h 17m	
Debrecen		2m	13:05 13:03	depart arrive arrive depart	16:28 16:34	6m		Debrecen
	2h 0m						1h 46m	
Záhony		38m	11:03 10:25	depart arrive arrive depart	18:20 19:40	1h 20m		Záhony
	19m						20m	
Chop		76.1 km/h	11:06	depart arrive	21:00	50.5 km/h		Chop
	2d 0h 39m						1d 22h 28m	
TOTAL	2d 0h 39m	1d 1h 9m				1d 2h 52m	3d 1h 20m	TOTAL

Table 28 Corridor 4: Optimised Timetable



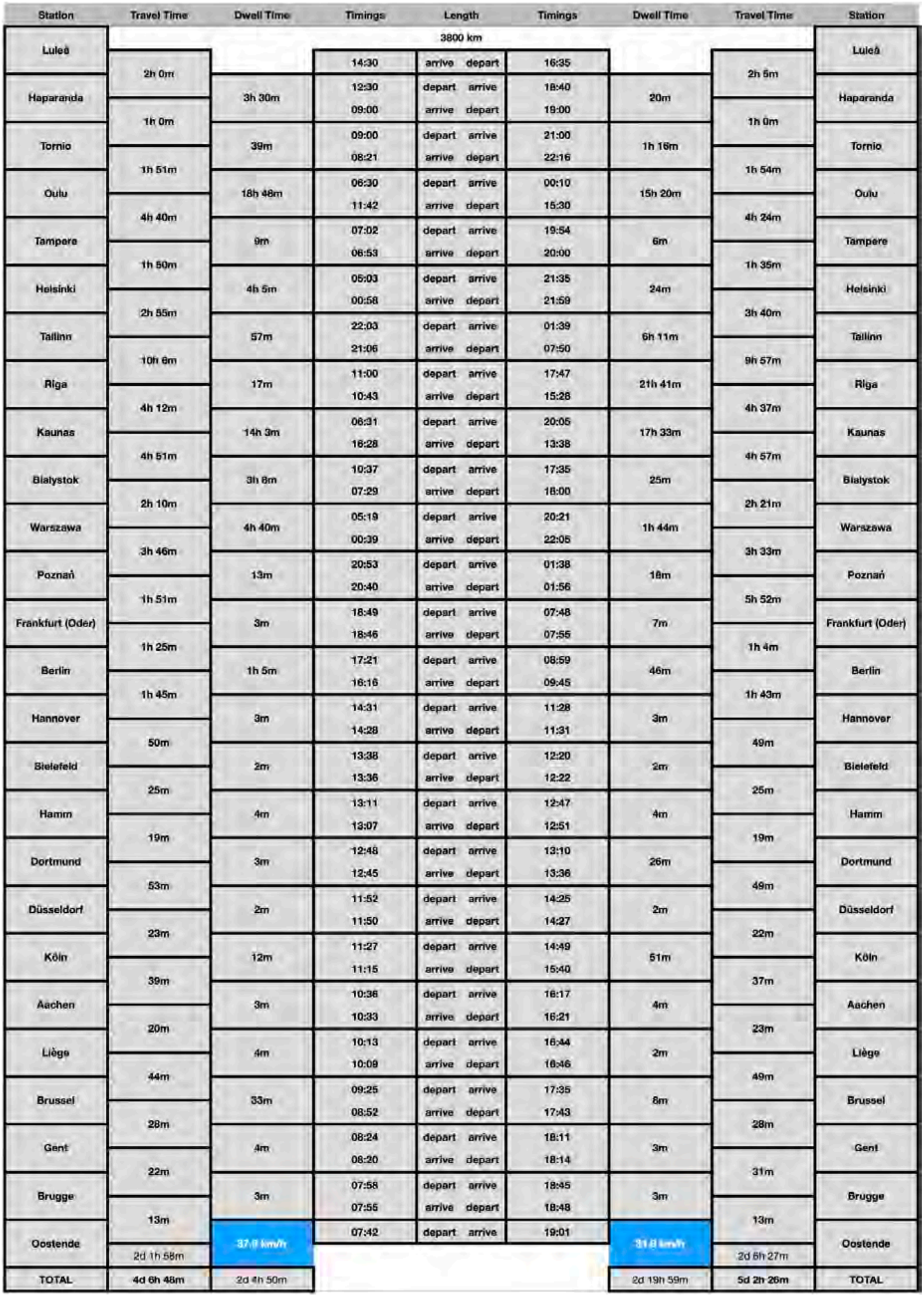
Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				3700 km				
Cádiz			12:25	arrive depart	15:25			Cádiz
	1h 16m						1h 16m	
Sevilla		5m	11:09 11:04	depart arrive arrive depart	16:41 16:46	5m		Sevilla
	41m						41m	
Córdoba		5m	10:23 10:18	depart arrive arrive depart	17:27 17:32	5m		Córdoba
	1h 42m						1h 42m	
Madrid		10m	08:36 08:26	depart arrive arrive depart	19:14 19:24	10m		Madrid
	2h 0m						2h 0m	
Tarragona		5m	06:26 06:21	depart arrive arrive depart	21:24 21:29	5m		Tarragona
	30m						30m	
Barcelona		5m	05:51 05:46	depart arrive arrive depart	21:59 22:04	5m		Barcelona
	1h 15m						1h 15m	
Perpignan		5m	04:31 04:26	depart arrive arrive depart	23:19 23:24	5m		Perpignan
	1h 17m						1h 17m	
Montpellier		5m	03:09 03:04	depart arrive arrive depart	00:41 00:46	5m		Montpellier
	1h 19m						1h 19m	
Lyon		10m	01:45 01:35	depart arrive arrive depart	02:05 02:15	10m		Lyon
	3h 1m						3h 1m	
Torino		5m	22:34 22:29	depart arrive arrive depart	05:16 05:21	5m		Torino
	43m						43m	
Milano		10m	21:46 21:36	depart arrive arrive depart	06:04 06:14	10m		Milano
	1h 6m						1h 6m	
Verona		5m	20:30 20:25	depart arrive arrive depart	07:20 07:25	5m		Verona
	51m						51m	
Venezia		10m	19:34 19:24	depart arrive arrive depart	08:16 08:26	10m		Venezia
	1h 21m						1h 21m	
Trieste		10m	18:03 17:53	depart arrive arrive depart	09:47 09:57	10m		Trieste
	2h 10m						2h 10m	
Ljubljana		5m	15:43 15:38	depart arrive arrive depart	12:07 12:12	5m		Ljubljana
	1h 42m						1h 42m	
Zagreb		5m	13:56 13:51	depart arrive arrive depart	13:54 13:59	5m		Zagreb
	4h 37m						4h 37m	
Budapest		10m	09:14 09:04	depart arrive arrive depart	18:36 18:46	10m		Budapest
	2h 18m						2h 18m	
Debrecen		5m	06:46 06:41	depart arrive arrive depart	21:04 21:09	5m		Debrecen
	1h 19m						1h 19m	
Záhony		1h 5m	05:22 04:17	depart arrive arrive depart	22:28 23:33	1h 5m		Záhony
	17m						17m	
Chop		114.1 km/h	05:00	depart arrive	00:50	114.1 km/h		Chop
	1d 5h 25m		-33.4%		-55.8%		1d 5h 25m	
TOTAL	1d 8h 25m	3h 0m				3h 0m	1d 8h 25m	TOTAL

Table 29 Corridor 4: Optimised Future Timetable



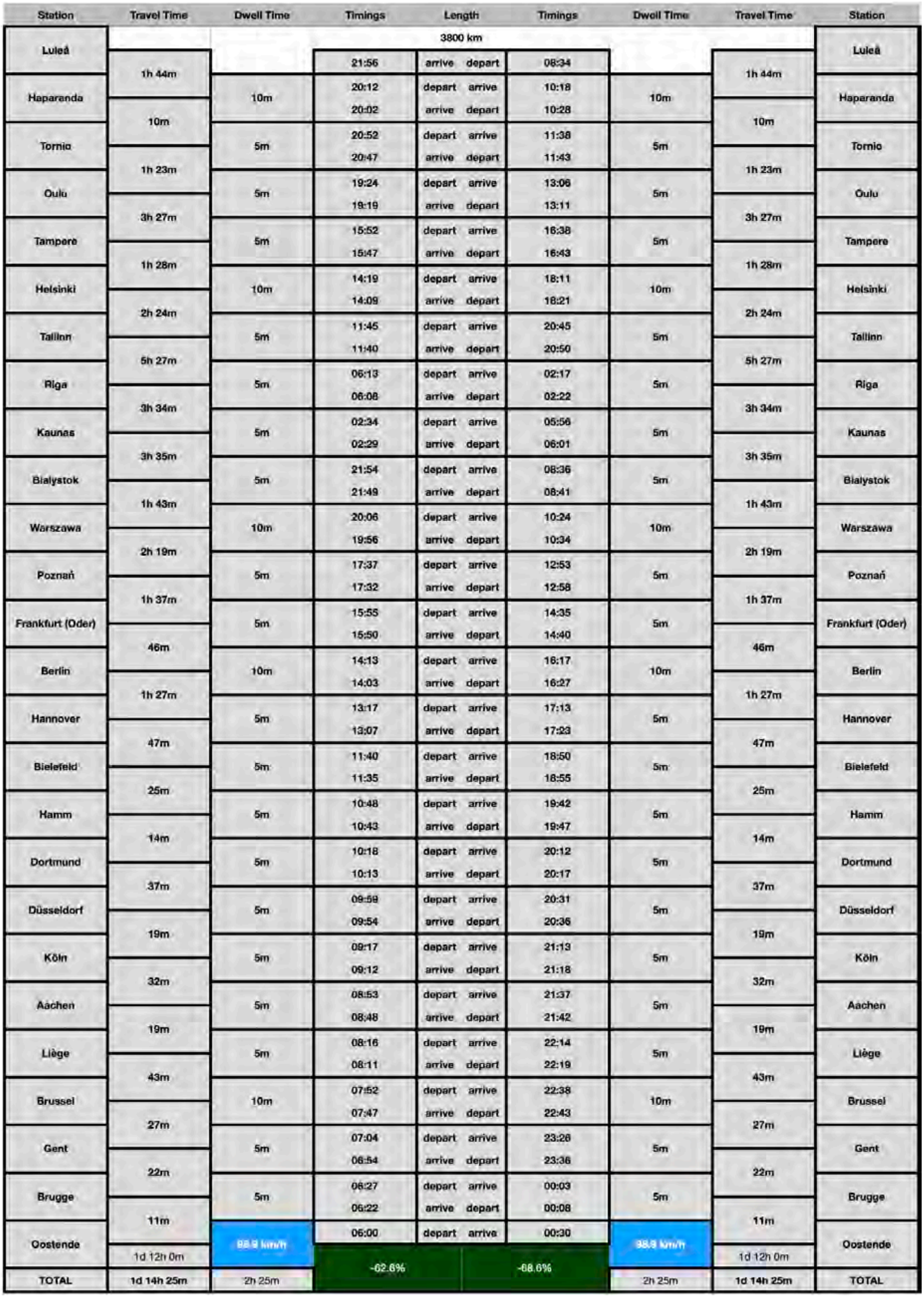
Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				3650 km				
Cádiz			00:44	arrive depart	04:33			Cádiz
	1h 16m						1h 16m	
Sevilla		5m	23:28 23:23	depart arrive arrive depart	05:49 05:54	5m		Sevilla
	41m						41m	
Córdoba		5m	22:42 22:37	depart arrive arrive depart	06:35 06:40	5m		Córdoba
	1h 42m						1h 42m	
Madrid		10m	20:55 20:45	depart arrive arrive depart	08:22 08:32	10m		Madrid
	2h 0m						2h 0m	
Tarragona		5m	18:45 18:40	depart arrive arrive depart	10:32 10:37	5m		Tarragona
	30m						30m	
Barcelona		5m	18:10 18:05	depart arrive arrive depart	11:07 11:12	5m		Barcelona
	1h 15m						1h 15m	
Perpignan		5m	16:50 16:45	depart arrive arrive depart	12:27 12:32	5m		Perpignan
	44m						44m	
Montpellier		5m	16:01 15:56	depart arrive arrive depart	13:16 13:21	5m		Montpellier
	1h 19m						1h 19m	
Lyon		10m	14:37 14:27	depart arrive arrive depart	14:40 14:50	10m		Lyon
	1h 30m						1h 30m	
Torino		5m	12:57 12:52	depart arrive arrive depart	16:20 16:25	5m		Torino
	43m						43m	
Milano		10m	12:09 11:59	depart arrive arrive depart	17:08 17:18	10m		Milano
	1h 0m						1h 0m	
Verona		5m	10:59 10:54	depart arrive arrive depart	18:18 18:23	5m		Verona
	50m						50m	
Venezia		10m	10:04 09:54	depart arrive arrive depart	19:13 19:23	10m		Venezia
	1h 21m						1h 21m	
Trieste		10m	08:33 08:23	depart arrive arrive depart	20:44 20:54	10m		Trieste
	2h 10m						2h 10m	
Ljubljana		5m	06:13 06:08	depart arrive arrive depart	23:04 23:09	5m		Ljubljana
	1h 42m						1h 42m	
Zagreb		5m	04:26 04:21	depart arrive arrive depart	00:51 00:56	5m		Zagreb
	4h 37m						4h 37m	
Budapest		10m	23:44 23:34	depart arrive arrive depart	05:33 05:43	10m		Budapest
	2h 18m						2h 18m	
Debrecen		5m	21:16 21:11	depart arrive arrive depart	08:01 08:06	5m		Debrecen
	1h 19m						1h 19m	
Záhony		1h 5m	19:52 18:47	depart arrive arrive depart	09:25 10:30	1h 5m		Záhony
	17m						17m	
Chop	1d 3h 14m	120.7 km/h	19:30	depart arrive	11:47	120.7 km/h	1d 3h 14m	Chop
TOTAL	1d 6h 14m	3h 0m	-37.9%		-58.8%	3h 0m	1d 6h 14m	TOTAL

Table 30 Corridor 5: Current Timetable



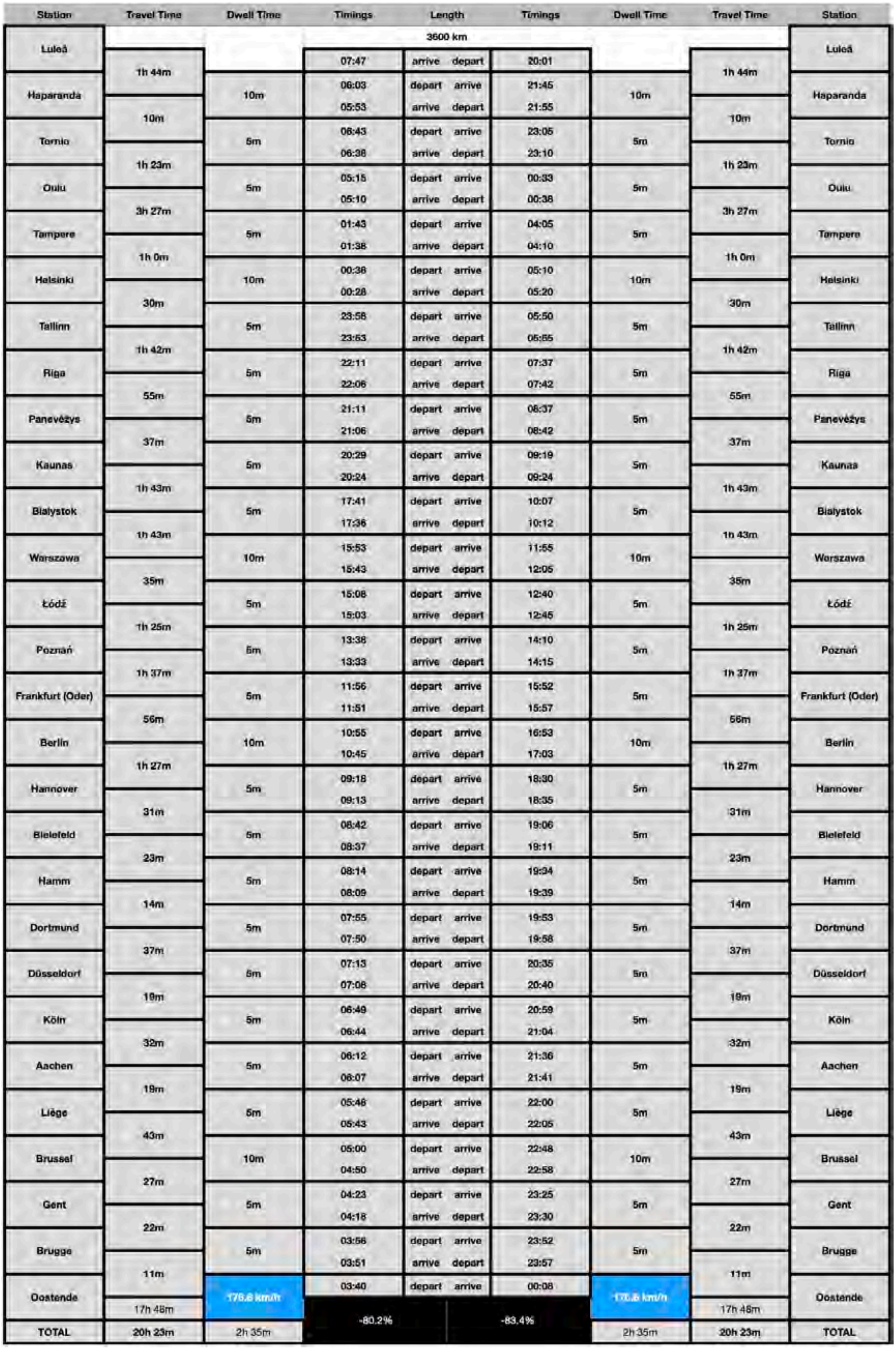
Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				3800 km				
Luleå			14:30	arrive depart	16:35			Luleå
	2h 0m						2h 5m	
Haparanda		3h 30m	12:30 09:00	depart arrive arrive depart	18:40 19:00	20m		Haparanda
	1h 0m						1h 0m	
Tornio		39m	09:00 08:21	depart arrive arrive depart	21:00 22:16	1h 16m		Tornio
	1h 51m						1h 54m	
Oulu		18h 48m	06:30 11:42	depart arrive arrive depart	00:10 15:30	15h 20m		Oulu
	4h 40m						4h 24m	
Tampere		9m	07:02 06:53	depart arrive arrive depart	19:54 20:00	6m		Tampere
	1h 50m						1h 35m	
Helsinki		4h 5m	05:03 00:58	depart arrive arrive depart	21:35 21:59	24m		Helsinki
	2h 55m						3h 40m	
Tallinn		57m	22:03 21:06	depart arrive arrive depart	01:39 07:50	6h 11m		Tallinn
	10h 6m						9h 57m	
Riga		17m	11:00 10:43	depart arrive arrive depart	17:47 15:28	21h 41m		Riga
	4h 12m						4h 37m	
Kaunas		14h 3m	06:31 16:28	depart arrive arrive depart	20:05 13:38	17h 33m		Kaunas
	4h 51m						4h 57m	
Bialystok		3h 8m	10:37 07:29	depart arrive arrive depart	17:35 18:00	25m		Bialystok
	2h 10m						2h 21m	
Warszawa		4h 40m	05:19 00:39	depart arrive arrive depart	20:21 22:05	1h 44m		Warszawa
	3h 46m						3h 33m	
Poznań		13m	20:53 20:40	depart arrive arrive depart	01:38 01:56	18m		Poznań
	1h 51m						5h 52m	
Frankfurt (Oder)		3m	18:49 18:46	depart arrive arrive depart	07:48 07:55	7m		Frankfurt (Oder)
	1h 25m						1h 4m	
Berlin		1h 5m	17:21 16:16	depart arrive arrive depart	08:59 09:45	46m		Berlin
	1h 45m						1h 43m	
Hannover		3m	14:31 14:28	depart arrive arrive depart	11:28 11:31	3m		Hannover
	50m						49m	
Bielefeld		2m	13:38 13:36	depart arrive arrive depart	12:20 12:22	2m		Bielefeld
	25m						25m	
Hamm		4m	13:11 13:07	depart arrive arrive depart	12:47 12:51	4m		Hamm
	19m						19m	
Dortmund		3m	12:48 12:45	depart arrive arrive depart	13:10 13:36	26m		Dortmund
	53m						49m	
Düsseldorf		2m	11:52 11:50	depart arrive arrive depart	14:25 14:27	2m		Düsseldorf
	23m						22m	
Köln		12m	11:27 11:15	depart arrive arrive depart	14:49 15:40	51m		Köln
	39m						37m	
Aachen		3m	10:36 10:33	depart arrive arrive depart	16:17 16:21	4m		Aachen
	20m						23m	
Liège		4m	10:13 10:09	depart arrive arrive depart	16:44 16:46	2m		Liège
	44m						49m	
Brussel		33m	09:25 08:52	depart arrive arrive depart	17:35 17:43	8m		Brussel
	28m						28m	
Gent		4m	08:24 08:20	depart arrive arrive depart	18:11 18:14	3m		Gent
	22m						31m	
Brugge		3m	07:58 07:55	depart arrive arrive depart	18:45 18:48	3m		Brugge
	13m						13m	
Oostende	2d 1h 58m	37.0 km/h	07:42	depart arrive	19:01	31.0 km/h	2d 6h 27m	Oostende
TOTAL	4d 6h 48m	2d 4h 50m				2d 19h 59m	5d 2h 26m	TOTAL

Table 31 Corridor 5: Optimised Timetable



Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				3800 km				
Luleå			21:56	arrive depart	08:34			Luleå
	1h 44m						1h 44m	
Haparanda		10m	20:12 20:02	depart arrive arrive depart	10:18 10:28	10m		Haparanda
	10m						10m	
Tornio		5m	20:52 20:47	depart arrive arrive depart	11:38 11:43	5m		Tornio
	1h 23m						1h 23m	
Oulu		5m	19:24 19:19	depart arrive arrive depart	13:06 13:11	5m		Oulu
	3h 27m						3h 27m	
Tampere		5m	15:52 15:47	depart arrive arrive depart	16:38 16:43	5m		Tampere
	1h 28m						1h 28m	
Helsinki		10m	14:19 14:09	depart arrive arrive depart	18:11 18:21	10m		Helsinki
	2h 24m						2h 24m	
Tallinn		5m	11:45 11:40	depart arrive arrive depart	20:45 20:50	5m		Tallinn
	5h 27m						5h 27m	
Riga		5m	06:13 06:08	depart arrive arrive depart	02:17 02:22	5m		Riga
	3h 34m						3h 34m	
Kaunas		5m	02:34 02:29	depart arrive arrive depart	05:56 06:01	5m		Kaunas
	3h 35m						3h 35m	
Bialystok		5m	21:54 21:49	depart arrive arrive depart	08:36 08:41	5m		Bialystok
	1h 43m						1h 43m	
Warszawa		10m	20:06 19:56	depart arrive arrive depart	10:24 10:34	10m		Warszawa
	2h 19m						2h 19m	
Poznań		5m	17:37 17:32	depart arrive arrive depart	12:53 12:58	5m		Poznań
	1h 37m						1h 37m	
Frankfurt (Oder)		5m	15:55 15:50	depart arrive arrive depart	14:35 14:40	5m		Frankfurt (Oder)
	46m						46m	
Berlin		10m	14:13 14:03	depart arrive arrive depart	16:17 16:27	10m		Berlin
	1h 27m						1h 27m	
Hannover		5m	13:17 13:07	depart arrive arrive depart	17:13 17:23	5m		Hannover
	47m						47m	
Bielefeld		5m	11:40 11:35	depart arrive arrive depart	18:50 18:55	5m		Bielefeld
	25m						25m	
Hamm		5m	10:48 10:43	depart arrive arrive depart	19:42 19:47	5m		Hamm
	14m						14m	
Dortmund		5m	10:18 10:13	depart arrive arrive depart	20:12 20:17	5m		Dortmund
	37m						37m	
Düsseldorf		5m	09:59 09:54	depart arrive arrive depart	20:31 20:36	5m		Düsseldorf
	19m						19m	
Köln		5m	09:17 09:12	depart arrive arrive depart	21:13 21:18	5m		Köln
	32m						32m	
Aachen		5m	08:53 08:48	depart arrive arrive depart	21:37 21:42	5m		Aachen
	19m						19m	
Liège		5m	08:16 08:11	depart arrive arrive depart	22:14 22:19	5m		Liège
	43m						43m	
Brussel		10m	07:52 07:47	depart arrive arrive depart	22:38 22:43	10m		Brussel
	27m						27m	
Gent		5m	07:04 06:54	depart arrive arrive depart	23:26 23:36	5m		Gent
	22m						22m	
Brugge		5m	06:27 06:22	depart arrive arrive depart	00:03 00:08	5m		Brugge
	11m						11m	
Oostende		98.9 km/h	06:00	depart arrive	00:30	98.9 km/h		Oostende
	1d 12h 0m		-62.6%		-68.6%		1d 12h 0m	
TOTAL	1d 14h 25m	2h 25m				2h 25m	1d 14h 25m	TOTAL

Table 32 Corridor 5: Optimised Future Timetable

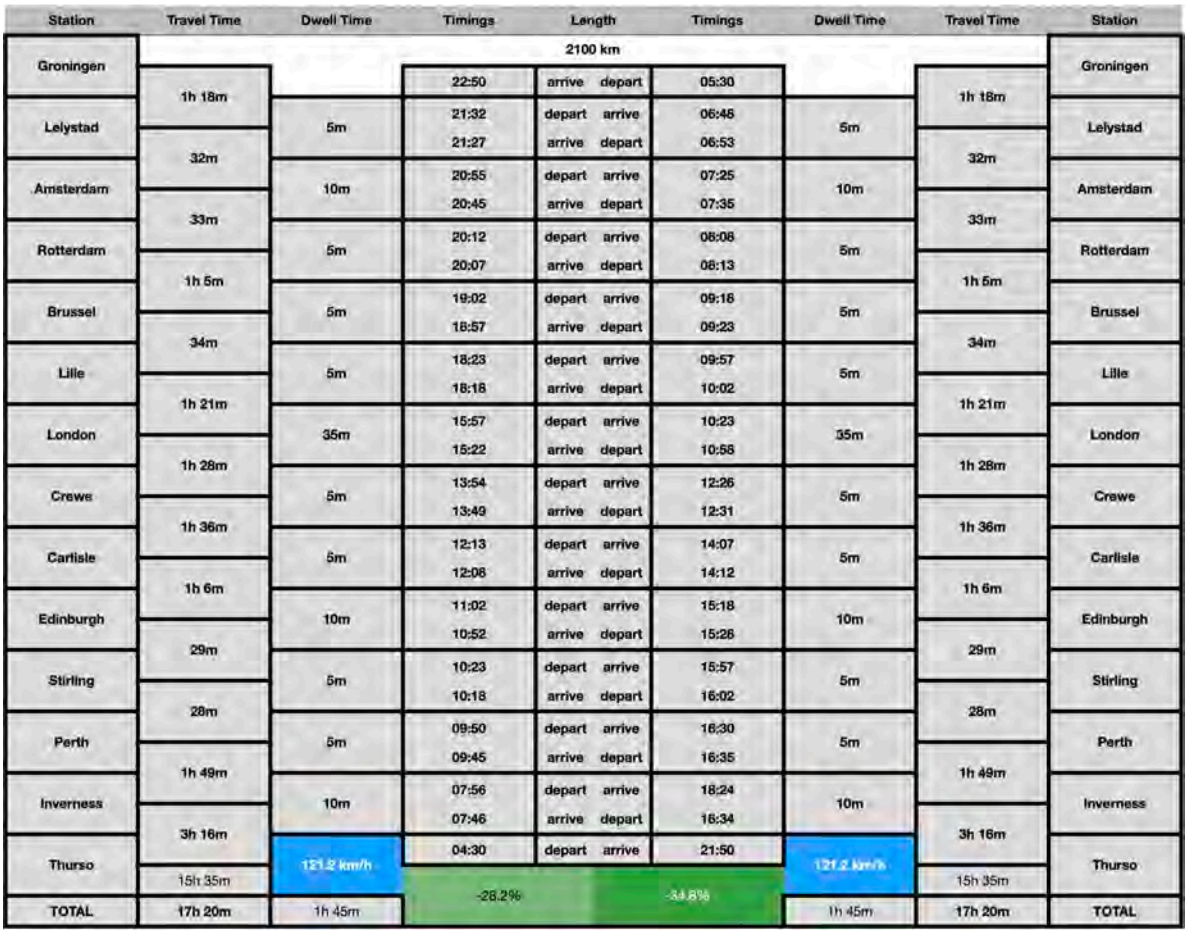


Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				3600 km				
Luleå			07:47	arrive depart	20:01			Luleå
	1h 44m						1h 44m	
Haparanda		10m	06:03 05:53	depart arrive arrive depart	21:45 21:55	10m		Haparanda
	10m						10m	
Tornio		5m	06:43 06:38	depart arrive arrive depart	23:05 23:10	5m		Tornio
	1h 23m						1h 23m	
Oulu		5m	05:15 05:10	depart arrive arrive depart	00:33 00:38	5m		Oulu
	3h 27m						3h 27m	
Tampere		5m	01:43 01:38	depart arrive arrive depart	04:05 04:10	5m		Tampere
	1h 0m						1h 0m	
Helsinki		10m	00:38 00:28	depart arrive arrive depart	05:10 05:20	10m		Helsinki
	30m						30m	
Tallinn		5m	23:58 23:53	depart arrive arrive depart	05:50 05:55	5m		Tallinn
	1h 42m						1h 42m	
Riga		5m	22:11 22:06	depart arrive arrive depart	07:37 07:42	5m		Riga
	55m						55m	
Panevėžys		5m	21:11 21:06	depart arrive arrive depart	08:37 08:42	5m		Panevėžys
	37m						37m	
Kaunas		5m	20:29 20:24	depart arrive arrive depart	09:19 09:24	5m		Kaunas
	1h 43m						1h 43m	
Bialystok		5m	17:41 17:36	depart arrive arrive depart	10:07 10:12	5m		Bialystok
	1h 43m						1h 43m	
Warszawa		10m	15:53 15:43	depart arrive arrive depart	11:55 12:05	10m		Warszawa
	35m						35m	
Łódź		5m	15:08 15:03	depart arrive arrive depart	12:40 12:45	5m		Łódź
	1h 25m						1h 25m	
Poznań		5m	13:38 13:33	depart arrive arrive depart	14:10 14:15	5m		Poznań
	1h 37m						1h 37m	
Frankfurt (Oder)		5m	11:56 11:51	depart arrive arrive depart	15:52 15:57	5m		Frankfurt (Oder)
	56m						56m	
Berlin		10m	10:55 10:45	depart arrive arrive depart	16:53 17:03	10m		Berlin
	1h 27m						1h 27m	
Hannover		5m	09:18 09:13	depart arrive arrive depart	18:30 18:35	5m		Hannover
	31m						31m	
Bielefeld		5m	08:42 08:37	depart arrive arrive depart	19:06 19:11	5m		Bielefeld
	23m						23m	
Hamm		5m	08:14 08:09	depart arrive arrive depart	19:34 19:39	5m		Hamm
	14m						14m	
Dortmund		5m	07:55 07:50	depart arrive arrive depart	19:53 19:58	5m		Dortmund
	37m						37m	
Düsseldorf		5m	07:13 07:08	depart arrive arrive depart	20:35 20:40	5m		Düsseldorf
	19m						19m	
Köln		5m	06:49 06:44	depart arrive arrive depart	20:59 21:04	5m		Köln
	32m						32m	
Aachen		5m	06:12 06:07	depart arrive arrive depart	21:36 21:41	5m		Aachen
	19m						19m	
Liège		5m	05:48 05:43	depart arrive arrive depart	22:00 22:05	5m		Liège
	43m						43m	
Brussel		10m	05:00 04:50	depart arrive arrive depart	22:48 22:58	10m		Brussel
	27m						27m	
Gent		5m	04:23 04:18	depart arrive arrive depart	23:25 23:30	5m		Gent
	22m						22m	
Brugge		5m	03:56 03:51	depart arrive arrive depart	23:52 23:57	5m		Brugge
	11m						11m	
Oostende		176.6 km/h	03:40	depart arrive	00:08	176.6 km/h		Oostende
	17h 48m						17h 48m	
TOTAL	20h 23m	2h 35m	-80.2%		-83.4%	2h 35m	20h 23m	TOTAL

Table 33 Corridor 6: Current Timetable

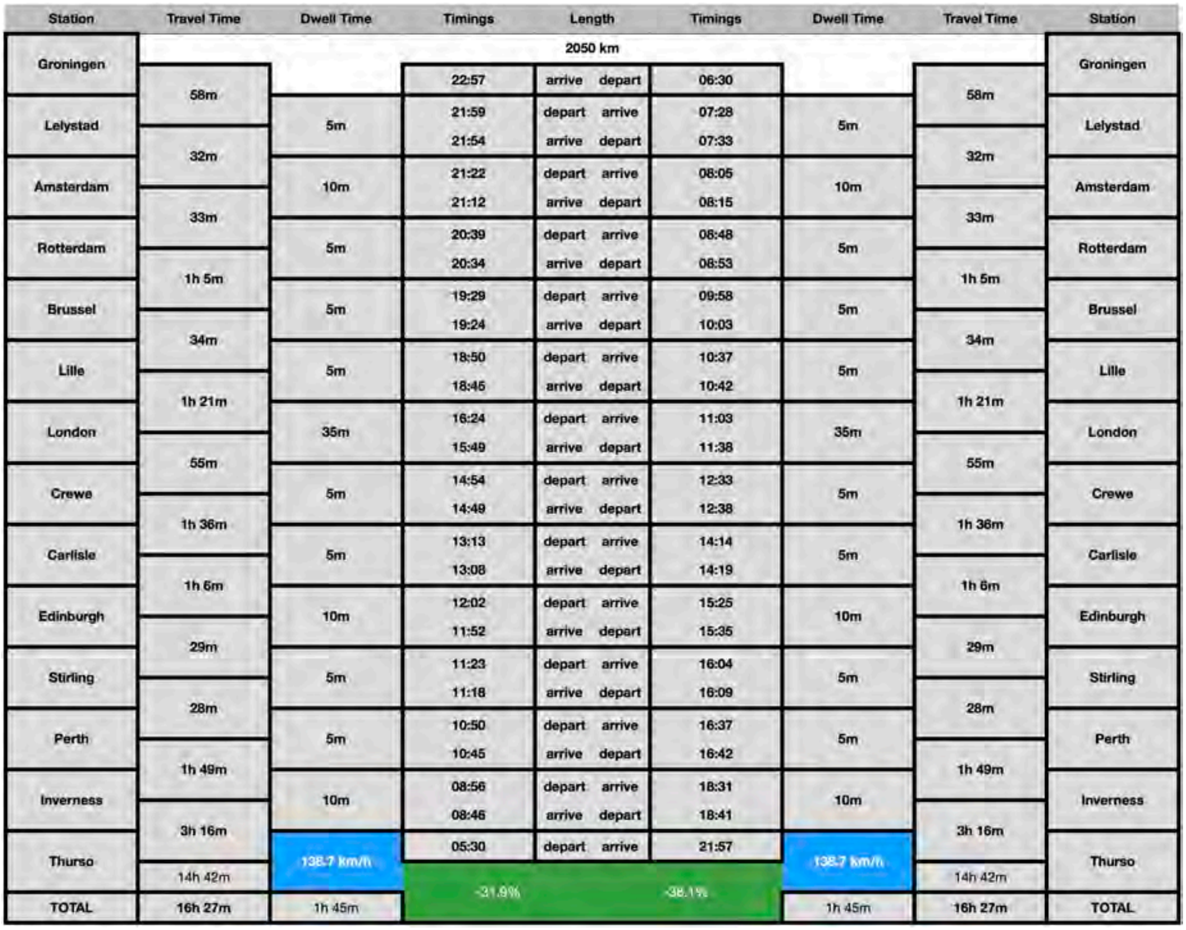
Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				2100 km				
Groningen			17:41	arrive depart	12:49			Groningen
	1h 24m						1h 23m	
Lelystad		1m	16:17 16:16	depart arrive arrive depart	14:12 14:13	1m		Lelystad
	34m						39m	
Amsterdam		1m	15:42 15:41	depart arrive arrive depart	14:52 16:45	113m		Amsterdam
	1h 6m						39m	
Rotterdam		3m	14:35 14:32	depart arrive arrive depart	17:24 17:28	4m		Rotterdam
	1h 10m						1h 10m	
Brussel		77m	13:22 12:05	depart arrive arrive depart	18:38 18:51	0h 13m		Brussel
	35m						35m	
Lille		4m	11:30 11:26	depart arrive arrive depart	19:26 19:28	2m		Lille
	1h 25m						1h 19m	
London		94m	09:01 07:27	depart arrive arrive depart	19:47 21:15	88m		London
	1h 50m						2h 25m	
Crewe		7m	05:37 05:30	depart arrive arrive depart	23:40 23:45	5m		Crewe
	5h 19m						5h 15m	
Stirling		5m	00:11 00:06	depart arrive arrive depart	05:00 05:05	5m		Stirling
	40m						38m	
Perth		5m	23:26 23:21	depart arrive arrive depart	05:43 05:48	0h 5m		Perth
	2h 36m						2h 57m	
Inverness		31m	20:45 20:14	depart arrive arrive depart	08:45 10:41	116m		Inverness
	3h 42m						3h 43m	
Thurso	20h 21m	87.0 km/h	16:32	depart arrive	14:24	79.0 km/h	20h 43m	Thurso
TOTAL	1d 0h 9m	3h 48m				5h 52m	1d 2h 35m	TOTAL

Table 34 Corridor 6: Optimised Timetable



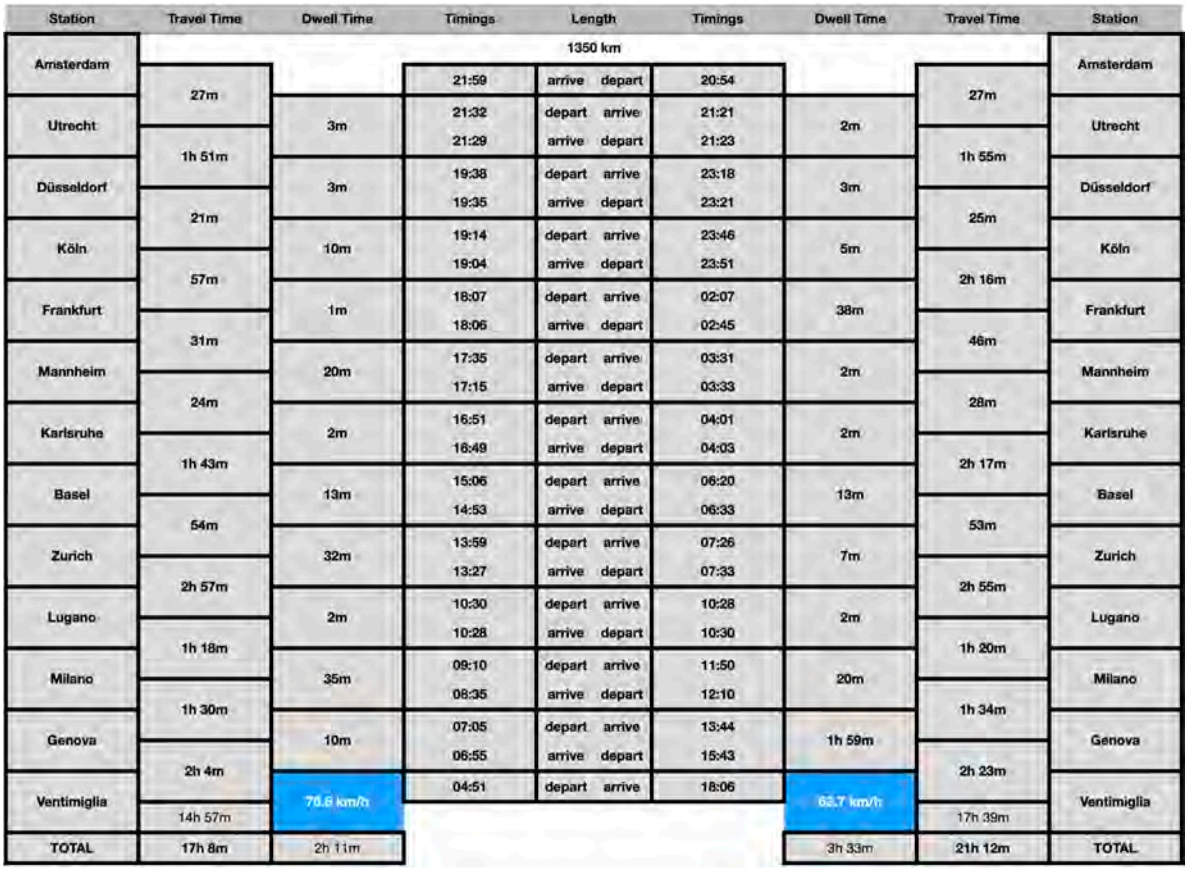
Station	Travel Time	Dwell Time	Timings	Length		Timings	Dwell Time	Travel Time	Station
				2100 km					
Groningen			22:50	arrive	depart	05:30			Groningen
	1h 18m							1h 18m	
Lelystad		5m	21:32 21:27	depart arrive	arrive depart	06:46 06:53	5m		Lelystad
	32m							32m	
Amsterdam		10m	20:55 20:45	depart arrive	arrive depart	07:25 07:35	10m		Amsterdam
	33m							33m	
Rotterdam		5m	20:12 20:07	depart arrive	arrive depart	08:08 08:13	5m		Rotterdam
	1h 5m							1h 5m	
Brussel		5m	19:02 18:57	depart arrive	arrive depart	09:18 09:23	5m		Brussel
	34m							34m	
Lille		5m	18:23 18:18	depart arrive	arrive depart	09:57 10:02	5m		Lille
	1h 21m							1h 21m	
London		35m	15:57 15:22	depart arrive	arrive depart	10:23 10:58	35m		London
	1h 28m							1h 28m	
Crewe		5m	13:54 13:49	depart arrive	arrive depart	12:26 12:31	5m		Crewe
	1h 36m							1h 36m	
Carlisle		5m	12:13 12:08	depart arrive	arrive depart	14:07 14:12	5m		Carlisle
	1h 6m							1h 6m	
Edinburgh		10m	11:02 10:52	depart arrive	arrive depart	15:18 15:28	10m		Edinburgh
	29m							29m	
Stirling		5m	10:23 10:18	depart arrive	arrive depart	15:57 16:02	5m		Stirling
	28m							28m	
Perth		5m	09:50 09:45	depart arrive	arrive depart	16:30 16:35	5m		Perth
	1h 49m							1h 49m	
Inverness		10m	07:56 07:46	depart arrive	arrive depart	18:24 18:34	10m		Inverness
	3h 16m							3h 16m	
Thurso		121.2 km/h	04:30	depart	arrive	21:50	121.2 km/h		Thurso
	15h 35m							15h 35m	
TOTAL	17h 20m	1h 45m	-28.2%			-34.8%	1h 45m	17h 20m	TOTAL

Table 35 Corridor 6: Optimised Future Timetable



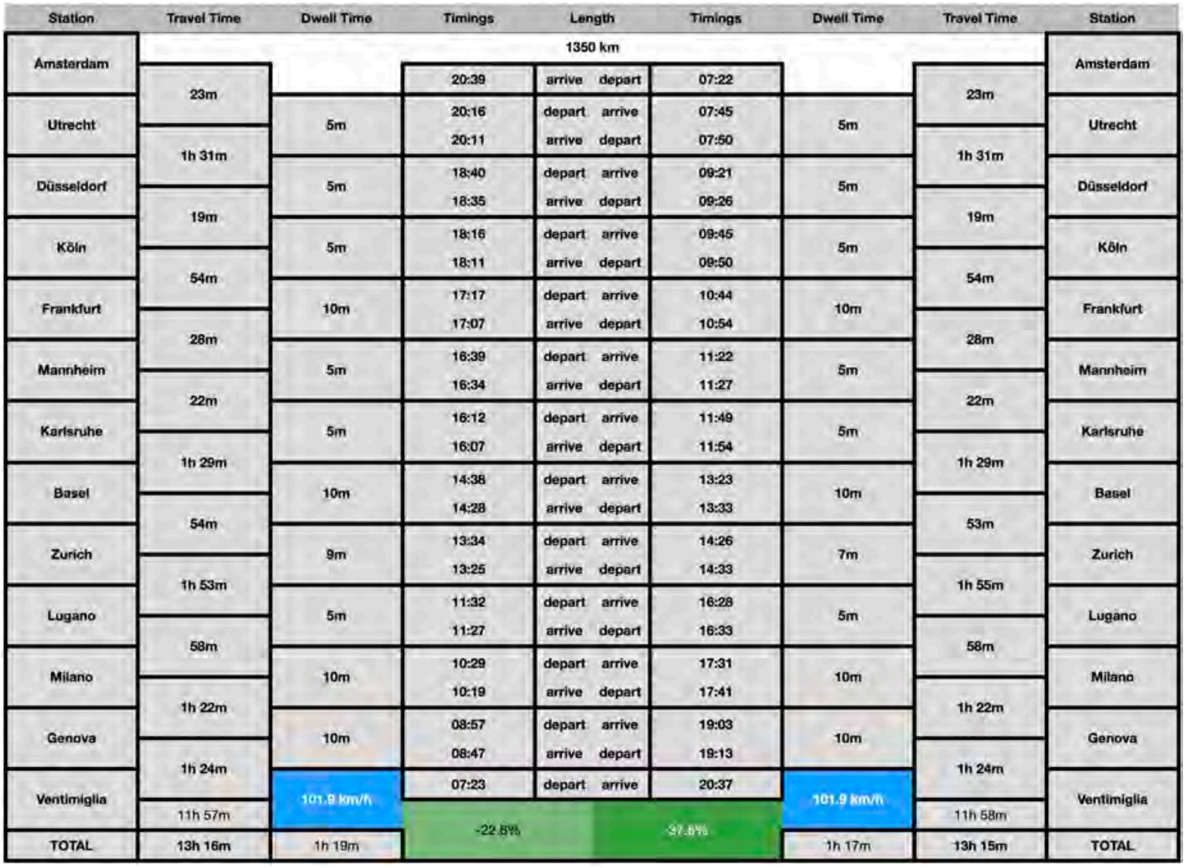
Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				2050 km				
Groningen			22:57	arrive depart	06:30			Groningen
	58m						58m	
Lelystad		5m	21:59 21:54	depart arrive arrive depart	07:28 07:33	5m		Lelystad
	32m						32m	
Amsterdam		10m	21:22 21:12	depart arrive arrive depart	08:05 08:15	10m		Amsterdam
	33m						33m	
Rotterdam		5m	20:39 20:34	depart arrive arrive depart	08:48 08:53	5m		Rotterdam
	1h 5m						1h 5m	
Brussel		5m	19:29 19:24	depart arrive arrive depart	09:58 10:03	5m		Brussel
	34m						34m	
Lille		5m	18:50 18:45	depart arrive arrive depart	10:37 10:42	5m		Lille
	1h 21m						1h 21m	
London		35m	16:24 15:49	depart arrive arrive depart	11:03 11:38	35m		London
	55m						55m	
Crewe		5m	14:54 14:49	depart arrive arrive depart	12:33 12:38	5m		Crewe
	1h 36m						1h 36m	
Carlisle		5m	13:13 13:08	depart arrive arrive depart	14:14 14:19	5m		Carlisle
	1h 6m						1h 6m	
Edinburgh		10m	12:02 11:52	depart arrive arrive depart	15:25 15:35	10m		Edinburgh
	29m						29m	
Stirling		5m	11:23 11:18	depart arrive arrive depart	16:04 16:09	5m		Stirling
	28m						28m	
Perth		5m	10:50 10:45	depart arrive arrive depart	16:37 16:42	5m		Perth
	1h 49m						1h 49m	
Inverness		10m	08:56 08:46	depart arrive arrive depart	18:31 18:41	10m		Inverness
	3h 16m						3h 16m	
Thurso		138.7 km/h	05:30	depart arrive	21:57	138.7 km/h		Thurso
	14h 42m		-31.9%		-38.1%		14h 42m	
TOTAL	16h 27m	1h 45m				1h 45m	16h 27m	TOTAL

Table 36 Corridor 7: Current Timetable



Station	Travel Time	Dwell Time	Timings	Length		Timings	Dwell Time	Travel Time	Station
				1350 km					
Amsterdam			21:59	arrive	depart	20:54			Amsterdam
	27m							27m	
Utrecht		3m	21:32 21:29	depart arrive	arrive depart	21:21 21:23	2m		Utrecht
	1h 51m							1h 55m	
Düsseldorf		3m	19:38 19:35	depart arrive	arrive depart	23:18 23:21	3m		Düsseldorf
	21m							25m	
Köln		10m	19:14 19:04	depart arrive	arrive depart	23:46 23:51	5m		Köln
	57m							2h 16m	
Frankfurt		1m	18:07 18:06	depart arrive	arrive depart	02:07 02:45	38m		Frankfurt
	31m							46m	
Mannheim		20m	17:35 17:15	depart arrive	arrive depart	03:31 03:33	2m		Mannheim
	24m							28m	
Karlsruhe		2m	16:51 16:49	depart arrive	arrive depart	04:01 04:03	2m		Karlsruhe
	1h 43m							2h 17m	
Basel		13m	15:06 14:53	depart arrive	arrive depart	06:20 06:33	13m		Basel
	54m							53m	
Zurich		32m	13:59 13:27	depart arrive	arrive depart	07:26 07:33	7m		Zurich
	2h 57m							2h 55m	
Lugano		2m	10:30 10:28	depart arrive	arrive depart	10:28 10:30	2m		Lugano
	1h 18m							1h 20m	
Milano		35m	09:10 08:35	depart arrive	arrive depart	11:50 12:10	20m		Milano
	1h 30m							1h 34m	
Genova		10m	07:05 06:55	depart arrive	arrive depart	13:44 15:43	1h 59m		Genova
	2h 4m							2h 23m	
Ventimiglia		78.8 km/h	04:51	depart	arrive	18:06	63.7 km/h		Ventimiglia
	14h 57m							17h 39m	
TOTAL	17h 8m	2h 11m					3h 33m	21h 12m	TOTAL

Table 37 Corridor 7: Optimised Timetable



Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				1350 km				
Amsterdam			20:39	arrive depart	07:22			Amsterdam
	23m						23m	
Utrecht		5m	20:16 20:11	depart arrive arrive depart	07:45 07:50	5m		Utrecht
	1h 31m						1h 31m	
Düsseldorf		5m	18:40 18:35	depart arrive arrive depart	09:21 09:26	5m		Düsseldorf
	19m						19m	
Köln		5m	18:16 18:11	depart arrive arrive depart	09:45 09:50	5m		Köln
	54m						54m	
Frankfurt		10m	17:17 17:07	depart arrive arrive depart	10:44 10:54	10m		Frankfurt
	28m						28m	
Mannheim		5m	16:39 16:34	depart arrive arrive depart	11:22 11:27	5m		Mannheim
	22m						22m	
Karlsruhe		5m	16:12 16:07	depart arrive arrive depart	11:49 11:54	5m		Karlsruhe
	1h 29m						1h 29m	
Basel		10m	14:38 14:28	depart arrive arrive depart	13:23 13:33	10m		Basel
	54m						53m	
Zurich		9m	13:34 13:25	depart arrive arrive depart	14:26 14:33	7m		Zurich
	1h 53m						1h 55m	
Lugano		5m	11:32 11:27	depart arrive arrive depart	16:28 16:33	5m		Lugano
	58m						58m	
Milano		10m	10:29 10:19	depart arrive arrive depart	17:31 17:41	10m		Milano
	1h 22m						1h 22m	
Genova		10m	08:57 08:47	depart arrive arrive depart	19:03 19:13	10m		Genova
	1h 24m						1h 24m	
Ventimiglia	11h 57m	101.9 km/h	07:23	depart arrive	20:37	101.9 km/h	11h 58m	Ventimiglia
TOTAL	13h 16m	1h 19m	-22.6%		-37.6%	1h 17m	13h 15m	TOTAL

Table 38 Corridor 7: Optimised Future Timetable

Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				1350 km				
Amsterdam			20:01	arrive depart	06:59			Amsterdam
	23m						23m	
Utrecht		5m	19:38 19:33	depart arrive arrive depart	07:22 07:27	5m		Utrecht
	1h 31m						1h 31m	
Düsseldorf		5m	18:02 17:57	depart arrive arrive depart	08:58 09:03	5m		Düsseldorf
	19m						19m	
Köln		5m	17:38 17:33	depart arrive arrive depart	09:22 09:27	5m		Köln
	54m						54m	
Frankfurt		10m	16:39 16:29	depart arrive arrive depart	10:21 10:31	10m		Frankfurt
	28m						28m	
Mannheim		5m	16:01 15:56	depart arrive arrive depart	10:59 11:04	5m		Mannheim
	22m						22m	
Karlsruhe		5m	15:34 15:29	depart arrive arrive depart	11:26 11:31	5m		Karlsruhe
	1h 22m						1h 22m	
Basel		10m	14:07 13:57	depart arrive arrive depart	12:53 13:03	10m		Basel
	53m						53m	
Zurich		7m	13:04 12:57	depart arrive arrive depart	13:56 14:03	7m		Zurich
	1h 41m						1h 41m	
Lugano		5m	11:16 11:11	depart arrive arrive depart	15:44 15:49	5m		Lugano
	58m						58m	
Milano		10m	10:13 10:03	depart arrive arrive depart	16:47 16:57	10m		Milano
	1h 5m						1h 5m	
Genova		10m	08:58 08:48	depart arrive arrive depart	18:02 18:12	10m		Genova
	1h 24m						1h 24m	
Ventimiglia		107.0 km/h	07:24	depart arrive	19:36	107.0 km/h		Ventimiglia
	11h 20m						11h 20m	
TOTAL	12h 37m	1h 17m	-26.4%		-40.5%	1h 17m	12h 37m	TOTAL

Table 39 Corridor 8: Current Timetable

Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				1750 km				
Ventimiglia			20:41	arrive depart	05:46			Ventimiglia
	51m						55m	
Nice		14m	19:50 19:36	depart arrive arrive depart	06:41 07:00	19m		Nice
	2h 41m						2h 32m	
Marseille		1h 51m	16:55 15:04	depart arrive arrive depart	09:32 09:46	14m		Marseille
	1h 58m						1h 40m	
Lyon		10m	13:06 12:56	depart arrive arrive depart	11:26 11:38	12m		Lyon
	2h 58m						3h 16m	
Mulhouse		3m	09:58 09:55	depart arrive arrive depart	14:54 14:58	4m		Mulhouse
	51m						56m	
Strasbourg		7m	09:04 08:57	depart arrive arrive depart	15:54 16:49	55m		Strasbourg
	47m						1h 46m	
Metz		5m	08:10 08:05	depart arrive arrive depart	18:35 19:10	35m		Metz
	41m						42m	
Luxembourg		7h 35m	07:24 23:49	depart arrive arrive depart	19:52 20:11	19m		Luxembourg
	3h 16m						3h 17m	
Brussel		25m	20:33 20:08	depart arrive arrive depart	23:28 05:45	6h 17m		Brussel
	1h 57m						2h 50m	
Amsterdam	16h 0m	66.0 km/h	18:11	depart arrive	08:35	65.3 km/h	17h 54m	Amsterdam
TOTAL	1d 2h 30m	10h 30m				8h 55m	1d 2h 49m	TOTAL

Table 40 Corridor 8: Optimised Timetable

Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				1750 km				
Ventimiglia			20:46	arrive depart	07:00			Ventimiglia
	30m						30m	
Nice		5m	20:16 20:11	depart arrive arrive depart	07:30 07:35	5m		Nice
	2h 7m						2h 7m	
Marseille		10m	18:04 17:54	depart arrive arrive depart	09:42 09:52	10m		Marseille
	1h 26m						1h 26m	
Lyon		5m	16:28 16:23	depart arrive arrive depart	11:18 11:23	5m		Lyon
	2h 22m						2h 22m	
Mulhouse		10m	14:01 13:51	depart arrive arrive depart	13:45 13:55	10m		Mulhouse
	43m						43m	
Strasbourg		5m	13:08 13:03	depart arrive arrive depart	14:38 14:43	5m		Strasbourg
	47m						47m	
Metz		5m	12:16 12:11	depart arrive arrive depart	15:30 15:35	5m		Metz
	32m						32m	
Luxembourg		10m	11:39 11:29	depart arrive arrive depart	16:07 16:17	10m		Luxembourg
	2h 41m						2h 41m	
Brussel		10m	08:48 08:38	depart arrive arrive depart	18:58 19:08	10m		Brussel
	1h 38m						1h 38m	
Amsterdam		127.1 km/h	07:00	depart arrive	20:46	127.1 km/h		Amsterdam
	12h 46m		-48.1%		-48.7%		12h 46m	
TOTAL	13h 46m	1h 0m				1h 0m	13h 46m	TOTAL

Table 41 Corridor 8: Optimised Future Timetable

Station	Travel Time	Dwell Time	Timings	Length		Timings	Dwell Time	Travel Time	Station
				1700 km					
Ventimiglia			18:56	arrive	depart	07:00			Ventimiglia
	30m							30m	
Nice		5m	18:26 18:21	depart arrive	arrive depart	07:30 07:35	5m		Nice
	1h 10m							1h 10m	
Marseille		10m	17:11 17:01	depart arrive	arrive depart	08:45 08:55	10m		Marseille
	1h 26m							1h 26m	
Lyon		5m	15:35 15:30	depart arrive	arrive depart	10:21 10:26	5m		Lyon
	1h 35m							1h 35m	
Mulhouse		10m	13:55 13:45	depart arrive	arrive depart	12:01 12:11	10m		Mulhouse
	43m							43m	
Strasbourg		5m	13:02 12:57	depart arrive	arrive depart	12:54 12:59	5m		Strasbourg
	47m							47m	
Metz		5m	12:10 12:05	depart arrive	arrive depart	13:46 13:51	5m		Metz
	32m							32m	
Luxembourg		10m	11:33 11:23	depart arrive	arrive depart	14:23 14:33	10m		Luxembourg
	2h 35m							2h 35m	
Brussel		10m	08:48 08:38	depart arrive	arrive depart	17:08 17:18	10m		Brussel
	1h 38m							1h 38m	
Amsterdam		142.5 km/h	07:00	depart	arrive	18:56	142.5 km/h		Amsterdam
	10h 56m		-55.0%			-55.5%		10h 56m	
TOTAL	11h 56m	1h 0m					1h 0m	11h 56m	TOTAL

Table 42 Corridor 9: Current Timetable

Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				2100 km				
Paris			20:59	arrive depart	10:04			Paris
	2h 13m						2h 10m	
Bordeaux		6m	18:46 18:40	depart arrive arrive depart	12:14 12:20	6m		Bordeaux
	2h 29m						2h 27m	
Hendaye		2h 19m	16:11 13:52	depart arrive arrive depart	14:47 15:27	40m		Hendaye
	1h 11m						1h 16m	
San Sebastián		6m	12:41 12:35	depart arrive arrive depart	16:43 17:00	17m		San Sebastián
	1h 44m						1h 44m	
Vitoria-Gasteiz		2m	10:51 10:49	depart arrive arrive depart	18:44 18:46	2m		Vitoria-Gasteiz
	1h 30m						1h 30m	
Burgos		2m	09:19 09:17	depart arrive arrive depart	20:16 20:18	2m		Burgos
	55m						46m	
Valladolid		2m	08:22 08:20	depart arrive arrive depart	21:04 21:06	2m		Valladolid
	1h 5m						1h 7m	
Madrid		8h 36m	07:15 22:39	depart arrive arrive depart	22:13 08:30	10h 17m		Madrid
	5h 3m						5h 9m	
Badajoz		10m	17:36 17:26	depart arrive arrive depart	13:39 14:09	30m		Badajoz
	4h 47m						2h 43m	
Lisboa		64.9 km/h	12:39	depart arrive	16:52	68.2 km/h		Lisboa
	20h 57m						18h 52m	
TOTAL	1d 8h 20m	11h 23m				11h 56m	1d 6h 48m	TOTAL

Table 43 Corridor 9: Optimised Timetable

Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				2100 km				
Paris			23:11	arrive depart	07:00			Paris
	2h 3m						2h 3m	
Bordeaux		5m	21:08 21:03	depart arrive arrive depart	09:03 09:08	5m		Bordeaux
	1h 59m						1h 59m	
Hendaye		10m	19:04 18:54	depart arrive arrive depart	11:07 11:17	10m		Hendaye
	25m						25m	
San Sebastián		5m	18:29 18:24	depart arrive arrive depart	11:42 11:47	5m		San Sebastián
	1h 31m						1h 31m	
Vitoria-Gasteiz		5m	16:53 16:48	depart arrive arrive depart	13:18 13:23	5m		Vitoria-Gasteiz
	1h 9m						1h 9m	
Burgos		5m	15:39 15:34	depart arrive arrive depart	14:32 14:37	5m		Burgos
	36m						36m	
Valladolid		5m	14:58 14:53	depart arrive arrive depart	15:13 15:18	5m		Valladolid
	50m						50m	
Madrid		60m	14:03 13:03	depart arrive arrive depart	16:08 17:08	60m		Madrid
	3h 54m						3h 54m	
Badajoz		5m	09:09 09:04	depart arrive arrive depart	21:02 21:07	5m		Badajoz
	3h 4m						3h 4m	
Lisboa		122.2 km/h	05:00	depart arrive	23:11	122.2 km/h		Lisboa
	15h 31m		-46.2%		-44.2%		15h 31m	
TOTAL	17h 11m	1h 40m				1h 40m	17h 11m	TOTAL

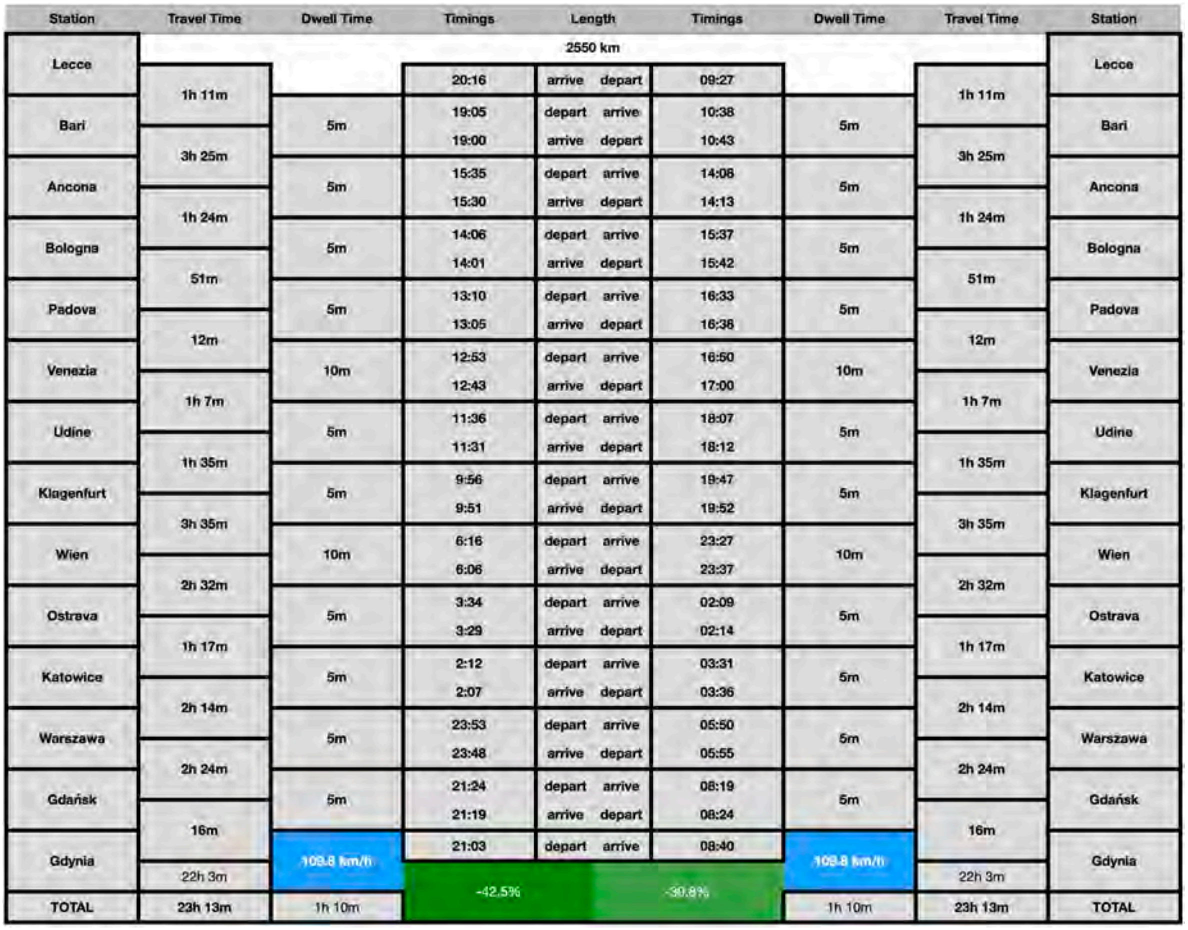
Table 44 Corridor 9: Optimised Future Timetable

Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				1950 km				
Paris			18:46	arrive depart	08:00			Paris
	2h 3m						2h 3m	
Bordeaux		5m	16:43 16:38	depart arrive arrive depart	10:03 10:08	5m		Bordeaux
	1h 17m						1h 17m	
Hendaye		10m	15:21 15:11	depart arrive arrive depart	11:25 11:35	10m		Hendaye
	25m						25m	
San Sebastián		5m	14:46 14:41	depart arrive arrive depart	12:00 12:05	5m		San Sebastián
	34m						34m	
Vitoria-Gasteiz		5m	14:07 14:02	depart arrive arrive depart	12:39 12:44	5m		Vitoria-Gasteiz
	30m						30m	
Burgos		5m	13:32 13:27	depart arrive arrive depart	13:14 13:19	5m		Burgos
	36m						36m	
Valladolid		5m	12:51 12:46	depart arrive arrive depart	13:55 14:00	5m		Valladolid
	50m						50m	
Madrid		60m	11:56 10:56	depart arrive arrive depart	14:50 15:50	60m		Madrid
	2h 31m						2h 31m	
Badajoz		5m	08:25 08:20	depart arrive arrive depart	18:21 18:26	5m		Badajoz
	1h 20m						1h 20m	
Lisboa		165.7 km/h	06:00	depart arrive	18:46	165.7 km/h		Lisboa
	10h 6m		-63.6%		-61.8%		10h 6m	
TOTAL	11h 46m	1h 40m				1h 40m	11h 46m	TOTAL

Table 45 Corridor 10: Current Timetable

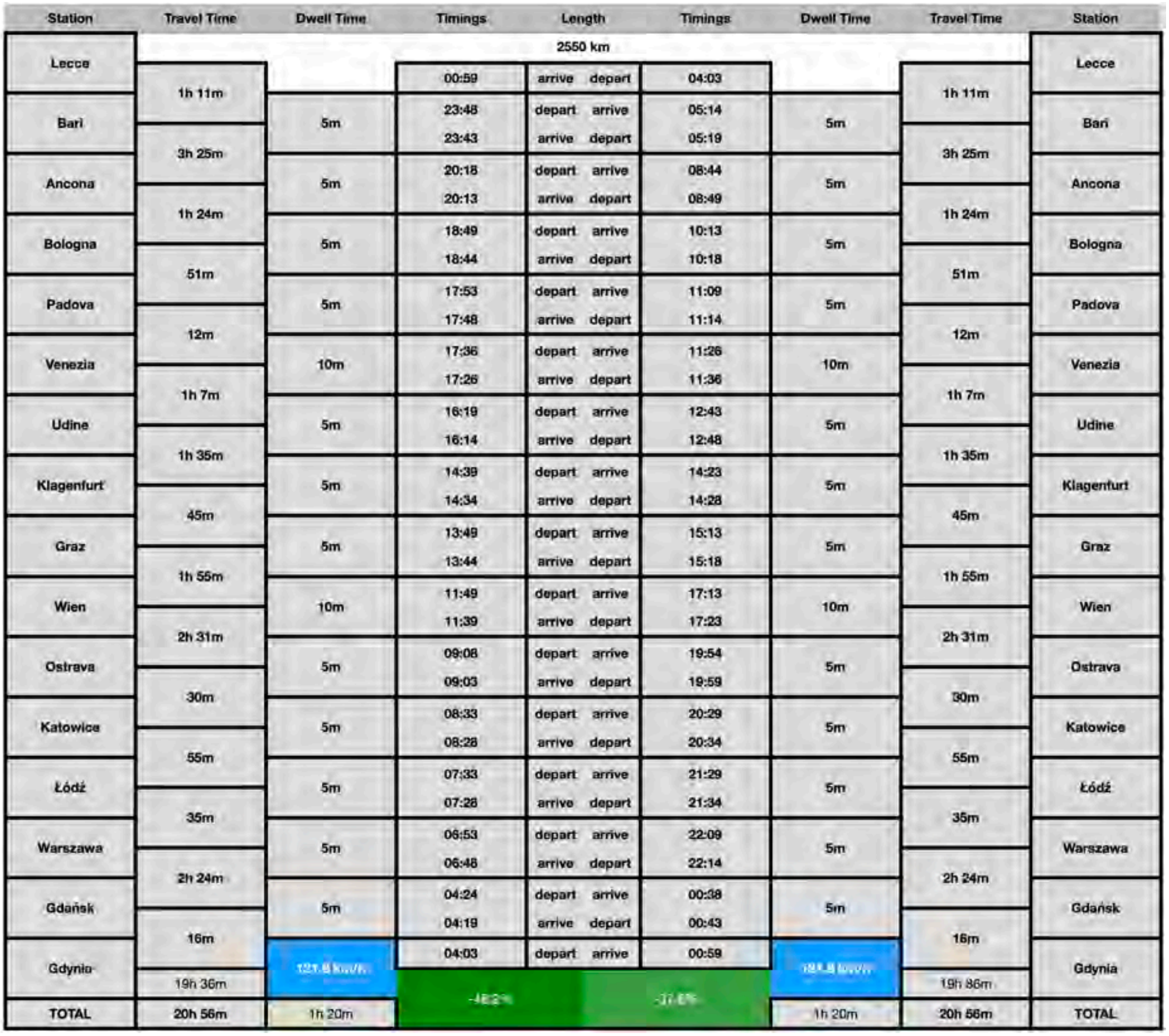
Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				2550 km				
Lecce			15:58	arrive depart	14:17			Lecce
	1h 23m						1h 41m	
Bari		4m	14:35 14:31	depart arrive arrive depart	15:58 16:30	32m		Bari
	3h 57m						3h 52m	
Ancona		3m	10:34 10:31	depart arrive arrive depart	20:22 20:25	3m		Ancona
	1h 46m						1h 50m	
Bologna		3h 6m	08:45 05:39	depart arrive arrive depart	22:15 23:21	1h 6m		Bologna
	5h 1m						5h 17m	
Klagenfurt		5h 19m	23:38 18:19	depart arrive arrive depart	04:38 04:40	2m		Klagenfurt
	3h 55m						6h 14m	
Wien		35m	14:24 13:49	depart arrive arrive depart	10:54 11:10	16m		Wien
	2h 58m						2h 53m	
Ostrava		2m	10:51 10:49	depart arrive arrive depart	14:03 14:05	2m		Ostrava
	1h 49m						2h 31m	
Katowice		5m	09:00 08:55	depart arrive arrive depart	16:36 18:04	1h 28m		Katowice
	2h 51m						2h 25m	
Warszawa		2h 30m	06:04 03:34	depart arrive arrive depart	20:29 20:45	16m		Warszawa
	3h 30m						2h 39m	
Gdańsk		3m	00:04 00:01	depart arrive arrive depart	23:24 23:26	2m		Gdańsk
	26m						24m	
Gdynia		63.1 km/h	23:35	depart arrive	23:50	76.0 km/h		Gdynia
	1d 4h 36m						1d 5h 46m	
TOTAL	1d 16h 23m	11h 47m				3h 47m	1d 9h 33m	TOTAL

Table 46 Corridor 10: Optimised Timetable



Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				2550 km				
Lecce			20:16	arrive depart	09:27			Lecce
	1h 11m						1h 11m	
Bari		5m	19:05 19:00	depart arrive arrive depart	10:38 10:43	5m		Bari
	3h 25m						3h 25m	
Ancona		5m	15:35 15:30	depart arrive arrive depart	14:08 14:13	5m		Ancona
	1h 24m						1h 24m	
Bologna		5m	14:06 14:01	depart arrive arrive depart	15:37 15:42	5m		Bologna
	51m						51m	
Padova		5m	13:10 13:05	depart arrive arrive depart	16:33 16:38	5m		Padova
	12m						12m	
Venezia		10m	12:53 12:43	depart arrive arrive depart	16:50 17:00	10m		Venezia
	1h 7m						1h 7m	
Udine		5m	11:36 11:31	depart arrive arrive depart	18:07 18:12	5m		Udine
	1h 35m						1h 35m	
Klagenfurt		5m	9:56 9:51	depart arrive arrive depart	19:47 19:52	5m		Klagenfurt
	3h 35m						3h 35m	
Wien		10m	6:16 6:06	depart arrive arrive depart	23:27 23:37	10m		Wien
	2h 32m						2h 32m	
Ostrava		5m	3:34 3:29	depart arrive arrive depart	02:09 02:14	5m		Ostrava
	1h 17m						1h 17m	
Katowice		5m	2:12 2:07	depart arrive arrive depart	03:31 03:36	5m		Katowice
	2h 14m						2h 14m	
Warszawa		5m	23:53 23:48	depart arrive arrive depart	05:50 05:55	5m		Warszawa
	2h 24m						2h 24m	
Gdańsk		5m	21:24 21:19	depart arrive arrive depart	08:19 08:24	5m		Gdańsk
	16m						16m	
Gdynia		109.8 km/h	21:03	depart arrive	08:40	109.8 km/h		Gdynia
	22h 3m						22h 3m	
TOTAL	23h 13m	1h 10m	-42.5%		-39.8%	1h 10m	23h 13m	TOTAL

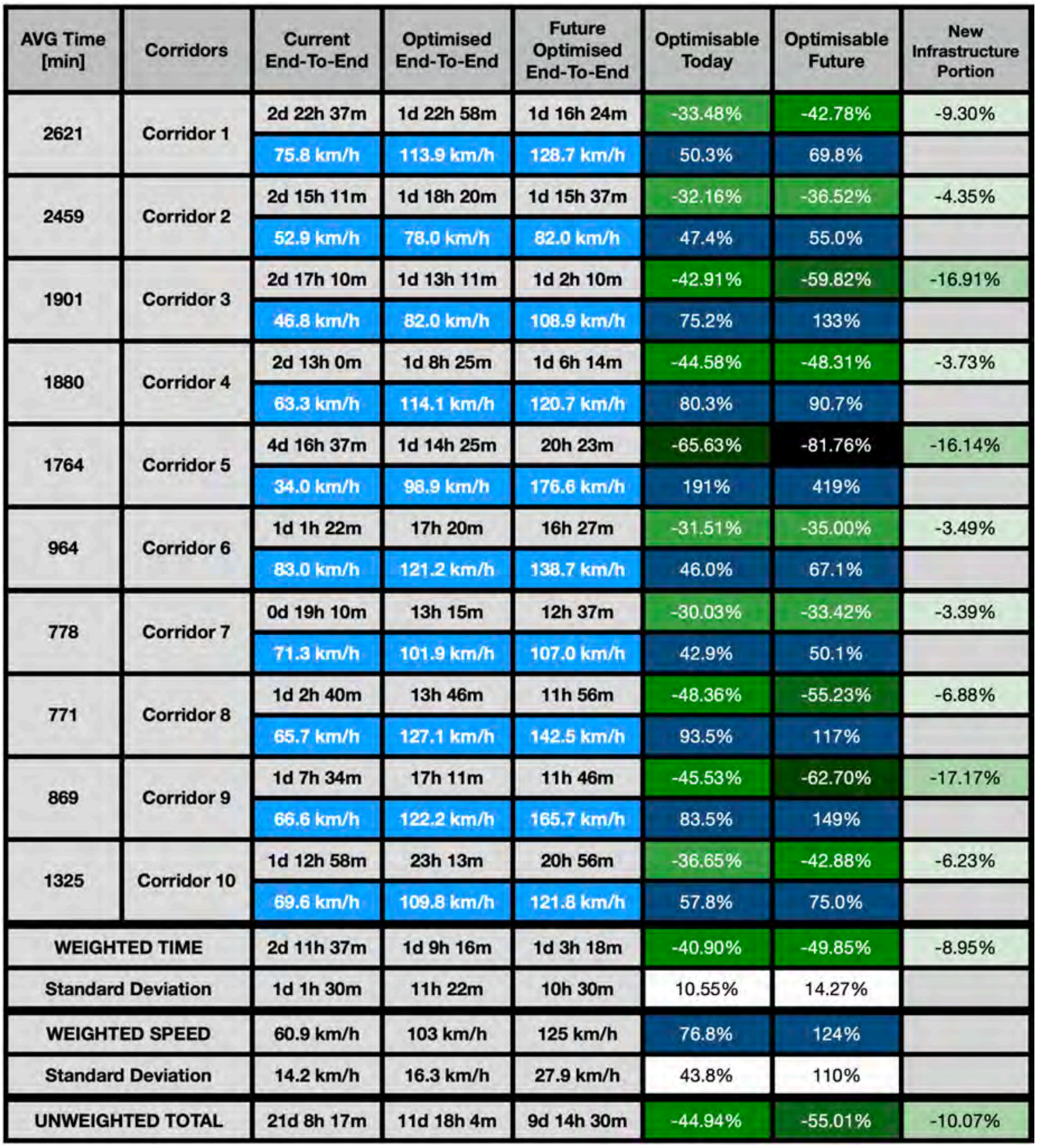
Table 47 Corridor 10: Optimised Future Timetable



Station	Travel Time	Dwell Time	Timings	Length	Timings	Dwell Time	Travel Time	Station
				2550 km				
Lecce			00:59	arrive depart	04:03			Lecce
	1h 11m						1h 11m	
Bari		5m	23:48 23:43	depart arrive arrive depart	05:14 05:19	5m		Bari
	3h 25m						3h 25m	
Ancona		5m	20:18 20:13	depart arrive arrive depart	08:44 08:49	5m		Ancona
	1h 24m						1h 24m	
Bologna		5m	18:49 18:44	depart arrive arrive depart	10:13 10:18	5m		Bologna
	51m						51m	
Padova		5m	17:53 17:48	depart arrive arrive depart	11:09 11:14	5m		Padova
	12m						12m	
Venezia		10m	17:36 17:26	depart arrive arrive depart	11:26 11:36	10m		Venezia
	1h 7m						1h 7m	
Udine		5m	16:19 16:14	depart arrive arrive depart	12:43 12:48	5m		Udine
	1h 35m						1h 35m	
Klagenfurt		5m	14:39 14:34	depart arrive arrive depart	14:23 14:28	5m		Klagenfurt
	45m						45m	
Graz		5m	13:49 13:44	depart arrive arrive depart	15:13 15:18	5m		Graz
	1h 55m						1h 55m	
Wien		10m	11:49 11:39	depart arrive arrive depart	17:13 17:23	10m		Wien
	2h 31m						2h 31m	
Ostrava		5m	09:08 09:03	depart arrive arrive depart	19:54 19:59	5m		Ostrava
	30m						30m	
Katowice		5m	08:33 08:28	depart arrive arrive depart	20:29 20:34	5m		Katowice
	55m						55m	
Łódź		5m	07:33 07:28	depart arrive arrive depart	21:29 21:34	5m		Łódź
	35m						35m	
Warszawa		5m	06:53 06:48	depart arrive arrive depart	22:09 22:14	5m		Warszawa
	2h 24m						2h 24m	
Gdańsk		5m	04:24 04:19	depart arrive arrive depart	00:38 00:43	5m		Gdańsk
	16m						16m	
Gdynia		121.8 km/h	04:03	depart arrive	00:59	[illegible]		Gdynia
	19h 36m		[illegible]		[illegible]		19h 36m	
TOTAL	20h 56m	1h 20m				1h 20m	20h 56m	TOTAL

2.4. Corridor Timetable Results

Table 10.2 Potential end-to-end travel time and average speed improvement for each corridor



AVG Time [min]	Corridors	Current End-To-End	Optimised End-To-End	Future Optimised End-To-End	Optimisable Today	Optimisable Future	New Infrastructure Portion
2621	Corridor 1	2d 22h 37m	1d 22h 58m	1d 16h 24m	-33.48%	-42.78%	-9.30%
		75.8 km/h	113.9 km/h	128.7 km/h	50.3%	69.8%	
2459	Corridor 2	2d 15h 11m	1d 18h 20m	1d 15h 37m	-32.16%	-36.52%	-4.35%
		52.9 km/h	78.0 km/h	82.0 km/h	47.4%	55.0%	
1901	Corridor 3	2d 17h 10m	1d 13h 11m	1d 2h 10m	-42.91%	-59.82%	-16.91%
		46.8 km/h	82.0 km/h	108.9 km/h	75.2%	133%	
1880	Corridor 4	2d 13h 0m	1d 8h 25m	1d 6h 14m	-44.58%	-48.31%	-3.73%
		63.3 km/h	114.1 km/h	120.7 km/h	80.3%	90.7%	
1764	Corridor 5	4d 16h 37m	1d 14h 25m	20h 23m	-65.63%	-81.76%	-16.14%
		34.0 km/h	98.9 km/h	176.6 km/h	191%	419%	
964	Corridor 6	1d 1h 22m	17h 20m	16h 27m	-31.51%	-35.00%	-3.49%
		83.0 km/h	121.2 km/h	138.7 km/h	46.0%	67.1%	
778	Corridor 7	0d 19h 10m	13h 15m	12h 37m	-30.03%	-33.42%	-3.39%
		71.3 km/h	101.9 km/h	107.0 km/h	42.9%	50.1%	
771	Corridor 8	1d 2h 40m	13h 46m	11h 56m	-48.36%	-55.23%	-6.88%
		65.7 km/h	127.1 km/h	142.5 km/h	93.5%	117%	
869	Corridor 9	1d 7h 34m	17h 11m	11h 46m	-45.53%	-62.70%	-17.17%
		66.6 km/h	122.2 km/h	165.7 km/h	83.5%	149%	
1325	Corridor 10	1d 12h 58m	23h 13m	20h 56m	-36.65%	-42.88%	-6.23%
		69.6 km/h	109.8 km/h	121.8 km/h	57.8%	75.0%	
WEIGHTED TIME		2d 11h 37m	1d 9h 16m	1d 3h 18m	-40.90%	-49.85%	-8.95%
Standard Deviation		1d 1h 30m	11h 22m	10h 30m	10.55%	14.27%	
WEIGHTED SPEED		60.9 km/h	103 km/h	125 km/h	76.8%	124%	
Standard Deviation		14.2 km/h	16.3 km/h	27.9 km/h	43.8%	110%	
UNWEIGHTED TOTAL		21d 8h 17m	11d 18h 4m	9d 14h 30m	-44.94%	-55.01%	-10.07%