

## Progress towards Federated Logistics through the Integration of TEN-T into A Global Trade Network

### D1.1 EGTN Foundational Position Papers and Simulation Scenarios

#### Document Summary Information

<b>Grant Agreement No</b>	860274	<b>Acronym</b>	PLANET
<b>Full Title</b>	<u>Progress towards Federated Logistics through the Integration of TEN-T into A Global Trade Network.</u>		
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<b>Work Package</b>	WP1		
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<b>Lead Beneficiary</b>	ITAINNOVA		
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0.2	09-04-2021	25%	PP1	<i>Maurice Jansen Niels van Saase</i>
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### Foundational Position Papers

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### Simulation scenarios

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0& 87!R!Critical uncertainties!#####NC!  
0& 87!\$J!Scenario demand variations!#####NO!  
0& 87!\$S!Scenario supply variations!#####NN!

0&; 87!\$ "" Scenario Technology variations ##### NS!  
 0&; 87!\$ CM Scenario parameters ##### INR!  
 0&; 87!\$ OW Consolidated KPI s ##### S\$!

## Glossary of terms and abbreviations used

Abbreviation / Term	Description
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/D0. !!	M)37*:837=!D:77)!/`ED8?; &0!P,!. 73<?:V!!
D-!!	D:&)=!-*:77F7)3!!
MQO!	M)G?:F&3(?)!&=!A?FF2)(A&3(?)4!37AK)?&?*T!
MD14!	M)37: *?97: )F7)3&8!1: *&)(a&3(?)4!!
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M?0!	M)37: )73!?G!OK() *4!
M@0!	M)8&)=!b&37:<&T!0:&)4' ?:3!
\+M!	\7T!+7:G?:F&)A7!M)=7U!!
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@1/4!	@3&37!1<)7=!/)37:':(474!
0/. EO!!	0:&)4E/2:?' 7&)!0:&)4' ?:3&3(?)!. 73<?:V!!
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` MQ!	M)37: )&3(?)&&2)(?)!?G:&(&<&T4!

# 1 Executive Summary

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## 2 Introduction

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## A

The purpose of this section is to map PLANET's Grant Agreement commitments both within the formal Deliverable and Task description against the project's respective outputs and work performed

Table 1: Adherence to PLANET's GA Deliverable &amp; Tasks Descriptions

PLANET GA Component Title	PLANET GA Component Outline	Respective Document Chapter(s)	Justification
<b>DELIVERABLE</b>			
D1.1 EGTN Foundational Position Papers and Simulation Scenarios	Four position papers consolidating an initial view of EGTN and a set of associated simulation scenarios and target improvement KPIs. Final Version enhanced based on LL feedback M26.	Chapter 3	Chapter 3 has a summary of the four position papers.
<b>SUBTASKS</b>			
<b>ST1.1.1 EGTN Foundational Position Papers</b>	This subtask will provide a compendium of research and study results (position papers) on month 2, consolidating an initial view of EGTN, focusing on the following issues (1) Geo-economics impact of new trade routes for Europe; (2) New trade routes' impact on TEN-T Corridors and nodes; (3) Interconnection issues of railway transport-corridors to/from Europe; (4) Transition towards the	Chapter 3	Chapter 3 has a summary of the four position papers.

	Physical Internet paradigm. The intention is to publish this compendium in month 2, update it in month 12, and publish it as a book towards the end of the project in month 30 with all additional related project results included.		
<b>ST1.1.2</b> <b>Simulation scenarios</b>	This subtask will be responsible for Scenario Building to be used in Tasks 1.2 (physical flows simulation), and 1.4 (new technologies simulation). The scenarios will be based on the LL requirements and the results obtained through the Foundational Position Papers.	Chapter 4	Chapter 4 defines scenarios from Position Paper.
	Scenario analysis will use long-term demand forecasting. analysis and selection of technological alternatives; assessment of new transport infrastructure requirements; strategic, non-monetary factors, plus robustness and feasibility for each scenario.	Chapter 4.5	Chapter 4.5 identifies the key variables and levels for the scenarios.
	The scenarios will incorporate the targeted KPI improvements for transport cost, reliability, and emissions.	Chapter 4.6	Chapter 4.6 describes the main indicators.

!

OK7!A?)37)3! ?G!3K(4!=?A2F7)3!(4!43:2A32:7!=()!N!AK&'37:4#!OK&'37:4!\$!A?)3&()4!3K7!7U7A23(97!42FF&:T! ?G!3K7!=?A2F7)3#!QK&'37:!"!A?)3&()4!3K7!()3:?=2A3(?)!?G!3K7!=?A2F7)3!&=!()=(A&374!3K7!:78&3(?)!?G!3K7!=?A2F7)3!3?!=3K7!':?c7A3!:742834!QK&'37:!C!A?)3&()4!&=74A:('3(?)!?G!3K7!F&()!&4'7A34!?G!3K7!'?4(3(?)!'&'7:4#!-3!3K7!7)=!3K7:7!(4!&47A3(?)!HC#N!A?)3&() \*!&A?)4?8(=&37!=9(7<!?G!3K7!G?2:!'&'7:4#!QK&'37:!:0!A?)3&()4!3K7!=74A:('3(?)!?G!3K7!4A7)&:(?4!A?)4(=7:7!=@7A3(?)!0#N!A?)3&()4!3K7!A?)4?8(=&37!=7G()3(?)!?G!3K7!4A7)&:(?4!A?)=!47A3(?)!0#S!3K7!A?)4?8(=&37!=!()=(A&3?:4#!QK&'37:!:N!A?)3&()4!3K7!A?)A824(?)4!&=!3K7!=7G()3(?)!?G!3K7!)7U3!437'4!&=!QK&'37:!:S!3K7!;();8?\*:&K(A!:7G7:7)A74#!OK7!G28!=?A2F7)3!G?!=7&AK!?G!3K7!'?4(3(?)!'&'7:4!A&)!;7!G?2)=!()!-))7U!\$!?G!3K(4!=?A2F7)3!!

- ++\$!D7?E7A?)?F(A4!(F'&A3!?)!)7<!3:&=7!:?2374!G?:!2:?'7#
- ++"!!7<!3:&=7!:?2374]!(F'&A3!?)!0/.E0!Q?::(=?4!&)=!)?=74#!
- ++C!W!37:A?) )7A3(?)!(44274!?G!:&(8<&T!3:&)4'?:3EA?::(=?4!3?ZG:?F!/2:?'7#
- ++0!W!0:&)4(3(?)!3?<&:=4!3K7!+KT4(A&8!W!37:)73!'&:&=(\*F#

### 3 Foundational Position Papers

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OK? 9(4(?))! ?G! +, - . /O! (4! 3? &=9&) A7! 3K7! /2:? 7&) !Q?FF(44(?)) J4! 43:&37\*T! G?::!@F&:3! D:77)! &=!M) 37\*: &37!=0:&) 4' ?:3! &)=! , ?\*(43(A4! ; T! 7GG(A7) 38T! () 37:A?)) 7A3() \*! () G:&43:2A32:7! H0/. EO\_ >&(&E^:7(\*K3! Q?::(=?4! <(3K! \*7? ?8(3(A&8! =7978? F7) 34! &4! <78! &4! 3? !? 3(F(47! 3K7! 247! ?G! A2::7) 3! P! 7F7:\*(\*)! 3:&) 4' ?:3! F?=74! &)=! 37AK) ?8?\*(A&8! 4?823(?)) 4\_! <K(87! 7) 42:() \*! 7X2(3& 87! () A824(9(3T! ?G! &8! ' &:3(A(' &) 34\_! () A: 7&4() \*! 3K7! ' :?4! 7:(3T! ?G! ) &3(?)) 4\_! ' :747:9() \*! 3K7! 7) 9(:?) F7) 3\_!&)=!7) K&) A() \*!Q(3(a7) 4!X2&(3T! ?G! 8(G7#!OK7! 7&(a&3(?)) !?G! 3K(4!9(4(?)) !4! <K&3! +, - . /O!A&884!3K7!M) 37\*: &37=ID:77)! /` ED8?; &8!OP,!. 73<?:V!H/D0. I!#1) 7!F&c?::!?: c7A3(97!3K&3!+, - . /O!& ' :?&AK74! (4!3? !&44744!3K7!(F' &A3! ?G! 7F7:\*(\*)! 3:&=7!A?::(=?4!?) !3K7!0/. EO!) 73<?:V!&)=!7) 42:7! 7GG7A3(97!A?)) 7A3(9(3T!&)=! 4243&(& ; (8(3T! ?G! 3K7! /2:? 7&) !D8?; &8!. 73<?:V!#Q: 2A(&8!G? !3K(4!(4!3?!, 7!&<:& 7! ?G! \*7?E7A?) ?F(A!=7978? F7) 34! 3K&3! =:(97! 3K747! 7F7:\*(\*)! 3:&=7! G8? <4!0?&) &8T47! &8!3K747! ?; c7A3(974\_!3K7!G?88? <() \*!: 747&:AK!X2743(?)) 4! &:7! ' ?:? 747=#!

1

! "#"\$%& ' () \* "#+, - . #/((

#\$ What is the relation between geo economics and new trade routes what are the dynamics of these trade routes and how can we measure and monitor the impact on existing TEN T corridors !

"# *What is the impact of new and emerging trade routes What are the underlying trends How can the EU anticipate managing these routes !*

C# *What should future rail developments look like in order to improve the interconnectivity of the European transport network ?*

0# What is the impact of PLANET logistics and transport concepts and technologies such as Synchromodality AI IoT Blockchain as contributing to the PI roadmap on corridor development !

0?!:74' ?)=!3?!3K747!X2743(?)4!G?2!:V7T!+?4(3(?)!+&' 7:4!H++!!K&97!; 77)!=7978?' 7!=!3K&3!&)8&T47!3K7!' :?c7A3e4!  
?; c7A3(974!G:?F!=!(G67:7)3! '?()34!?G!9(7<#!0K7!V7T!' ?4(3(?)!' &' 7:4!A&)!; 7!G?2)=!()!-)) 7U!\$!?G!3K(4!=?A2F7)3#!

## ***Geo-economic developments impacting global corridors for trade (PP1)***

0?!(A?::?&37!3K7!\*7?E7A?)?F(A! 7:4' 7A3(97\_!3K(4!G?2)=&3(?)&! ' 4(3(?)! ' & 7:1!& ' 8(74!3K7!G?88?<() \*!43:2A32:7!3?G()&88T!7)=!2' !&3!3K7!QOM!!^(:43\_!<7!=74A:(; 7!3K7!A?)A7' 34!?G!\*7?' ?8(3(A4!&)=!\*7?E7A?)?F(A4!3K&3!8(7!; &47=?!)!3K(4!& 7:#!b7!()3:?=2A7!4K(G3)\*!3:&=7!&337:)4!3K&3!:&7!788; ?:&37=?!)!G2:3K7:!!&37:#!OK(=:\_!<7!A:7&37!&!!(37:&32:7!:79(7<!3K&3!47:974!&4!&G:&F7<?:V!3K&3!4K?<4!<K&3!(4!&8:7=&T!V)?<)!& ?23!A?::(=?!:A?))7A3(9(3T!:78&37=#!OK7!:7' ?:3!78&: ?:&374!?)!3:&)4' ?:3!)73<?:V4\_!3K7!4787A3(?)!G! ?:34!&)!=F?==&8(3(74!; T!4K(' 7:4\_!A?::(=?!:A?))7A3(9(3T!:4!&!)7<!=GG7:7)3(&3?:\_!&)=!!&438T!3K7!3K:77!F?43!4(\*) (G(A)&3!AK&)\*() \*!3:&=7!G8?<4!&3!3K7!F?F7)3!HL>M! -:A3(A!>?237\_!()A:7&47!()!3:&)4K(' F7)3!K2; 4!()!%7=(37::&)7&)!P!%(&=87!/&43!&)=!M)37:)&3(?)&! . ?:3KE@?23K!0:&=7!Q?::(=?!:HML @OQ1!!^2:3K7!:3?!)3K(4\_!<7!()3:?=2A7!3K7!F?=788()!\*':&A3(A74!3K&3!<(88!3&V7!' 8&A7!3?!)7\*:37!3K7!QOM!!L74(=74!8??V!) \*! ()3?!)3K7! '&43\_!<7!& ' 8T! &! 4A7)&:(?! F73K?=?8!\*T!G?!)3K7!=7978? F7)3! ?G! 0/ . EO!)73<?:V4\_!A?)4(=7:() \*!3K7!F?43!(F' ?:3&)3!G&A3?:4!3K&3!<(88!4K' 7!3K7!G232:7! ?G!3K7!0/ . EO!F!3K?47!<(3K!3K7!K(\*K743!(F' &A3!&)=!2)A7:3&()3T#197:9(7<!?G!3K7!7F7: \*() \*!3:&=7!?:2374!!

*New trade routes' impact on TEN-T Corridors and nodes (PP2)*

OK7!F7:\*()\*)!7<!?:2374!&:7!7U' 7A37!=3?!AK&)\*7!G:7(\*K3!G8?<4!<(3K()!3K7!0/. EO!) 73<?:V!<K(AK!<(88!:74283!()!4797:&!(F' &A34!42AK!&4!3K7! :7442:7!?)!A2::7)3!()G:&43:2A32:7!&)=!3K7!A:7&3(?)!?G; ?3387) 7AV4!3K7!AK&)\*()!\*?G!3K7!(F' ?:3&)A7!?G!)=?74Z8()V4!73A#!+, -. /0!; 78(7974!3K&3!3K7!4797:(3T!?G!3K747!(F' &A34!&)=!3K7!A&'&; (8(3T!?G!4377:()!\*!3K747!G8?<4!3?!)3K7!=74(:7!=A?::(=?:4Z8()V4Z)=?74!<(3K()!3K7!/2?:?7&!)!73<?:V!(4!=7'7)=7)3!?)!3K7!

&9&(8; 87! () 6:&43:2A32:7! &)=! 3K7! (F' 87F7) 3&3(?) ! ?G! () ?9&3(97! 37AK) ?8?\*(A&8! 3??84! <K(AK! A&) 7) K&) A7! 3K7! ?' 7:&3(?) ! ?G! 3K7!) 73<?:V#!OK7!' & 7!:=74A:(; 74!3K7!; ??F! ?G! \*8?; &8!G:7(\*K3!3:&) 4' ?:3&3(?) \_!3K7! \*7?E7A?) ?F(A4! 3:7)=4!&)=!3K7!) 7<!3:&=7!:?2374#!B&84?\*!(974!()=(A&3(?) 4!?) !K?<!3?&=&' 3!3?3K7!) 7<!A(:A2F43&) A74#!

### **Interconnection issues of railway transport-corridors to/from Europe (PP3)**

!M!3K(4!G?2)=&3(?) &8! ?4(3(?) !' 7:\_!3K7!&) &8T4(4!G?A2474!?) !3K7!9&:(?24! ?44( 87!() 37:A?) ) 7A3(?) 4! ?G!3K7! /2:?' 7&) !>&(<&T!. 73<?:V!<(3K!(34!) 7(\*K; 2?:(\*)!A?2) 3:(74!&)=!A?) 3(7) 34!42AK!&4!-4(&!) =!-G:(A#&OK7!; &4(4! ?G!3K(4! !' 7!: (4!H\$!1!3K7!A?) 4?8(=&3(?) !?G!3K7!A?::(=?!:!74A:(' 3(?) 4! ?G! &8!0/. EO!: &(&8<&T!8( 74!&)=!>&(&8! :7(\*K3!Q?::(=?!:!7879&) 3! &4!V7T!g)?=74!G?::!() 37:A?) 3(7) 3&8!3:&) 4' ?:3! <(3K! &G?A24!?) !3K7! /2:&4(&) !A?::(=?!:!4!H! !3K7!A?87A3(?) !?G!; &4(A! () G:&43:2A32:7! &:&F737:4!H42AK!&4!3:&AV!\*&2\*74\_!3?3&8!&=F(44( 87!3:&() !<7(\*K3Z87) \*3K!\_!&U87!8?&=&!) =!3:&) 4' ?:37!=! 9?82F74!&)=!HCl!&) !() 97) 3?:T! ?G!3K7!F &c?:!43&V7K?8=7:4!&)=!() 43(323(?) 4!() 9?897=!() !() 37:A?) 3(7) 3&8!3:&) 4' ?:3!#

### **Transition towards the Physical Internet paradigm (PP4)**

!M! (4! 7U' 7A37!=!3K&3!3K7!) (A:7&47!() !7GG(A(7) AT!&)=! ! :?=2A3(93T! ?G!G:7(\*K3!3:&) 4' ?:3!&)=!8?\*(43(A4! <(88! ; :() \*!3K7! 4&9! \*4!&)=!9&827!) 77=7=3?7!7) & 87!A?F' &) (74!3? !' &T!G?:!3K7!; 7X2(:7!=&4473!3:&) 4(3(?) H#\_!3?<&:=4!3K7! \*:77) () \*! ?G! &8!3:&) 4' ?:3! &44734!#h73\_!8?\*(43(A4!) 73<?:V4!&:7!43(88!K(\*K8T!G:&\*F7) 37=\_!F&() 8T!=7=(A&37!=3?&!A?F' &) T!?:!& 4' 7A(G(A!F:&V73\_!4!':?F?37=!:T!3K7!42' ' 8T!AK(&) !A?) A7! 3!&)=!97:3(A&8!A??:=() &3(?) #!OK7!+KT4(A&8!M) 37:) 73H!+M!(! A?) 4(=7:7!=3?; 7!3K7!9(4(?) &:T! !:&=(\*F!42' ' 8T() \*!&!) 37\*:37!=!&':?&AK!3?&=:=744!8?\*(43(A4!) 37\*:3(?) !&)=! A?&8!; ?:&3(?) !(44274!&)=!3? !' &97!3K7!:?&=!G?:<&:=!3?!=7' 8T() \*!7GG(A(7) 3!42' ' 8T!AK(&) 4#!OK7!+M(4!&!\*&F7EAK&)\*() \*! 9(4?) !3K&3!A&247!=&\*(3&3(?) !() !3K7!8?\*(43(A4!) =243:T#!=9&) A7!=! (8?3!(F' 87F7) 3&3(?) 4! ?G!3K7!+KT4(A&8!M) 37:) 73! A?) A7! 3! &:7! 7U' 7A37!=3?; 7! ?' 7:&3(?) &8! &=!A?F F?) !() =243:T! !:&A3(A7! ; T! "JCJ!A?) 3:(; 23) \*!3?&!CJ! ! :7=2A3(?) !() !A?) \*743(?) !\_!F(44(?) 4!&)=!7) 7: \*T!A?) 42F' 3(?) !G?:F!3K7!3:&) 4' ?:3!47A3?:#

The following sections to summarize the main results and conclusions of the Position Papers produced in the project available in Annex of this document

bK7:7&4!3K7!A?88& 47! ?G!3K7!M? ) !Q2:3&() !() !\$RBR!&)=! 3K7!:72)(6(A&3(?) !?G!3K7!3<?!D7:F&)(74!) !\$RRJ!&:7!F&:V7!=&4!3K7!F?43!4(\*)(G(A&) 3!F?F7) 34! ?G!3K7!47A?) =!K&8! ?G!3K7! "J<sup>th</sup> A7) 32:T\_!3K7!7) 3:T! ?G!QK() &() 3?3!3K7!b?:8!=0:&=7! 1:\*&)(a&3(?) !4734!3K7!4A7) 7!0? :!3K7! "\$<sup>st</sup> A7) 32:T#!b?:8!=3!&=7!(4!3K7! ?23A?F7! ?G!3K7!6:(7)=8T!:78&3(?) 4!; 73<77) !43&37! \*?97:) F7) 34! <K?7U7:3!3K7(:! ?<7:4! 3K: ?2\*K!() 37:) &3(?) &8! (43(323(?) 4!42AK!&4!3K7! ) (37!=!. &3(?) !@7A2:(3T! Q?2) A@! b?:8!=! L&V\_! M) 37:) &3(?) &8! %?) 73:&T! ^2)=! b?:8!=! 0:&=7! 1:\*&)(a&3(?) !&)=! F&() T! ?3K7!: (0) 37: \*?97:) F7) 3&8!?:\*&)(a&3(?) 4!HMD14!#OK7! \*7?\*:& K(A&8!=(F7) 4(?) !?G! ?<7:<K(AK!(4!A?) A7:) 7!=<(3K!(0) 37:) &3(?) &8! :78&3(?) 4!&)=!0! !:&3(A2&:&3K7! \*7?43:&37\*(A!A?) A7:) 4! ?G!F &c?:! ?<7:4!(4! <K&3! <7!:767:13?&4! \*7? ' ?83(A4#!OK7!() G827) A7! ?G! 3K747! <?8!=! ?<7:4!K&4!A?F7!3? !42:6&A7!() !F&) T! <&T4! ?97:3K7! &43!=7A&=74M<&:4!:7\*(F7!AK&)\*74!: (9&8:T! ?97!:74?2:A74\_! ?(8!A:(474#!M) 3K7! ?43EA?8!=&:7:&! \*7? ' ?83(A4!K&97!; 7A?F7!F?:7!=(' 8?F&3(A!&)=!7A?) ?F(A&8!T! ?7:&3(?) &8!a7=#D7?43:&37\*(A!A?) A7:) 4! :78&37! 3? =?F() &A7! ?97!:4A&:A7!:74?2:A74!H?(!&)=! \*4! ' :7A(:24! F73&84!\_88)=!G?:&\*:(A2832:7\_! 37AK) ?8?\*T\_! &=! &AA744! 3? !F&:V734! b?:8!=3:&=7! &=! &AA744! 3? !3:&=7! ; 8?AV4! &=! : (9&8:T! G?:& (0) G:&43:2A32:7!f! ; 3K!3:&) 4' ?:3! &4! <7:88!&4! (0) G?:F &3(?) !37AK) ?8?\*T! (0) G:&43:2A32:7!E! (4! 43(88! =?F() &37!=! ; T! 3K747! ' ?43EbbMMD14\_! <(3K!3K7! ) (37!=! @3&374! ?G! -F7:(A&!OK() &\_!>244(&) ^7=7:&3(?) !^:&) A7!&)=! 3 K 7 ! ) (37!=! \() \*=?F!&4!3K7!43:?) \*743! ?<7:4!#

. ?<&=&T4\_! F283() &3(?) &&A?F' &) (74!&4! <788!&4! @3&37! 1<) 7!=! /) 37: ' :(474!H@1/4!247!3K7!2) 7X2&8!87978! ' &T() \*! G(78!=3?3K7(:! &=9!) 3&\*7#Q?) 47X27) 3(&&T\_! F283() &3(?) &8!H%. Q4! !473!2' !F&) 2&A32:() \*!G&A@3(74!() !8?<E<&\*7! A?2) 3:(74!\_!4?2\*K3!3:&U!K&97!) 4!&)=!&9?(&=7!=! 7\*28&3(?) 4! <K7:7! ?44( 87!#[(A7!97:4&\_!3K747!%. Q4!&)=!@1/4!&:7!&84? 247!=! ; T! \*?97:) F7) 34!3?7U7:A(47! ?<7:7(3K7!3?!) :?37A3!?:! :?9(=7!F2AKE) 77=7!=74?2:A74#!M!(4!3K7!() 37: ' &T!

?G!()37:)&3(?)&!7A?)?F(A4\_!\*7?'?8(3(A4\_!&)=!A?F'&)T!43:&37\*T!<K&3!7U'&()4!K?<!3:&=()!\*!7&3(?)4K('4!&:7!4K'&7=#!

### 3.1.1 Trade patterns are shifting

1) !&!\*8?;&&4A&87\_3:&=7!&337:4!&7!4K(G3()\*#OK747!&=7!&337:)4!&7!=:(97)!T!\*&97: F7)34!2:42()\*&87:)&3(97!4K('()!\*!2374\_!7(3K7!&9(&8:7E4A&87!()G:&43:2A32:7!:&?c7A34!&:&?&=!?:!9(&13K7!&7)()!\*!G!)&32:&&47&!:2374!<K(AK!&7!;7A?F()!\*?':?32)7!=27!3?13K7!<&:F()!\*A&(F&37!&)=!3K7!42;47X27)3!F783()!\*?G!3K7!&:A3(A!<&37:4!()!42FF7:#^?/:2/?7!3!(4!(F'?:3&)3!3?A?F':7K7)=!3K7!7F7:\*(0!\*3:&=7!:&2374\_!3K7!-:A3(A!@7!&:2374\_!QK()&4!L783!&)=!>?&=!M(3(&3(97!&)=!3K7!:(47!?G!%7=(37:&)7&)!'?:34!HF&()8T!;7A&247!?G!3:&)4K('F7)3!&A3(9(3(74!&)=!3K7!H48?<!7F7:7)A7!?G!3K7!M37:)&3(?)&8!.?:3KE@?23K!0:&)4'?:3!Q?::(=?:#!

- OK7!T7:&!J\$C!F:&:V7!=!T7:&!?G!4(\*)(G(A&)3!AK)&7!<(3K!3K7!&))?2)A7!=!79(9&8!?G!3K7!&)A(7)3!@8V!>?&=\_!<K(AK!K&4!;7A?F7!V)?<)!&4!3K7!L783!&)=!>?&=!M(3(&3(97!H>M!\_A?)7A3()!\*QK()&3?!=!2/?7!T!;T!8&)=!47&!9(&1;7337:E A?))7A37!=!':?34!&)=!()&43:2A32:7!OK()747!&A3(97!':?F?3(?)!?G!?97:47&4!()G:&43:2A32:7!=7978?'F7)3! \*?74!K&)=!()!K&)=!<(3K!3K7!<743<&:!=4K(G3!G:&F!QK()&3?!)=243:(&8!':?2A3(?)!<(3K!3K7!&(F!3?!=7978?'!3K7!8744!=7978?'7!=<7437:)!'&:3!?G!QK()&1&)=!A?)7A3!3?!(?)37:)&3(?)&8!3:&=()!\*1)73<?:V4!F&()8T!?97:18&)=!;T!:&#!
- OK7!:47!?G!%7=(37:&)7&)!'?:34!()=(A&374!&)?3K7!:4K(G3!()!3:&=7!&337:)4#&+?:34!?)!3K7!/&43!A?&43!?G!.?3K!-F7:(A&I&7!&8:7&=T!<(3)744()&1F?7!G:7X27)3!A&84!?G!4K('4G:&F!%7=(37:&)7&)!K2;!?:34!42AK!&4!-8\*7A(&4!&)=!0&)\*(7:4\_3K7:7;T!A?))7A3()!\*Q&)&=&3?13K7!%(&=87!/&43!M)=(&\_!+&V(43&)\_!-G:(A&\_&)=!3K7!&:1&/&43#!
- OK7!3K(:!=4K(G3!()!3:&=7!&337:)4!F&T!A?F7!G:&F!\*&8?;&8!<&:F()\*&#-4!3K7!(A7!A?97:()!3K7!&:A3(A!(4!4(\*)G(A&)38T!7=2A7!=!;?3K!\*&97:)F7)34!&4!<788!&4!A?F'&)(74!32:)!3K7!3K:7&3!()3?!)!?'':?32)(3T#OK7!':&44&\*7H4!9(&13K7!'.?:3K!A?28!=4&97!2'!3?!)OJ1!?G!3K7!=!(43&)A7!3:&97887!=!;73<77)!j&!)&)=!>?337:=&F!\_A?F'&:7!=!3?13K7!3:&=(3(?)&8!:?237!9(&13K7!@27a!Q&)&8!M!7F&()4!T73!3?;7!477)!<K73K7!:&!)!?'7)!47&!:?237!<(8!A?F7!&4!&9(&87!&87:)&3(97!A?)4(=7:()!\*3K&3!>244(&1F(\*K3!<&)3!3?!(F'&47!AK&:&74!G?&1&4&G7!&)=!?'7)!1&44&\*7!-84?\_!3K7!=2:&3(?)!?G!3K7!g(A7E!G:77)!47&4?!)!4!4?F73K()!\*A&:&?!)<7:4!<28!=<&)3!3?!)A?)4(=7:1<K7)!AK??4()!\*3?!)&8&A7!;??V()\*4!?)!3K7!4AK7=287!=!)?3K7:)!A?))7A3(?)4#!
- OK7!^?2:3K!4K(G3!()!3:&=7!&337:)4\_3K?2\*K!K(\*K8T!2)A7:3&()\_A?F74!G:&F!3K7!&F; (3?)!?G!>244(&1&)=!M=(&3?!)A?)7A3!9(&13K7!.?:3KE@?23K!0:&)4'?:3!Q?::(=?:\_!&F283(F?=&8!)73<?:V!3K&3!A?4474!8&)=!&)=!<37:18&)=!;T'&4474!3K7!@27a!Q&)&8#

### 3.1.2 Belt and Road Initiative

>7\*(?)&8!()37\*:3(?)!;T!F7&)4!?G!7A?)?F(A!A?))7A3(9(3T!&)=!':?8(3(A&8!A?7:&3(?)!4!<K&3!A?)43(32374!3K7!\*7?'?8(3(A&8!9(7<?)!3K7!L783!&)=!>?&=!M(3(&3(97!^?:F()!\*!7&3(?)4!3K:7?2\*K!7A?)?F(A!A?))7A3()4!K&4!()37)=!&)=!2()37)=!&7?':?8(3(A&8!A?)47X27)A74#OK()&!(4!7)&A3()!\*!&7?'?8(3(A&8!A?!=7!3K:7?2\*K!3<()!7A?)?F(A!&)=!':?8(3(A&8!43:&37\*(74!?G!<K(AK!3K7!L>M(4!3K7!A7)3:7'(7A7#OK7!G24()!)?G!7A?)?F(A!&7)AT!3K&3!G?:F4!3K7!L>M<(3K!3K7!&7?'?8(3(A&8!\*&84!?G!QK()&1:7434!?)!3K7!':&A3(A7!&)=!9(4?)!?G!7\*?(&8!)37\*:3(?)!H^8!3!&)=!kK2!"J\$RI#!

OK7!L783!&)=!>?&=!M(3(&3(97!&(F4!3?!)&AK(797!\*:7&37!:7A?)?F(A!()37\*:3(?)!&)=!7978?'F7)3!3K:7?2\*K!;7337!:A?))7A3(9(3T#OK7!L>M!A?)A7'3!':?F?374!A?))7A3(9(3T!&4!3K7!F&()7)&87!:!?G!3:&=7!\*:?<3K!&)=!3:&=7E=:!(97)!':?4'7:(3T#OK(4!A?))7A3(9(3T!A?)4(434!?G!G(97!A?K7:7)3!=!(F7)4(?)4!Hj&A?;4\_!"J\$RI#

- M!G:&43:2A32:&8!A?))7A3(9(3T!M(F'?:?97!3K7!7\*?(&)]4!()G:&43:2A32:7!&)=!23!()!8&A7!&47A2:7!&)=!7GG(A(7)3!

- ) 73<?:V! ?G!&)=!47&\_!&)!=&(:! ' &44&\*74\_!8(G3() \*!3K7(:!A?)) 7A3(9(3T!3?&!K(\*K7!:8797&!G2:3K7!:7) K&)A7!  
3:&=7! &)=!() 9743F7) 3!G&A(8(3&3(?)\_!743&: 8(4K() \*!&) 73<?:V! ?G!G:77!3:&=7!&: 7&4!3K&3!F 773!K(\*K143&)=&:=4#
- 0:&=7!A?)) 7A3(9(3T!3:&=7!A&)!; 7!7) K&)A7!=; ?3K!2' 43:7&F!&4!<788!&4!=?<) 43:7&F!() !3K7!9&827!AK&() #
- ^()&A(&8!A?)) 7A3(9(3T!3:&=7!42:' 824!&G!QK() &!<(3K!3K7!<?:8!=; 742834!()!&: 2)=&)A7!?G!` @!=?88&:4!?)  
3K7! ; &&A7! &AA?2) 3! ?G! QK() &#! M) 9743() \*! () ! () 6:&43:2A32:7! &)=! :7&8! 743&37! ' &:3(A2&:8T! () ! 47A3?;4!  
42' ' ?;3! QK() &4! ' ?4(3?!)!() !3K7!<?:8=#!
- +?8(3(A&! A?)) 7A3(9(3T! &A3(97! =(' 8?F&AT! (4! ; 7() \*! & ' 8(7!=3?&G?437!:A??' 7:&3(?)! &)=! 4(\*)! ; (8&37:&8!  
&\*:77F7) 34!<(3K!A?2) 3:(74#
- Q2832:&8!A?)) 7A3(9(3T!3K:2?\*K! ' :?F?3(?)!?G!V)?<87=\*7!3:&) 467:4! &)=!A2832:&8!7UAK&)\*7!9(&! 7?&87E  
3?E' 7?&87!A?)) 7A3(?) 4!7#\*!432=7) 3!7UAK&)\*7! ' :?\*:;&F4#

OK7!L>M(4!&4?8() V7!=3?&QK() &4!&%&=7!() !QK() &!J"Nm!43:&37\*T!<K7:7() !QK() &!?238() 7!=3?&42' 7:47=7!3K7!` ) (37!=  
@3&374!&)=!j&' &)!4!() =243:(&8!K(\*KE37AK!F&) 2G&A32:7!:!; T!"J"Nm!

OK7! 7U&A3! :?237! 4K?28=!) ?3! ; 7!3&V7)!8(37:&8T#! OK7! 9(4(?) 4! &)=! &A3(?) 4! 6:&F7<?:V! =?A2F7) 3! 42\*\*743! 3K&3!  
G(97! \*7) 7:&8! :?2374! H3K:77! ?97!:8)=! 3<?! ; T! 47&! &: 7! A2:7) 38T! ; 7() \*! A?) 4=7:7!=!H-:(4! "J\$S!# L>M 3&V74!  
&=9& 3&\*7!?G! () 37:)&3(?)&8!3:&4' ?;3! :?2374!&4!<788!&4!A?: 7!A(3(74!3?&G2:3K7!:43:7) \*3K7)!A?88& ; ?:&3(?)#0K7:7!  
&:7! 4(U! () 37:)&3(?)&8! A?::(=?:4! (=7) 3(G(7= M . 7<! /2:&4(&), &)=! L:(=?7\_! QK() &E%?) \*?8&E>244(& /A?) ?F(A!  
A?::(=?:\_!QK() &E! +&V(43&)! /A?) ?F(A! Q?::(=?:\_!QK() &EQ7) 3:&8! &)=! L:7437:)! -4(& /A?) ?F(A! Q?::(=?:\_!QK() &E  
M)=?AK() &+7) () 428&! /A?) ?F(A! Q?::(=?:\_!QK() &EQ7) 3:&8! &)=! L:7437:)! -4(& /A?) ?F(A! Q?::(=?:\_!QK() &E  
>&) \_!&)=!@(A?) \*!"J\$R!#

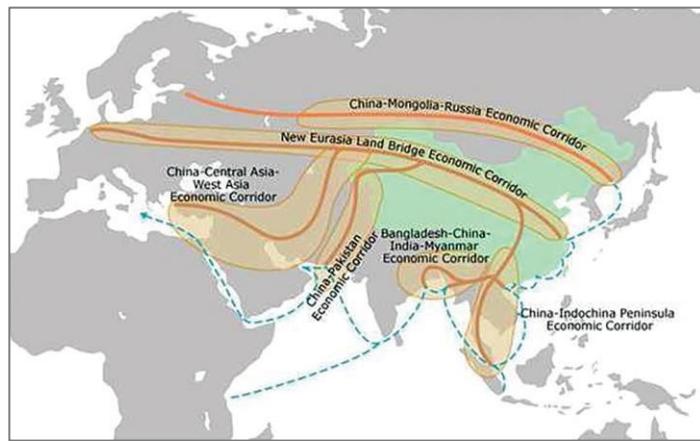


Figure 1: Six economic corridors. Source: [www.china-trade-research.hktdc.com](http://www.china-trade-research.hktdc.com)

OK7!4797)!A?)) 7A3(?) 4!&8?) \*!3K7! /2:&4(&!, &)=!L:(=?7!&: 7!3K7!G?88?<() \* M

Table 2: Details of BRI railway connections

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QK?) *X() *E! 62(4; 2:*	"J\$\$!	\$\$-\$5R!	\$S!=&T4!	6?43TV!H\k!!&)=!L:743! H\h!!	j [!h2U() ?2E0/, !H6L! @AK7)V7:!!
QK?) *=2E, ?=a! , () 7!	"J\$"!	R_RSN!	\$"E\$0!=&T4!	6?43TV!&)=!L:743!H\h!!	6n,! D8?; &8! ^?:<&:=() *!

OK7)*=2E! 0(; 2:!*	"J\$S!	\$\$_JJJ!	\$S!=&T4!	6?43TV!H\k!!&)=!L:743! HLh!!	/87A3:?) (A4W @&F42)*_!678!, D_
kk7)*aK?2	"J\$C!	\$J_"\$0!	\$\$E\$0!=&T4!	E!	6L!@AK7)V7:!
@2aK?2E! b:&4<!	"J\$0!	\$\$_JJ!	\$0!=&T4!	%&&&4Aa7<(Aa7EL:743! k&: &/(V&MV%&)aK?28!	. ?V(&_L?4AK!
h(<2E%&:(:!=	"J\$0!	\$C_JJJ!	"\$!=&T4!	E!	bK?874&87!
o(&)f! n&F; 2:!*	"J\$R!	R_0JJ!	\$J!f!"!=&T4!	%&F?)?9?!!>`IE! L:&)(7<?H+, !!	6n,! D8?; &! ^?:<&:() *!

### 3.1.2.1 Chinese investments in European transport infrastructure

!@()A7!3K7!43&:3!G3K7!"\$st A7)32:T\_IQ1@Q1!@K(' ' () \*!+?:34!&=!QK() &!%7:AK&)34!+?:3!K?8=() \*4!K&97!&AX2(:7=I43&V74!  
()W+?:3!@&(!f!/\*T' 3!Q&4&; 8&)A&!)&=!0&)\*(7:4!f!%?:?AA?\_!%&:4&U8?VV!f!%&83\_![7)(A7!f!MB&8T\_!M3&); 28f!02:V7T\_!  
+(&724\_!&)=!OK744&?) (V!f!D:77A7!L(8; &?\_!&)=! [ &87)A(&f!f@' &!)!%&:47(87\_!. &)374\_!, 7!n&9:7\_!&)=!62)V(:V!f!  
^:)&A7\_!-)3<7: '\_!&)=! K77; :2\*\*7!f!L78\*(2F\_!&)=!>?37:=&F!f!OK7!. 73K7:8&)=4#QK()747!()9743F7)34!()! ?:34!  
?)!3K7!&:37:(74!?G!F&c?:! 3:&=7!?:2374!()=(A&37!3K&3!3:&)4' ?:3!9?82F74!&:7!4K(G3) \*!&4!<788!A&)!&:7&=7!<(3)744!  
3K7!:79(9&!?G! ?:34\_42AK! &4!+(&724!&)=!K77; :2\*\*7#!b77V8T! ?:3!A&84!&:7!&=7=\_!9?82F74!&:7!?)!3K7!:(47!&)=!  
=78(97:7!=!; T!797:E&:&7!4K(' 4#

Table 3: Chinese investments in European ports (China Global Investment Tracker, 2020)

	c					c
2007	China Ocean Shipping (COSCO)	\$140	80%	Burg Industries/ transport equipment	Shipping	The Netherlands, Port region Rotterdam
2008	China Ocean Shipping (COSCO)	\$5.790	51%	Piraeus Port	Shipping	Greece, Port of Piraeus
2010	China Electronics Technology	\$170	-	China Belarus Industrial	Rail	Belarus
2012	Shandong Heavy	\$460	75%	Ferretti / luxury yacht maker	Shipping	Italy, Marina di Pescara
2013	China Merchants	\$530	49%	CMA CGM / Terminal Link	Shipping	France, Port of Dunkirk, HAROPA, port of Marseille, Port of Casablanca, Port of Tangiers, Port of Marsaxlokk
2013	Dalian Wanda	\$500	92%	Sunseeker / yachts building	Shipping	Britain, Port of Southampton
2014	China Communications Construction	\$950		Railway link ilat - Mediterranean	Shipping	Israel, ilat Harbour
2015	China Railway Engineering	\$400		Solel Boneh	Rail	Israel
2015	CSR Corporation	\$190	100%	Specialist Machine Developments	Shipping	Britain

2016	China Communications Construction	\$110		Riga Commercial Port	Shipping	Latvia, Port of Riga
2016	China Ocean Shipping	\$420	67%	Piraeus Port	Shipping	Greece, Port of Piraeus
2016	China Ocean Shipping (COSCO) Qingdao Port Group	\$150	40%	APMT sells off Vado (Genoa) port	Shipping	Italy, Port of Genoa
2016	China Ocean Shipping (COSCO) Qingdao Port Group	\$143	35%	uromax Terminal, CT	Shipping	The Netherlands, Port of Rotterdam
2017	Shenzhen Metro, China Railway Construction	\$170		BOM Metro light rail Tel Aviv	Rail	Israel
2017	China Railway Engineering	\$350		Belgrade-Stara-Pazova section	Rail	Serbia
2017	China Ocean Shipping	\$230	51%	Noatum Ports	Shipping	Spain
2018	China Railway Engineering	\$710			Rail	Israel
2018	China Railway Engineering, China Communications Construction	\$1.090		Novi Sad-Subotica section (Belgrade-Budapest)	Rail	Serbia
2018	CMG	-	11%	CNG terminal	Shipping	Greece, Port of Thessaloniki
2019	China Railway Engineering	-	50%	Opus Global / link Belgrade-Budapest	Rail	Hungary
2019	Sinomach	\$130		Logistics Centre Varna	Shipping	Bulgaria, Port of Varna
2019	China Ocean Shipping (COSCO)	\$670	32%	Piraeus Port	Shipping	Greece, Port of Piraeus

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## Ports

OK7! ?:34!() !3K7!. ?:3K!-=(&3(A!@7&:&7!?)!() 37:743!; 7A&247!?G!3K7!4K?;37:!=(&3(A! A7!G;?F!3K7!^&:!/&43!() 3?!)Q7)3:&8! &)=!/&437:!)!2:?' 7#!OK7! ?:237!G;?F!@K&)\*K&(!3?!. ?:3K!-=(&3(A! (4! "JJJ! F!@74! 4K?;37:!3K&!)!3K7! ?:237!3?!)n&F; 2:!\*!H\?; ?79(A! 2:378&\_!P! [2c(A(A!"J\$BI#!OK7:7!&:7!4797:&8! ?:34!3K&3!&:7!()!&!\*??=!' ?4(3?!)3?!)G28!(8!3K7! :?87!?)G! 3K7!)=?7!()!3K7!QK() 747!3:&=7!)73<?:V!A?)4=7():\*!3K7! ?4(3?!)!)!3K7!4?23K!4=7!?)G!3K7!-8' 4#!OK7! . ?:3K!-=(&3(A! ?:34! A?))7A3!<78!<(3K!3K7!L&8(AE-=(&3(A!A?:(=?:!<K(AK!:2)4!G;?F!D=&)4V!D=T)(&\_!@aAa7A()\_&)=!p<()?2cqA(7!()!3K7! )?3K!3?!)3K7!-=(&3(A! ?:34!?)G! ?' 7:\_!O:(7437\_![7](A7\_!&)=!>&97))&(!!3K7!4?23K#!-8?) \*! 3K7! A?::(=?:! 3K7:7! &:7! F&c?::! ()=243:(&8! :7\*(?)4! ()! 4?23K7:)! +?8&)=! \&3?<(A7E\:&V?<\_! 143:&9&Zk(8)&\_! L:&3(4&9&\_![7])&\_!8&\*7)G2:3!&)=!` =() 7#!OK7!<K?87!4T437F!?)G!-=(&3(A! ?:34!A?28=!7F7: \*7!() 3?!)&!F283(E' ?:3! \*&37<&T\_!A?)=(3?!)&! 3?!)G2:3K7!:()37\*:3?!)! ; 73<77)!G(97! F&()! ' ?:34! ()! 3K7! :7\*(?)! &:7! 7)K&)A7=#!OK7! %7=(37:::&)7&)!Q?::(=?!(4! 3K7! ?3K7!: (F' ?:3&)3! 3:&)4' ?:3! A?))7A3?!)<(3K!3K7!. ?:3K!-=(&3(A! +?34#!OK(4! A?::(=?!:A:&474!4(U! /`!A?2)3:(74!@!&()!\_!^:&)A7!\_!MB&T\_!@?97)(&\_!Q!:&3(&\_!&)=!n2)\*&:T#!MB!A?))7A34!8?\*(43(A4! &)=! 2:;&)!K2; 4!42AK!&4!-8F7:(&E![&87)A(&\_![&87)A(&Z%&=:(=!\_!K&:&\*?a&ZL&:A78?)&!f!%&:47(887!f!,T?)!E!02:()!f! %(&!)f![7:?)&E! +&=2&Z[7)(A7!E!0:(7437Z\?7:\_!f!,c2:&&)&!f!L2=&' 743!EkrK?)T#!

## Terminals

b(3K!3K7!3:&)4&A3(?)!()! "J\$C! <(3K!Q%-!QD%\_!OK()&!%7:AK&)34!n?8=() \*!&AX2(:7!=!ORi !7X2(3T!43&V7!()! 07:F()&8! ,()V\_!<K(AK! ?<)7!=!\$N!A?)3&()7!:37:F()&84!()!B!A?2)3:(74!M! "J\$5!Q%-!QD%! :7()G?A7!=!3K7!

A??' 7:&3(?)!<(3K! QK() &!<(3K!3K7!%7F?:&)=2F!7G! )=7:43&)=() \*!; 73<77) !Q%-!07: F() &&ln?8=() \*\_3K7!Q%-! QD%!' ?:3!42; 4(=&:T! <(3K!Q1@Q1!@K(' ') \*!+?:34#/ &:8(7:!)!"J\$5!Q1@Q1!@K(' ') \*!+?:34!:7A7(97=!G()&) A(&8! 42' ' ?:3!?G!` @6!"S!; (8(?)! ?97!:3K7!) 7U3!G(97!T7&:4G?:F!3K7!QK() &!67978?' F7) 3!L&) V##!

### **Chinese actors involved in Europe's transport infrastructure**

OK7!F&()!&A3?:4!()9?897!=()!7:8&3(?)!3?/2?:7]4!3:&)4' ?:3!()G:&43:2A32:7!&:7!3K7!G?8<() \*!A?F' &)(74!W

- Q1@Q1!@K(' ') \*!+?:34!, (F(37=\_!A?)3&()7!:37:F() &&? 7:&3?:!K&4!AK?47)!+(&724!&4!3K7!F&()!K2; !()! 3K7! %7=(37:&)7&)!; 23!&4?K&4!&4(\*) (G(A&)3!43&V7!()!>?337:=&F!9(&!&CNi !43&V7!()!/00!/2:&?F&U! 37:F() && &)=!>?337:=&F!b?:8!=D&37<&T#
- QK() &!%7:AK&)3!4!+?:3!&37:F() &&? 7:&3?:!<(3K!43:?) \*!8()V4!3?Q%-!QD%#!L?3K!A?F' &)(74!K&97! (O:A:7&4() \*8T!3(\*K37!:A??' 7:&3(?)!3K7:7; T!A?F; ()() \*!8()7!:4K(' ') \*!)73<?:V4!<(3K!A?)3&()7!:37:F() && ' ?4(?)4!()!43:&37\*(A&&T!AK?47)!/2?:7&)!47' ?:34#
- >&(!? 7:&3?:!QK() &! >&(&T!Q?)3&()7!:0:&)4' ?:3!Q?:!#K&4!AK?47)! 62(4' ?:3!3K7! 8&: \*743! ()8&)=! 37:F() && ()!/2?:7!()!62(4; 2:&4!3K7(:!F&()!K2; !&)=!/2?:7&)!K7&=X2&:37:4#
- Q?)43:2A3(?)!A?F' &)(74!3K&3!&:7!42' ' ?:3! \*!3K7!=7978?' F7)3!?G!()G:&43:2A32:7!&?) \*!3K7!:?237#!OK()V! ?G!37:F() &&=7978?' F7)3!=:&2\*K3!()A:7&474!&)=!A??:(:=?:!()G:&43:2A32:7!<?:V4#!

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### **3.1.3 Geopolitical interest in the Arctic**

-AA?:=() \*!3?A2:7)3!743(F&3(?)4!-:A3(A!@2F7:4!()!F(=E"\$st!A7)32:T!<(88! :?; & 8T! ; 7!K?3!7) ?2\*K!3?F783!F?43?G!3K7!(A7!3K&3!G?:F4!()!3K7!<()37!:47&4?)#!OK(4!F&V74!3K7!:237!)&9(\*;& 87! <(3K?23!3K7!)77!=G?:!7U3:& 7X2('F7)3!=2:() \*!3K7!42FF7!:F?)3K4#!Q2:7)38T!7U3:& 7X2('F7)3!8(V7!(A7; :7&V7:4!&)=!32\*; ?&34!&:7! :7X2(:7!=!H%&:(3(F7! /U7A23(97! "J\$RI#!0:&)4' ?:3!9?82F74!&:7!:7' ?:37!=4()A7!3K7!7&:8T!\$RCJ4\_!&3(F7!()!<K(AK!A:& \*?I9?82F74!<7:7!97:T!8(F37=\_!?:!c243!)?3!:7' ?:37=#Q&: \*?I9?82F74!&7&V7=I&3!S#S!F(88(?)!3?)4!()!RB5\_!&G7< T7:&4!; 7G?:7!3K7!?GG(A(&!)7=() \*!?G!3K7!@?9(73!7:&!)!\$RR\$#![?82F74!<7:7!F&()8T!=:(97)!; T!3K7!()=243:(&4&3(?)! ?G!@(:7:&1; 23!=7A8()7!=4K&:8T!&G37:<&:=4!-G37!:!\$RR\$!3K7!G(:43!.?)E>244(&)!G&\*\*7!=4K('4!<7:7!&8?<7!=3?!=7'8?T!3K7!.@>#!@()A7!"J\$J3:&)4' ?:3!9?82F74!&:7!()A:7&4() \*!&\*&()!2)3!8&87978!G!J#N!F(88(?)!3?)4!()!J\$5!H477! ^(\*2:7!"I#M!)@7'37F; 7!:!"J\$B\_!3K7! [7)3&!%&7:4V!HC\_NRS!0/`!!<&4!3K7!G(:43!.A?)3&()7:4K('!3?4&(!G: ?F!@3#! +737:4; 2:&3?![8&=(9?43?V!9(&3K7!.@>!()437&=!?G!3&V() \*!3K7!@27aEQ&)&&OK(4!<&4!F7&)3!&4!&3:(&3?!) \*&()! 7U'7:(7)A7!<(3K!4&8() \*!3K: ?2\*K!3K7!-:A3(A#!!

!

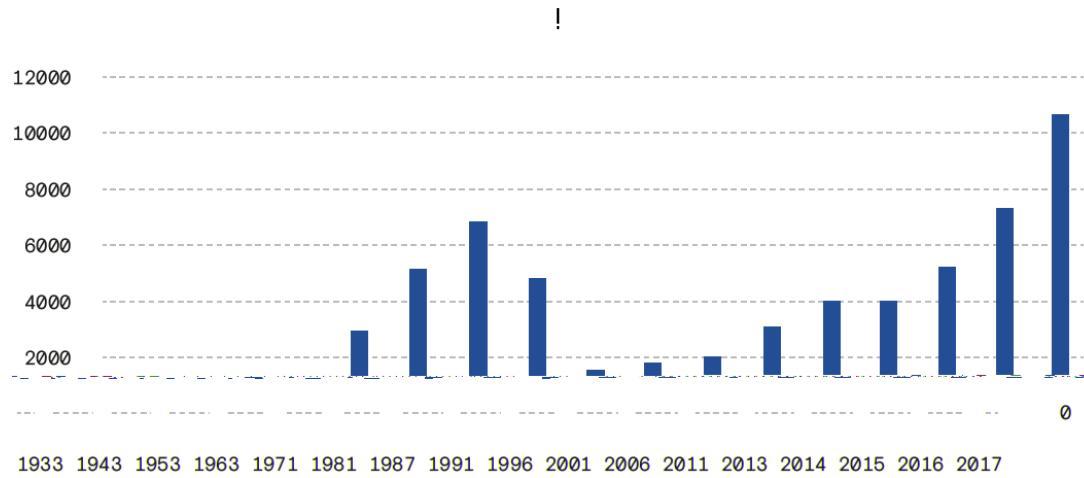


Figure 2: Annual cargo volume x1000 tons on the Northern Sea Route (Source: Northern Sea Route Administration)

Q2::7)38T!3K7!24&\*7!?G!3K7!-:A3(A!?:237!(4!&(F(37=#!Q&: \*?3K: ?2\*K' 23!9?82F74!&:7!&:22)=!\$J#N!F(88(?)!3?)4!&)=!3:&GG(A!(4!F&()8T!()3:&E&:A3(A!&)=!78&37=!3?1?(&7U3:&A3(?)!()!3K7!:7\*(?)#0:&)4(3!9?82F74!()A:7&47=!43:?) \*8T!G:&F!J\_\$\$!F(88(?)!3?)4!()!"J\$J!3?!.CN!F(88(?)!3?)4!()!"J\$C#!-637!:J\$C!9?82F74!=:?'7=4377'8T!=27!3?4797:&&:7&4?)4W!7A?)?F(A!=?<)32:)\_!\*7?'?8(3(A&8!37)4(?)4!4&)A3(?)4!&\*&()43!>244(&\_&)=!\*&8AV!?G!(A7;:7&V7:&A&A(3T!G?&13:&)4(3!f?2:)7T4!=27!3?13K7!&44(\*)F7)3!?G!3K747!(A7;:7&V7:4!G?:!?(8!&)=!\*&4E:78&37=!'?:7A34#1627!3?13K747!G&A3?:4!3K7!A?43!=(GG7:7)A7!;73<77)!3K7!:?237!9(&13K7!@27aEQ&)&8!&)=!3K7!:?237!9(&13K7!.?&3K7:)!@7&!:?237!=(&F()4K74!&)=!7A?F74!\*&(&!)!G&9?2:!?G!3K7!@27aQ&)&8!&!"J\$5!3K7!3:&)4(3!9?82F74!<7:7!&3!&8797!&?G!J\_R!F(88(?)!3?)4!<K(AK!7X2&84!\$\_Bi!7G!3K7!3?3&8!A&: \*?I?82F74!3:&)4'?:37=!?97!3K7!:?237#!!

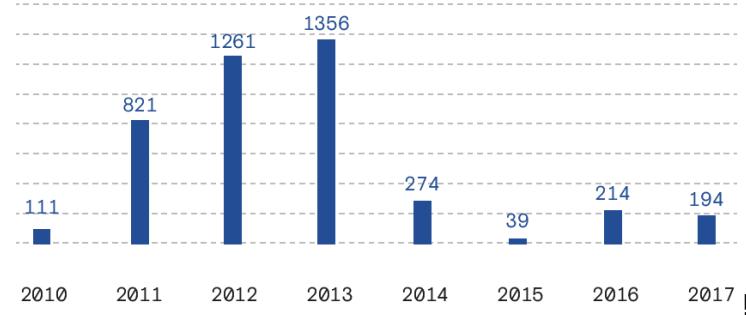


Figure 3: Transit cargo volumes x1000 tons through the Northern Sea Route

-)3K7!:!7:4'7A3(97!(4!3K7!=(9(4(?)!?G!F283('87!4K('3T'74!?97!3K7!9?T&\*74!3K&3!&V7!'8&A7#M)!(\*2:7!0&)!?97:9(7<!?G!3K(4!(4!4K?<)!?97!:3K7!T7:&!"J\$5#!OK7!3? '!N!974478!3T'74!2)=7:3&V() \*!9?T&\*74!?)!3K7!.@>!&:7!3&)V7:4!HCOi!L! \*7)7:&8!A&: \*?9744784!HCJi!L!(A7;:7&V7:4!HN\_Ni!\_!32\*4!HN\_Ni!&)=!A?)3&()7:9744784!HN\_Oi!#!OK7!)2F;7:!:?G!9?T&\*74!F&=7!()!"J\$5!<&4!\$RJB\_!4'?:7&=!?97!:!"BC!9744784#

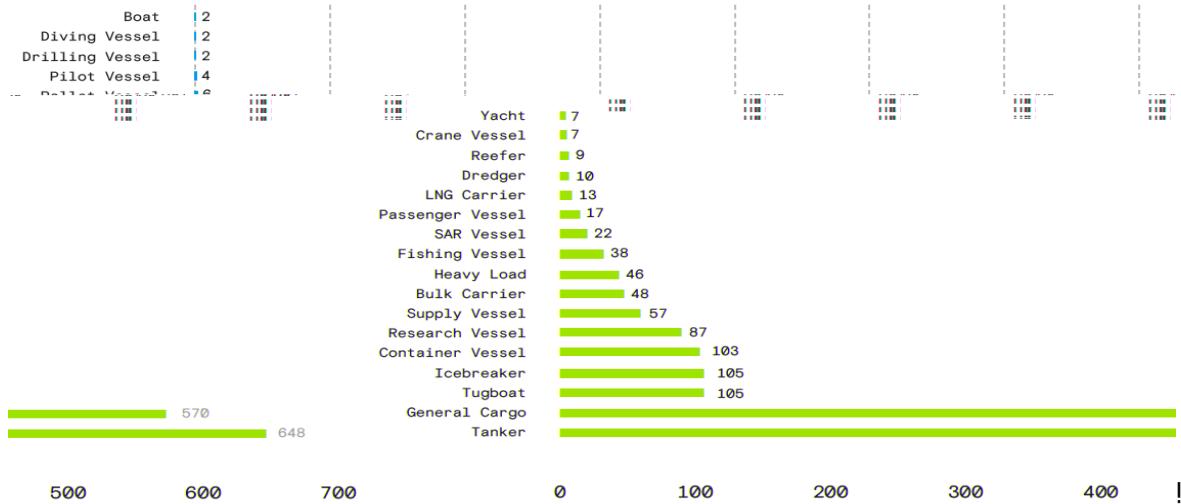


Figure 4: Number of voyages per ship type in 2017

OK7!>244(&)\*?97:)F7)3!K&4!K(\*K!&F;(3(?)4!&)=!(&F4!G?:!3K: ?2\*K' 23!9?82F74! ?G!BJ!F(88(?)!3?)4!()!"J"N!&AA?:=() \*3?13K7!-:A3(A!%&437:'88)&I!H,&:2788!J"J!#^?13K7!+, - . /0!':?c7A3\_!(3!(4!F&()8T!()37:743() \*!3?477!K?<()37:A?)3()7)3&8!A?)3&()7:!:3:&)4'?:3!F(\*K3!AK&)\*7!<K7)!3K7!.@>!()A:7&474!()!?'2&:(3T#!OK7!>244(&)\*?97:)F7)3!(4!-7G()378T!)?3!3K7!?)8T!=:(97!:7K()=!3K7!()A:7&47!:!=7A:7&47!?G!A?)3&()7:13:&GG(A!&44() \*3K: ?2\*K!3K7!.@>!&4!&!HA?)3&()7:!:4K(' ')\*!?:237#!MB!4K?<4!3K&3!3K7:7!(4!43(88!8:&\*7!2)A7:3&()3T!&?23!3K7!9(&!(3T!?)G!3K7!:?237!&)=!&?23!3K7!3(F7!:7:(?=!)!<K(AK!<7!<(88!477!4(\*)(G(A&)3!3:&=7!G8?<4!4K(G3!) \*G:&F!7U(43!) \*!?:2374!3?<&:=4!3K7!.@>#!

OK7!9(&; (8(3T!?)3K7! - :A3(A!<&37:4!&4!&!)!7F7: \*() \*!3:&=() \*!?:237!(4!)?3!?)8T!=7'7)=7)3!?)!\*7?'?8(3(A&&!)37:7434!; 23!&4!?=7'7)=4!?)!3K7! 7:A7(97!=&33:&A3(97)744!&F?) \*!A:&\*?!=<)7:4#@()A7!3K7!; 7)7G(A(&:T!A&:&\*?!=<)7:4!&:7! :74'?)4(; 87!G?:!F&V() \*!3K7!3:&)4'?:3! =7A(4?)4!F?) (3?:() \*!3K7! &33(32=7! ?G!4K('7:4!3?<&:=4!3K7! . @>!(4!F'?:3&)3#OK7!G?8?<() \*!3&; 87!4K?<4!&)!97:9(7<!?G!G&A3?:4!3K&3!=737:F()7!3K7!A?FF7:A(&&124&\*7!?)G!3K7!. @>#!

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Ca	Fac
<i>Economy</i>	Additional fees (e.g., tugs)
	Availability and training of sailing personnel
	Traveling distance
	Fuel costs (different fuels)
	Legal status of NSR
	Costs of ice-class vessels
	Risk of oil spills
	Sailing speed
	Insurance rates can be higher (between 50-200%)
<i>Infrastructure</i>	Availability of port services
	Availability of infrastructure
	Level of safety for navigation
	Bathymetry (draft)
<i>Weather</i>	Stability of weather conditions
	Length of navigability window
	Seasonal availability of the corridor(s)
<i>Geopolitics</i>	Attitude and rulings between countries
<i>Ethics</i>	Attitude of shippers, shipping lines and other stakeholders

Table 4: factors determining the commercial usage of the NSR (own elaboration)

-83?\*73K7:\_3K7:7!&:7!A87&:14(\*)4!3K&3!3:&=7! &337:)4!&:7!4K(G3() \*!; ?3K!; T!\*7?E7A?)?F(A&&A3(?)4!&)=!A?FF7:A(&&43:&37\*(74#M)!++\$!<7!; :() \*!G?:<&:=!3K7!A?)A7'3! ?G!A?) )7A3(9(3T!&)=!K?<!3K(4! :78&374!3?3K7!)?=74!&)=!A?::(=?4!?G!3K7!0/. EO!)73<?:V#!b7!8??V!&3!K?<!\*8?; &8!4K(G3() \*!3:&=7! &337:)4!A&)!()G827)A7!3K7!A?) )7A3(9(3T!?G!0/. EO!A?::(=?4!<(3K!3K7!?234(=7!; ?:=7:4!?G!2:?'7!&)=!K?<!3?F?) (3?:!3K(4#!

### 3.1.4 Transhipment hubs in the Mediterranean ports & Middle East

n7:7!<7!<(8!78&: ?:&37!?)!3K7!7F7: \*7)A7!?G!3:&)4K('F7)3!':34!42AK!&4!-8\*7A(:&4!H%&7:4V\_!7&:8T!"JJJ4!&)=!0&)\*7:4!H%?:?AA?1!<K(AK!:7A7)38T!7U'&)=7!=!-+%0!A?)3&()7!:G&A8(3(74#:@&F7!<(3K!%&:4&U8?VV!H%&83&I!D(?&0&2:?!HMB&8T!\_!+?3!@&(?=H/\*T'3!#OK747!?'34!47:97!&4!3:&)4K('F7)3!K2; 4!&)=!&:7!43:&37\*(A&&T!8?A&37=!)?3K7!/&43E b743!3:&=7!:&?2374#-8\*7A(:&4!&)=!0&)\*7:4!K&97!&)?3K7!:&=9&)\*3&\*7!<K(AK!(4!3K7!8?A&3(?)!?)!; ?3K!/&43E b743!&)=! . ?:3KE@?23K!3:&=7!:&?2374#07:F()&84!&:7!?G37!)<)7=!=; T!A&::(7:4!3K&3!247!3K747!G&A8(3(74!&4!32:)3&; 874!&)=!3K747!K2; 4!&:7!4787A37=!3?47:97!A?)3()7)34!()437&=!G!:7\*(?)4!3?G2)A3(?)!&4!&A:?44() \*!?)3!; 73<77)!3:&=7!8&:74#OK747!3:&)4K('F7)3!K2; 4!K&97!&G??38?47!)&32:7!&)=!3K7T!7&A3(?)!3K7!=T)&F(A4!()!<?:8!=3:&=7!H>?:(\*27\_ "J"J!#

@?F73K() \*!3K&3!4K?28=;!; 7!A?) 4(=7:7=!(4!3?<K&3!7U37) 3!7) 9(:?) F7) 3&8:7\*28&3(?) 4!()!3K7!/2:?' 7&)!37::(3?:(&8<&37:4!<(88!473!8(F(3&3(?) 4!3?&4K(' 4!()!42AK!&!<&T!3K&3!4K(' ' () \*!8() 74!<(88!=(97:3!3K7!3:&) 4K(' F7) 3!G2) A3(?)!?G!.. ?:3K7:)! /2:?' 7&)! ' ?:34!3?&1?34!()!3K7!%7=(37::&) 7&)!#OK747!8(F(3&3(?) 4!K&97!&8:7&=T!; 77)!()! ' &A7!2)=7:!3K7!428' K2:! A' !:7\*28&3(?) 4!H&84?&V) ?<)!&4!M%1 " J" J!!; 23!A&)!K&97! F?:7!(F' &A3!?)!4K(' ' () \*!:&?2374!<K7)!7F(44(?)!':(A!) \*! <?28=;!; 7!(F' 87F7) 37=;!; T!3K7!/2:?' 7&)!Q?FF(44(?)!?:!/~!F7F; 7!:A?2) 3:(74#!M) 3:?:=2A() \*!&! ' :(A7! G?:! A&:; ?)! 7F(44(?) 4!()!3K7!4K(' ' () \*!()=243:T!K&4!3K7!()37) 3(?)!3?!(G827) A7!3K7!=7A(4(?)EF&V() \*!?G!4K(' ?<) 7:4!?:!?' 7:&3?:4! 3?<&:=4!K(\*K7!:7) 7: \*TE7GG(A(7)AT!&)=!8?<7:!A&:; ?)!G??3' :(3!?G!3K7(:!G87734!H@3:7) \*! " J" J#!OK7!(F' 87F7) 3&3(?)!?G! 42AK! F7&42:74!(4!8(V78T!3K7!A&47!&4!/2:?' 7&)!Q?FF(44(?)!K&4!&) ?2) A7=!3K7!D:77)!67&&!<K(AK!&84?&14734!G?:<&:=! &! ' ?&(AT!3?&1?8&A7!3K7!

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### 3.1.5 International North-South Transport Corridor

OK7!M)37:)&3(?)&!. ?:3KE@?23K!0:&)4' ?:3!Q?::(=?:!HM. @0Q!(4!&5\_ "JJ!VF!8?) \*!3:&)4' ?:3!:?237!3K&3!43&:34!()!M)=(&!&) =!A:?4474!M:&) \_-G\*K&)(43&)\_!-:F7)(&\_!-a7:; &(&)\_!>244(&\_!Q7)3:&!-4(&\_!&)=!/\_2:?' 7#!OK7!:?237!G:?F!%2F; &(&) =!@(&)3E+737:4; 2:!\*A&!)!; 7!4K?:37)7!=!; T!\$J!=&T4!; T!3K7!M. @0Q!A?F' &:7!=3?!)3K7!:?237!3K&3!2474!3K7!@27a!Q&) &&!, (V7!3K7!L>M!3K7!M. @0Q!A?)4(434!?G!&!; 2)=87!?G!A?::(=?:4\_!; ?3K!?)!&)=!&)=!&47&#!OK7!; (\*\*743!=GG7:7)A7!(4!3K7! <&T!()!<K(AK!(3!(4!; 7!)!\*=7978?7#!OK7!L>M(4!&! 2:78T!QK!(&E4?7)4?7!=!&A3(9(3T!<K7:7&4!3K7!M. @0Q!A&)!; 7! A?)4(=7:7=I&F283(E43&V7K?8=7!&A3(9(3T#!Q?))7A3(9(3T!(4!&()!&V7T<?:=!(!)3K7!=7978?7#!F7)3!?G!3K(4!:?237!&)=!3K7! &(F!(4!3?!(A:7&47!3:&=7!A?))7A3(9(3T!; 73<77)!(F' ?:3:&)3!A(3(74!42AK!&4!%2F; &(!%?4A?<\_!L&V2!-43:&VK&)\_! 07K:&)!L&)=&!:!-; ; &4\_!&)=!L&)=&!:!- a&8!M!1!)3K7!%?4!b&T\_!"J"JI#!

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Figure 5: Mapping of the International North-South Transport Corridor

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L73<77)!"J\$0!&)=!"J\$5!&)2F; 7!:?G!:=T!:)2)4]!K&97!; 77)! 7:G?:F7!=?97!3K7!:?237!; 73<77)!%2F; &(!&)=!&(&)3E +737:4; 2:!\*#!OK7!:74283!?G!3K747!:)2)4!4K?<7!=!& '44(; 87!A?43!4&9() \*!?G! "#NJJ! `@6! ' 7!:N!3?)4!?G!A&: \*!&)=!& 4(F283&)7?24!=?:?E()!3:&)4(3!3(F7!G: ?F!0JESJ!=&T4!3?!)8T!"NECJ!=&T4!H>7A?) )7A3() \*!-4(&\_!"J"JI#! /97!)3K?2\*K! 3K7!:?237!K&4!&K(\*K! '37)3(&8!()!37: F4!?G!()A:7&4() \*!3:&)4' ?:3!7GG(A(7)AT\_!; ?3387)7AV4!:7F&()!; ?3K!()!37: F4!?G! ()G:&43:2A32:&Z7)\*()77:() \*!()!M:&)\_!&4!<78!&4!G: ?F!&G() &)A7! ' 7:4' 7A3(97#!Q2::7)38T\_!3K7!M. @0Q!&8:7&=T!7U(434!()!& G:&\*F7)37!=!; &47!?G!()G:&43:2A32:7!<(3K!&!3?3&8!A&' &A(3T!?G!&:?)2)=!N!F(88(?)!%0!M!)3K7!8?) \*!37: F\_!&F&U(F2F! A' &A(3T!?G!"J!F(88(?)!%0!(4!7U' 7A37=!3?; 7!3:&)4' ?:37!=&)2&8T!?97!:3K7!:?237#

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### 3.1.6 Impact of emerging routes development to the TEN

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#### 3.1.6.1 Dynamics and complexity: consequences on corridor level

OK7! ()37:)&3(?)&& A?F' 73(3(97! ' ?4(3(?)! ?G! ' ?:34! &)=! ()=243:(74! &?)\*! 0/. EO! A?::(=?:4! (4! ()G827)A7!=! ; T! =7978?' F7)34!( )()37:)&3(?)&&3(:&=7#M!)?2:&44744F7)3!?G3K7!(F' &A3!?G4K(G3() \*!3:&=7! &337:)4!3K7!F73K?=?8?\*T! G?8?<4! ; ?3K!&)!234(=7E()!&4!<788!&4!&)!()4(=7E?23! ' 7:4' 7A3(97!?)!3K7!=T)&F(A4!&)=!A?F' 87U(3T!?G!3:&)4' ?:3! )73<?:V4#!OK7!?234(=7E()! ' 7:4' 7A3(97!?)?V4!&3!3:&=7!G?<4!G:&F!&A:?4A? ' (A!87978!<K(AK!()A82=74!8?A&3(?)E ()=7' 7)=7!3!AK&)\*74!42AK!&4!3K7!7G67A34! ?G! \*8?; && <&:F() \*!?)!3K7!-:A3(A!@7&!:?2374! \*7? ' ?(3(A&!37)4(?)4! ; 73<77)!42! 7: ' ?<7:4!; 23!&84!?37AK) ?8?\*(A&8!&=9&)A7F7)34#!-3!3K7!4&F7!3(F7.!<7!&:7!; 2(8=() \*!&<&:7)744!?G! \*7?E7A?)?F(A!L=T)&F(A4!<K7:7; T!<7! 7:&:=A?F' &)T!43:&37\*(74!()9743F7)34!\_&)=!AK&)\*74!()3K7!473E2' !?G!\*8?; && 9&827!AK&()4!?G!F283()&3(?)&84#!^: ?F!3K7!()4(=7E?23!<7!&:7!<(3)744() \*! ' :?E&A3(97!43:&37\*(74!; T!()8&)=!)?>=74!3?!=7978?' !)7<!:?2374!42! ' ?:37!=<(3K!())?9&3(97!37AK) ?8?\*(74!3?!.; 7337!:A?))7A3!<(3K!47&' ?:34#! 6T)&F(A4! &:7! ; ?:V7!)! =?<)! ()3?!. ?' 7:&3(?)&& =T)&F(A4!\_ F:&:V73! =T)&F(A4!\_ 37AK) ?8?\*T! =T)&F(A4! &)=! A?2)37:':?>=2A3(97!=T)&F(A4#! 6T)&F(A4! ()!3K7! ?' 7:&3(?)&&4! K7:7! :78&37!G??:! ()43&)A7! 3?!)7<! 4&(8!) \*! :?2374! AK&)\*!K2; E&)=E4' ?V7!A?)G(\*2:&3(?)4!H7#\*#\_!3:&)4K(' F7)3!K2; 4!()!3K7!%7=(37:&)7&)!#%&:V73!=T)&F(A4!\_ 78&37! 3?!)G(7:A7!: A?F' 73(3(?)! ; 73<77)!A?F' &)(74! F:&:V73! A?)4?8(=&3(?)\_! 3K7! 7F7: \*7)A7! ?G! 7EG?:<&:=7:4!\_ 3K7! &33:&A3(97)744! ?G! &837:)&3(97!3:&)4' ?:3!F?=74\_!(F' 87F7)3&3(?)!?G!\*?97:)F7)!()43:2F7)34!3?!)43(F28&37!8?<! A&:; ?)!3:&)4' ?:3!G2784! &)=!3K7!:7X2(:7F7)3!; T!4K(' ' 7:4!G?:!4243&()&: 87!3:&)4' ?:3#! ^2:3K7:F?:7\_!3K7:7!&:7!=T)&F(A4!<K(AK!&:7!=:(97)!; T!37AK) ?8?\*(A&8!&=9&)A7F7)34\_!42AK!&4!3K7!=7978?' F7)3!?G! ; 8?AVAK&()!3K7!()37!:73!?G!3K() \*4!\_?)8! 7!; ??V() \*! ' 8&G?:F4!; (\*!=&3!&)&8T3(A4!\_ND!)73<?:V4\_!73A#! ,&438T\_!3K7! A?::(=?:! A?))7A3(93T!&84?!=7' 7)=4! ?)!F(3(\*&3() \*!A?2)37:':?>=2A3(97!=7978?' F7)34\_!42AK!&4!AT; 7!:3K:7&34\_! A:(F()&& &A3(9(3(74! &3!A?::(=?:!K?34' ?34\_!)7A744(3T! 3?!)F&V7! ()G?:F&8! ' &T F7)34#!-!X2743(?))&(:7!K&4! ; 77!) =7978?' 7!=G?:!8(9!) \*!8&; !' &:3(A(' &)34!3?!)A?887A3!G77=; &AV!?)!3K747!=T)&F(A4#

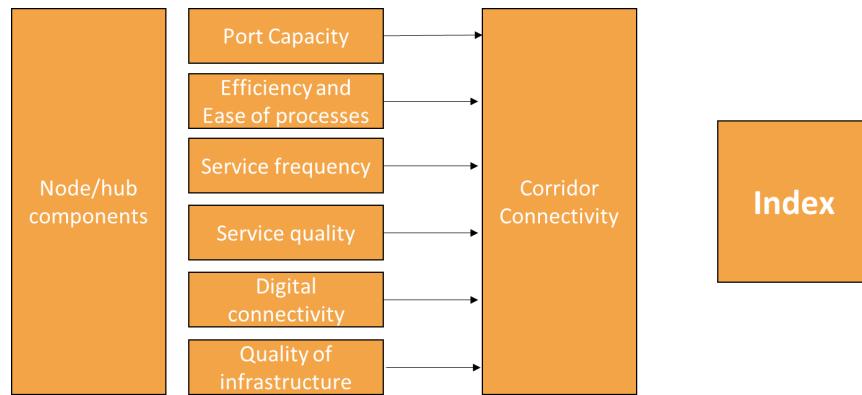
### 3.1.7 The Corridor Connectivity Index (CCI)

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OK7!43:&37\*(A!8?A&3(?)! ?G!3:&)4' ?:3!)?=74!()!3K7!()37:)&3(?)&&3:&)4' ?:3!)73<?:V!(4!&V7T!7)&: 87!:G??:!3:&=7#! OK7!7G?:7!gK2; 4!)?!:!gF&()E' ?:34!]?:!g' :()A(' &8!7)3:T!)?=74!]?:!7!9(3&!)?=74!&)=!A?))7A3(?)4!?97!:8&)=!\_!(&!:!)=! 47&#!OK7!)73<?:V!= (F7)4(?)!A?F' 87F7)34!3K7!7A?)?F(A!= (F7)4(?)!<K(AK!?G67:4!(F' ?:3&)3! ?G&A3??:4!G??: A82437:4! ?G! ()=243:(74#!D?97:)F7)34! ?G!A?2)3:(74!<(3K!&V77!)()37:743!()!3:&=7!&)=!8?\*(43(A4!\_ 42AK!&4!OK7! . 73K7:&&)=4! ; 23!&84?!)&:7!&)=!QK()&\_!K&97!A?)4(=7:7!=!gA?)7A3(9(3T!)()!3K7(:! ' ?(AT! ' 8&)4!&)=! &(F!3?!)43:7)\*3K7!)3K7(:!A?F' 73(3(97! ' ?4(3(?)!)!3K7!<?:8!=!H%() (43:T! ?G! /A?)?F(A! -GG&(:4! ?G!OK7!. 73K7:&&)=4\_!"JJRI#!67!, &)\*7)!&)=!@K&:T' ?9&!:J\$CI!= (43!) \*2(4K!3<?: ; ?:?&=!A8&4474! ?G!F7&42:74!3?!=74A:(; 73:&)4' ?:3!)73<?:V4!3K7!A?))7A3(9(3T!)G!&)73<?:V!&)=!3K7!&AA744(:8(3T!)G! 3K7!)?=7#!OK7!T! A?)4(=?:!A?))7A3(9(3T!&4!&)!&33:(; 237!:G!&!)73<?:V!3K&3! ()=(A&374!<K73K7!:!(3! (4! ' ?44(:87!3?!)7:&AK!&8!&:!A7:3&()!)?=74!G?:F!&4' 7A(GA!)?=7#MF' ?:3&)3!&:7!3K7!X2&&(3T!&)=!A?434!3?!:7&AK!=743()&3(?)4!9(& 3K7!)?=74#!>7A7)3!432=(74!4K?<!&=9&)A7!=!()4(\*K34!( )3?!)A?)=7A3(9(3T!)?G!F&:(3(F7!3:&)4' ?:3!)73<?:V4#!

@797:&&F73K?=4!&:7&=T!7U(43!3?!)F7&42:7!3K7!A?) ) 7A3(9(3T!?)G!8?\*(43(A4!8?A&3(?)4!&)=!7U' :744!3K(4!<(3K!&)!()=7U# -!)7U&F' 87!(4!3K7!b?;8!=+?:3!M)=7U!<K(AK! A?F' &:74!AK&:&A37:(43(A4\_! ' ?4(3?)\_!G&A(8(3(74\_!&)=!47:9(A74! ?G! 3K?24&)=4! ?G! ' ?34! &:2?)=!3K7!<?:8!= -?)3K7!:7U&F' 87!(4!3K7!,()7:@K(' ' ()\*!Q?))7A3(9(3T!)M)=7U!H,@QM!<K(AK! F7&42:7!3K7!()37\*:&3(?)!G!A?2)3:(74!<(3K!)!\*?; &&8()7!:4K(' ' ()\*!)73<?:V4!H` . Q0-6!"J\$R&I#n?<797:\_!3K747! ()=(A74! &:7!G?A24()!\*)!3K7!G?78&)=!&=! ?3!4(-7\_! <K7:7&4!3K(4! ' &7!G?A2474! ?)!3K7!A?) ) 7A3(9(3T! ?G! A?::(=?4ZK()37:8&)=! <(3K! H7F7:\*(\*)! 3:&=7! :?2374#!OK7!QM(4! &A?F; ()&3(?)! ?G! ?; c7A3(97! &)=!42; c7A3(97! A?F' ?)7)34!<K7:7! ?3!A&\*&A(3T\_!=(\*3&8!A?))7A3(9(3T!&)=!47:9(A7!G:7X27)AT!&:7!?; c7A3(97! &)=!<K7:7!7GG(A7)AT! &)=!7&47! ?G! :?A74474\_!47:9(A7!X2&8(3T!&)=!X2&8(3T!&G! ?3!()G:&43:2A32:7!&:7!42; c7A3(97! #

Figure 6: Diagnostic model of the Corridor Connectivity Index



QK&)\*74! ?G! 3K7! QM G: ?F! ?)7! T7&:! 3? ! 3K7! ?3K7!:! (=7)3(GT! 3K&3! 3K7! )?=7! (4! AK&)\*()!\*(34! A&: &(8(3(74Z4A&87Z&AA744; (8(3T#OK7!QM A&!)!; 7!& ' 8(7=!4!&!; &: ?F737!:! ?G!AK&)\*()!3:&=7!G?<4#! -!K(\*K7!:!QM F7&)4!3K&3!(3!; 7A?F74!F?:7!&33:&A3(97!3?3!:&)4' ?3!\*??=4!9(&3K(4!+:(A' &8!7)3:T!)?=7!?:!M&)=!)?=7#!

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OK7!7F7:\*(\*)!7<!:?2374!&:7!7U' 7A37=!3?!)AK&)\*7!G:7(\*K3!G?<4!<(3K!)!3K7!0/. EO!)73<?:V!<K(AK!<(8!74283!()! 4797:&&(F' &A34!42AK!&4!3K7! :7442:7!?)!A2::7)3!()G:&43:2A32:7!&)=!3K7!A:7&3(?)!?G!; ?3387)7AV4\_!3K7!AK&)\*()!?!G! 3K7!(F' ?3&A7! ?G!)?=74Z8()V4!73A#!+, -. /0!; 78(7974!3K&3!3K7!4797:(3T! ?G!3K747!(F' &A34! &)=!3K7!A&: &(8(3T! ?G! 4377:()!3K747!G?<4!3?!)3K7!=74(:7=!A?::(=?4Z8()V4Z)?=74!<(3K!)!3K7!/2?7&!)73<?:V!(4!8:&\*78T!=7'7)=7)3?!) 3K7!&9(&: 87!()G:&43:2A32:7!&)=!3K7!(F' 87F7)3&3(?)!?G!() ?9&3(97!37AK)?8?\*(A&8!3?8!4!<K(AK!A&!)7)K&)A7!3K7? !7:&3(?)!?G!3K7!)73<?:V#^?!)3K(4!:7&4?)\_!3K7! (=7)3(G7=!37AK)?8?\*(74!<(8!7!37437=!3K:2?\*K!4797:&8!4A7)&:(?4!)! C!, (9!)!&: 4!<K(AK!<(8! :?9(=7!G77=; &AV!?)!3K7!&A32&8!(F' &A3!3K747!37AK)?8?\*(74!A&)IK&97!()!3K7!G232:7!4A7)&:(?4!)! ?G!/D0. #!

OK7!()37)3(?)4!&:7!3?!)&44744!3K7!(F' &A34! ?G!)7<!\*?; &&3:&=7!:&?2374!?)!3K7!0/. EO!)73<?:V!()!2:?'7#!M&=&?'34!& 43:&37\*(A! &)\*87!A?)4=7:()!<K&3!3:7)=4!2)=7:8(7!3K7!7F7:7)A7! ?G!3K747!)7<!3:&=7!:&?2374! &)=!<K&3! :7A?F7)=&3(?)4!A&!)! 7!G?:F28&37=!4?!)3K&3!3K7!/\_!F(\*K3!7GG7A3(978T!&)3(A' &37!3K7?!)&3(74!&)=!AK&87)\*74! 3K&3!3K747!)7<3:&=7!:&?2374! ?47#!-G37!:!; :(7G8T!3:&AV!)\*!3K7!7F7:7)A7!&)=!7A8! ?!G!&c?!)K(43?:(A!3:&=7!:&?2374! 3K7!G?A24!4K(34!3?!)3K7!\$"st!A7)32:T!IK(\*K0(\*K3!)\*!V7T!=73&(&4! ?G!3K7!77!F&c?!)3:&=7!A?))7A3(?)4!WQK!&E/& !:&8!3K7! ()37:)&3(?)&8!. E@!:&?237!&)=!3K7!-:A3(A#!!

### 3.2.1 The boom of global freight transportation

OK7!?'?4(3?)!'&7!:+!"&4474474!3K7!(F'&A3!&)!=!&F'8(G7:4!?!G!3K7!\*&?; &&G:7(\*K3!; ??F!?!G!3K7!&43!4797)3T!T7:&4! MB!:&\*274!3K&3!A?)3&()7:(a&3?)!K&4!F:&V7!=!&4!(\*)(G(A)&3!32:)()!\*!?'()3!()!\*?; &&3:&=7!&)=!G:7(\*K3!3:&)4'?:3\_!&)=! 4' 7A(G(A&&8T!3K&3!3K7!)3:?:=2A3()?!G!3K7!A2::7)3!\*?; &&8T!&=?37!=A?)3&()7:43&)=&:=!K&4!'23!3:&=7!':?A74474!?!G! ()37\*:&3()!&)=!7GG(A(7)AT!()3?&!K(\*K7!1\*7&!:!&43K7!43&)=&:=!&88<4!()37:F?=&&8(3T#&OK7!A?)=(3?)4G!:3K7!A2::7)3!\*?; &&4'!7:&!=!?!G!'?:=2A3()?!G!42'!8T!AK&()4!?!G!%. 04!<7:7!A:7&37!=&)=!3<?!G&A3?:4!7:742837!=()!3K7!\*&?; && ()37\*:&3()?!G!3K7!HG:7(\*K3!7A?)?FT#!^(43\_!3K7!\*&7)7:&8!':?A744!?!G!A?)3&()7:(a&3()!F7&)3!3K&3!3:&)4'?:3!A?43!G??: F?43!3T'74!?!G!A:&\*?<7:7!\*:7&38T!7=2A7!=()!37:F4!?!G!A'&(3&8!&)=!3(F7#&@7A?)=\_!3K7!()37:F?=&&A?)3&()7:(F'&7!= 3K&3!9:(32&&8T!&&4?34!?!G!A:&\*?A?28!=A&)\*7!F?=74!7&4(8T#---=(3?)&&8T!3K7:7!&:7!3<?!3K7!<&T4!()!<K(AK! A?)3&()7:(a&3()!K&4!()G827)A7!=3K7!<?:8!=7A?)?FT!&)=!3:&)4'?:3!\_!^(43\_!&4!3K7!()A:7&47!()!A?)3&()7:(a7!= 3:&)4'?:3!:742837!=()!&43()!\*!()A:7&47!()!997:&&47&?:7!3:&)4'?:3!\_3K7!43:2A32:7!?!G!47'?:34!&)=!3K7!(): 37:&)=!()G:&43:2A32:7!<7:7!G?:A7!=3?43&)=&:=!a7\_!7A?F7!=7)47\_!&)=!()A:7&47!3K7(:!X2&(3T!3?!,7!&:87!3?!, K!)=87!G!&:7!\*9?82F74!&)=!4'7A(G(A!=F7)4()4!?!G!7(\*K3!A?)3&()7:4#&@7A?)=\_!A?)3&()7:(a&3()!()A:7&47!=3K7! 7)9(:?)F7)3&!(F'&A3!?!G!\*&?; &&3:&=7!&4!3K7!4'77!=&)=!9?82F74!<(3K!<K(AK!6:7(\*K3!4!3:&)4'?:37!=!\*&7:38T! ()A:7&47!=#!-4!3K747!()A:7&47!=3:&=7!9?82F74!&:7!7U7:3()!\*!7442:7!?)!K()37:&)=!()G:&43:2A32:74!F?3?:&<&T4!\*73! A?)\*7437=!!=74'(37!7GG?:34!3?!=!(43:(;237!3:&)4'?:3!F?:7!797)8T!&A:744!()8&)=!<&37:&<&T4!&)=!:&(8!\_!&)=!A?)3&()7!: 4K('4!:&7!':7442:()!\*3K7!7)9(:?)F7)3!3K?:2\*K!3K7(:!7F(44()4!H=74'(37!&:7A7)3!3:&)4(3?)!3?48!<!437&F()]\*!#!!

### 3.2.2 Geo-economic trends affecting global freight transportation

OK7!?:87!?:G!\*7?E7A?)?F(A!3:7)=4!()!4K&'()!\*A2::7)3!\*8?; &&G:7(\*K3!3:&)4'?:3&3(?)#!-3!(34!A?:7\_!3K(4!47A3(?)!&: \*274!3K&3!3K7!\*:8?; &&(a&3(?)!?:G!42'8T!AK&(&4!&)=!':?:=2A3(?)!A?28=3&V7!&32:)!3?<&:-4!&|F?:7!:7\*(?)&&(a7!=; &47#&0K7!&:3(&&879788() \*!?:G!8&; ?2:!A?434!A&)!; 7!477)!&4!3K7!()3(&3??:!?:G!3K(4!3:7)=!<K(87!=7F&)=4!G?:!K(\*K7!:43&)=&:=4!?:G!&:?:2A3(?)!&)=!':?:2A34!&)=!3K7!A2::7)3!Q1[M6E\$R!A:(4(4!A&)!; 7!477)!&4!G&A3?:4!3K&3!&F'8(GT!3K(4!3:7)=!3?2)V)?<)!7U37)34#>7\*(?)&&(a&3(?)!?:G!?:2A3(?)!4!7U'7A37=JG?:!K(\*KE7)=!HA'3&8!(?)37)4(97!A?)42F7!:\*??=4!; 23!)?3!4?F2AK!G?:!3K7(:!AK7!&H&)=!8744!A'3&8!(?)37)4(97!A?)237:'&:34#13K7!:G&A3?:4!3K&3!&:7!8(V78T!3?!)A?)3:(; 237!3??:7\*(?)&&(a&3(?)!&F?) \*!3K7!3:&)4'?:3&3(?)!&)=!':?:2A3(?)!&337:)4!?:G!A?)42F7!:\*??=4!&:7!43:&37\*(A!()37:7434!8&; ?2:!A?434!\_!&)=!K(\*K7!:43&)=&:=4!G?:!7)37:()!\*1/2?:?7&)!F&:V734!n?<797:\_!G?:!F(=E:&)\*7!?:2A34!3K7! (A32:7!F(\*K3!:7!=GG7:7)3!:7A&247!?:G!3K7!K(\*K7!:43&)=&:=4!G?:!':?:2A34!&)=!':?:2A3(?)!3K&3!b7437:)!F&:V734!&:7! (:)A:7&4()\*8T!(F'87F7)3()!():7GG?:34!3?&=:744!7)9(:?F7)3&8!&)=!88; ?2:E:78&37!=A?)A7:)4#-!43:?)\*7!:)&!= \*:&=2&8!=7A8()7!?:G!\*8?; &&G:7(\*K3!G8?<4!?:G!3K747!\*??=4!(4!3?; 7!7U'7A37=\_!)?3!87&43!; 7A&247!(F'?:3!&)=!7U'?:3!G8?<!(?)3?!)&=!G?:F!b7437:)!F&:V734!&:7!A&88()!\*G?:!G&43!:78(&:87\_!&)=!687U; 87!47:9(A74!:3K7!:3K&)!3K7!:78&3(978T!48?<?A7&)!G:7(\*K3#!-)?3K7!:4'7A3!(4!3K7!4(\*)G(A&)A7!?:G!3K7!G&A3!:3K&3!3K7!/\_!():A:7&4()\*8T!A8&44(G(74!)?:2A34!&4!g43:&37\*(A&8T!(F'?:3&)3!?:!g43:&37\*(A&8T!8744!(F'?:3&)3\_!74'7A(&8T!()!3K7!A?)37U3??:G!K(\*KE7)=!&)=!47F(E!) (4K7!=!':?:2A34!&OK(4!37)=7)AT!K&4!; 77)!4'&:V7!=; T!\*:?:<()!\*A?)A7:)4!G?:!1/2?:?74!47A2:(3T!)37:7434!(G!/2?:?7!<?28!=; 7A?F7!3??!=7'7)=7)3!G?:!3K7!42'8T!&)=Z?!=!':?:2A3(?)!G!43:&37\*(A&8T!(F'?:3&)3!?:\*??=4!?)!A?)3:(74!:7\*&:=7!=4!':?37)3(&&47A2:(3T!:(4V4!Q?)97:478T!\_\*??=4!477)!&4!g43:&37\*(A&8T!8744!(F'?:3&)3!F&T!477!&)!7X2&(&a&3(?)!?:G!3:&7!G8?<4!<(3K!K(\*KE37AK!)?:2A3(?)!G&A(0(3(74!; 78?)\*()!\*?3!3K7!4&F7!42'8T!AK&(&4!4'&7!=!97?!=GG7:7)3!A?)3()7)34#!M!4(F(8&!:7\*&:=!3K7!7!F(\*K3!?AA2!:!4!40(\*K3!F?=&8!4K(G3!&<T!G?:F!3K7!A7&)!&4!43&374!':7G7:7!3?!=7!74(87)3!3?142'8TEAK&(&4K?AV45#!

<sup>2</sup> Shipping the same freight container onto different modes of transport.

<sup>3</sup> Such as defense or security technologies.

<sup>4</sup> A greatly simplified example would be a European car manufacturer who acquires car parts in Asia, ships these to Europe for assembly, and then ships its finished cars back to Asia.

<sup>5</sup> The April 2021 blocking of the Suez-canal Ocean route by a freight vessel illustrated the vulnerability of the ocean.

### 3.2.3 New trade routes affecting TEN-T

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!&==3(?)!3?!\*8?; &!A?::(=?:4!=74A:(; 7!=()!++\$\_!3K(4!AK&' 37!:!7U' &&() 4!3K7!7GG7A3!?G!F&c?!) 7<!3:&=7!:?2374!?)!  
0/. EO\_!=79?3() \*!4' 7A(&!&337) 3(?)!3?\_!3K7!QK() 747!L\_783!&)=!>?&=!M(3(&3(97!HL>M\_!3K7!" ?37) 3(&!-:A3(A!@7&!:?237\_!&)=!  
3K7!M 37!)&3(?)!&!. ?:3KE@?23K!0:&)4' ?:3!Q?::(=?:#!0K7!=:(97!; 7K())=!3K7!L>M(4!=74A:(; 7!=!&4!G?437:() \*!7A?)?F(A!  
&)=! 3:&=7! \*?:<3K! ; T! 43:7)\*3K7()) \*! 3:&)4' ?:3! &)=! 8?\*(43(A4! 3(74! ; 73<77)! QK() &! &)=! 3K7! 8&: \*7!: /2:&4(&)!  
K7F(4' K7:7!&)=!3K7!() (3(&3(97!(4! ; :?V7)!=?<)!) 3?\_!3K7!g%&:(3(F7!@8V!>?&=!]!&)=!3K7!g@8V!>?&=!/A?)?F(A!L\_783#!  
OK7!()A2; &3(?)!?G!) 7<!:&(8G:7(\*K3!A?)) 7A3(?)4!(4!9(3&8G?!!\*7) 7:&3() \*!&=?F743(A!&)=!G?7(\*)!42' ' ?:3!; &47!G??:!3K7!  
(()3(&3(97\_! &4! (3! K&4! 3K7! ' ?37) 3(&! ?G! A:7&3() \*! & A?) 4(=7:& 87! ()A:7&47! ()G:7(\*K3! 3:&)4' ?:3&3(?)! &)=! :78&37!=  
:797)274#!OK:??2\*K! 3K(4!3:&)4' ?:3!G?<!3K7!A?)) 7A3(9(3T! ; 73<77)! F&c??:A(3(74! ()L\_7437:!)QK()&! &)=! /2:? 7!  
H()A82=() \*!<7437:!)>244(&I\_!&)=!; 73<77)!3K747!A(3(74!&)=!3K7(:!K()37:8&)=!4!\*&7&38T!()A:7&47=#Q2::7)38T\_!3K7!F?43!  
(F' ?:3&)3!()37:A?3()7)3&8!:&(&<T!A?::(=?:!A?)) 7A34!3K7! /~!&)=!QK()&!3K:&2\*K!+?8&)=!L\_788:&24\_!>244(&I\_&)=!  
\&a&VK43!)&H' 8&)=!?:\*&)(a7=;! T!QK()747!?' 7:&3?:4!&A3() \*!; T!?:=7!?:G!3K7(:!&23K?:3(74!\_!&)=!3K7!Q&4' (&)!  
/43E L\_7437!A?::(=?:!&)=!3K7!. ?:3KE@?23K!A?::(=?:!F(\*K3!\*&()!3:&A3()#0K7!G?:F7:!7%F()&3743<7)3T!=&T4!?G!3K7!  
87&=!3(F7!<K7!)A?F' &:7!=!3?\_!A7&)&)=!K&4!; :&V7!?G!:&(&3:&AV!\*&2\*7!&)=!A243?F4!':?A7=2:74!&3!3K7!+?8(4KE  
L\_788:&24(&)!&)=!&a&VKEQK()747!; ?:=7:4#- ' &:3!G?:F!F?:7!A?97:3!F?3(9&3(?)4\_!3K7!G&A3!3K&3!:&(&4!AK7' 7:3K&!)!  
&(! &)=!G&437:3K&!)?A7&)! F?3(9&3741&==3(?)&L>M:&(&7U' &)4(?)\_!&)=!G&A3?4!42AK!&4!?AA&4(&)?&A!&A(3T!  
4K?3:&\*74!()!?A7&)&)=!(&:G:7(\*K3!&:7!43:7)\*3K7()) \*!:&(&4!\*&7&8! . 797:3K78744\_!(F' ?:3&)3!AK&87)\*74!42AK!&4!  
()G:&43:2A32:7!4K?:3G&884!&)=!7&T4!&)=!A?) \*743(?)!&3!/~!&::(9&37: F()&84!:7F&(&\_!&)=!/~!4K(' 7:4!477!&==3(?)&8!  
?; 43&A874!42AK!&4!(F' ?:3!4&)A3(?)4!; 73<77)!3K7!/\_!&)=!>244(&#!  
-4!G?:!3K7!-:A3(A!?:237\_!?' 3(F(4F!K&4!; 77)!\*?:<() \*!3K&3!(3!F(\*K3!G?:F!&!42' ' 87F7)3!3?\_!3K7!F2AK!F?:7!3(F7E  
=7F&)=() \*!@27aEA&)&! :?237\_!=7' 7)=() \*!?)! (A7!A?)=(3(?)4!&)=!47&4?)&8!&AA744(); 8(3T#>7&8(4F!(4!<&::&)37=\_!  
K?<797:\_!4()A7!A?F F7:A(&!9(&: 8(3T!?G!3K7!:\_?237!(4!K&F' 7:7=;! T!()A:7&4!(\*!7)9(:?)F7)3&8!:7\*2&83(?)4\_!\*&44&\*7!  
879(74!G?:F!&=c&A7)3!43&371(3)60046:(7)2(6(!. 821F)8(!)-2151(&)1(;)1(60' (&)1(;)1(7)1(791(!)1(!)-2152(8&)1(T)2(601

(0 G:&43:2A32:7!) 73<?:V4!4(A7!A2::7) 3!G8?<4!; 73<77) !7) 3:T! ?() 34!A?28=!4K(G3!3?G8?<4!<(3K()!A?2)3:(74!?:!7\*(?)4# 0?&AK(797!3K(4!3K7!&8?A&3(?)!?)G!42GG(A(7)3!()9743F7)3!G?:!3K7!=7978?'F7)3!?G!:&(8!()G:&43:2A32:7!(4!)7A744&:T! HA?F; () \*!()3:&!)=!()37:A?)3()7)3&F?97F7)34!4(F&8!8T!?:?37=!()!=(\*)3&8!4?823(?)4!#M!3K7!-:A3(A!)7<!7)3:T! ' ?()34!<(8!7F7: \*7!H&4(=7!G: ?F!7U(43() \*!47&' ?:34!\_!c243!&4!)7<!?:!; 24(7!:7)3:T! ?()34!()!2:?'7#!

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### 3.2.5 Looking beyond TEN-T: how to adapt the network to changing circumstances?

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>7A?FF7)=&3(?)4!7\*&:=() \*!3K7!X2743(?)!?G!K?<!0/. EO!4K?28=!:74'?)=!3?3K7!AK&)\*() \*!A(:A2F43&)A74!?238()7!=! &?97#M!7447)A7\_!3K7!47A3(?)!&: \*274!3K&3!3K7!)7<!AK&87)\*74!&)=!?' '?:32)(3(74!<(8!7X2(:7!&IA?)A7:37=!7GG?:3! G?:F!&8!A&47E:78&37=!43&V7K?&=7:4#>74'?)474!()!3K7!G?:F!?G!:79(47!=!?' ?(AT!)!=!7\*&8!G:&F7<?:V4! \*?97:)&A7\_! '8!)() \*!&)=!F?) (3?:() \*! ?G!)73<?:V! =7978?'F7)3!&)=!3K7!37AK)(A&8!4'7A(G(A&3(?)4! ?G! &8! &4'7A34! ?G! 3K7! (0 G:&43:2A32:7!<(8!7!:7X2(:7!=#0K7!)!&4'7A(G(A&3(?)!?)G!AK&87)\*74!H7#\*!A!:7&3() \*!3:&4'4:&7)AT!()!3K7!4787A3(?)!?G! ' ?:7A343?I42' ' ?:3!&)=!()9743!()!74'7A(&8!T!)!7(\*K; ?2:(0 \*!A?2)3:(74!\_&)=!7-2A() \*!3K7!=?F!(&)A7!?G!?:!78(&)A7! ?)I4! \*87!A?2)3:(74!3?!.743:&!)! ?8(3(A&8!7A?)?F(A!)?<7:!!(4! ?:9!<7:#M!(4!&84?!.7A?FF7)=7=!3K&3!G232:7!:79(4?)! :?2)=4!?G!0/. EO!()A82=7!()G:&43:2A32:7!3K&3!G&A(8(3&374!3:&=7!3K&3!K&4!; 7A?F7!42; 43!3(&8!H7#\*!?:!2374!3?!.)=!G!:?F! 3K7!-:A3(A!#D?97:)&A7!':?A7=2:74!H&)=!A?::78&3() \*!87\*(4883(?)!!)77!=!7E7438; 8(4KF7)3!9(&A?)424!&)=! ' &:3)7:4K'!<(3K!':(0A'&!A3?4! ?G!3K7!)7<!3:&=7! :?2374!&)=!&4K(G3!&)=!&:243F7)3! ?G!<?:V() \*!':?A7=2:74! A2::7)38T!247!=&:7!)7A744&:T#!(F&8!8T!2'=&3() \*!&)=!7' ?:3() \*!':?A7=2:74!)77!=2'=!&3() \*!74'7A(&8!T!3?!.)A82=7!7U37():&!/ !A?2)3:(74!3?!.42; F(3!)&3(?)&!(F'87F7)3&3(?)! ' &4!&)=!7' ?:3() \*! ?G! \+M A?F' &(&)A7# \+M! 3K&3! F?) (3?:!3:&4' ?:3E4'7A(G(A!A?)A7:)4!H7#\*!\_!87&=!3(F7!4K?28=!:7!&=7!=!3?3K7!0/. 37A!\+M4T437F#!

M!&!=!(GG7:7)3!97()!3:&4' ?:3!)73<?:V! ?3387)7AV!&)&8T474!<?28=!&84?!.77!=!3?!.7!7U37)=7=!!3K?2\*K!A&23(?248T!! 3?!.)73<?:V!47A3(?)4! ?234(=7!3K7!A2::7)3!0/. EO!4A?7#-84?!.F73K?=4!3?!.:(?:3(a7!':?c7A34!.<K(AK!&:7!&8?!.) (0K7:7)38T! ' ?8(3(A&8!<(8!)77!=!3?!.7! :73K?2\*K3!4?!.3K&3!3K7!0/. EO!)73<?:V!A!)=7978?'!()!&G&(!&)=!; &8!A7!=!F!)7:#!,&3!0/. EO!<(8!)77!=!3?!.7A?F7!:74(8(7)3!&)=!G87U(87!7)2?\*K!3?!.<(3K43&)=!G232:7!:7&8(3(74!)&=!A&3&43:?'K(A!=!(4:2'3(?)4!H7#\*!&)=!7F(A4!?:!)&32:&8ZF&)&F&=7!=!(4&437:4()!?:!234(=7!3K7!/:!#13K7!:!AK&87)\*74!3K&3!2'4A&8() \*!3K7!0/. EO!A?28=!7)7:&37!:&7!3K7!\*7)7:&3(?)! ?G!)7<!G2)=! \*!3?!.2' \*:&=7!()G:&43:2A32:7!()!7<! \*!37<&T!A?2)3:(74!3K7!()A7'3(?)! ?G!:78(&87!3:&4' ?:3!G8?<!G?:7A&43!&)=!()G?:F&3(?)!3?!.2' \*:&=7!(F'7)=! \*! :?3387)7AV4!H77'(! \*!():!3?!.AA?2)3!':?\*:744! \*!37AK)?8?\*(A&8!())?9&3(?)4!42AK!&4!ND!3787A?FF2)(A&3(?)!\_!&)=!3K7!A?4(=7:&3(?)! ?G!3K7!A:7&3(?)! ?G!@T)7: \*T!':?c7A34!&)=! \*!77!)77: \*T!)73<?:V4!^2:3K7!:747&:AK!4K?28=!&84?!.7!A&::(7!=?23!3?!.2)=7:43&)=!(F'7)=! \*!AK&87)\*74!3K&3!F&T!A2::7)38T!0(7!234(=7!3K7!4A?!.7! ?G!3K7!G?:7A&43#!!!

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### 3.2.6 Principal conclusions

\$# -!\*: &=2&8!()3788T32&!&)=!8?\*(43(A&8!4K(G3!G: ?F!hinterland!3:&)4' ?:3&3(?)!3?!.inland!3:&)4' ?:3&3(?)!K?8=4!3K&3!3K7!0/. EO!4T437F!<(8!7!F?:7!()3:(A&37!3K&)!797!:76?7\_!7A744(3&3() \*!G:&E:7&AK() \*!=!(\*)3&8!() ?9&3(?)4!H74'7A(&8!T!G?:!3K7!4243&()&87!3:&4' ?:3!G!4() \*87!<\*&?)ZA?)3&()7!:!&)=!8744E3K&)EA?)3&()7!:!8?&4!&)=!(0)37\*:3() \*!7F7: \*() \*!3:&=7!:?2374!()3?!.A?)3(7)3&8!G8?<4!#

"# -84?!.7F7: \*() \*!3:&=7!:?2374!&4!<78!&4!AK&)\*() \*!()3:&7\*(?)&8!3:&4' ?:3! ' &337:4!F&T!()A:7&47!3K7!(F' ?:3&)A7! ?G!()G:&43:2A32:7!43:73AK74!G?:F!)&3()&8!3?!.2'7!&:7879&)A7!H74'7A(&8!T!+:(0A'&8!/)3:T!+?(0)34!&)=!(0G:&43:2A32:7!A?))7A3() \*! \*?:<() \*!4(374! ?G! ' ?:2A3(?)!#n?<797!:!F7F;7!:43&37! \*?97:()F7)34!&)=!3K7!/:!7!&84?!.87!3?!(G827)A7!3K7!&A&3(?)! ?G!)7<8T!:7\*(?)&&(a7!=!)=243:(74!3K7!:2\*K!(0G:&43:2A32:7!()9743F7)3#0K7!&=!(3(?)! ?G!)7<!3:&4' ?:3!A?::(=?4!&4!9(3&8!7U37)4(?)4!3?!.3K7!0/. EO!)73<?:V!<(8!7X2(:7!2'=&374!3?!.3K7!87\*(48&3(?)!&)=!3?!.2'=&3() \*!&)=!7' ?:3() \*!':?A7=2:74!H&4!&238()7!=!()!-:3(A87!ORI!74'7A(&8!T!3?!.)A82=7!7U37():&!/ !A?2)3:(74!3?!.42; F(3!)&3(?)&!(F'87F7)3&3(?)! ' &4!&)=!7' ?:3() \*! ?G! \+M A?F' &(&)A7#!

C# ^() &8T\_!&4!7F7:\*() \*!3:&=7!?:2374\_!?637)!7)37:() \*!3K7!/^ ]4!37::(3?:T!9(&!3K(:=!A?2)3:(74\_!7U7:3!&! :?G?2)=! ()6827)A7!?)!()3:&EO/. EO!=7978?' F7)3\_!3K7!/^ !(4!()A:7&4) \*8!A?F' 7887=!3?I3&V7!43?AV!()!7U3:&37::(3?:(&! ()6:&43:2A32:7!=7978?' F7)3!3??<sup>6</sup>#!

!

### 3.3.1 Problem background

OK7!/2:?' 7&)!>&(!^:7(\*K3!Q?::(=?4!H>^Q!!&)=!3K7!0:&)E/2:?' 7&)!0:&4' ?:3!. 73<?:V4!H0/. EO!&:7!3K7!A?887A3(?)! ?G3K?47!:&(&<&T!()74!?:G3K7!/2:?' 7&)! )?(!&(!G:&43:2A32:7!)73<?:V\_!<K(AK!&:7!247=;! T!G:7(\*K3!3:&)4!G?:!3K7(.! A:&44E; ?:=7:!&2: )7T4#!>^Q4!&)=!0/. EO!&:7!8()V7=!3?I3K7!7U37:)&8!; ?:=7:EA:?:44() \*8!()V4!3K&3!A?)) 7A3!3K7!/2:?' 7&)! )?(!) ]4!:&(!G:&43:2A32:7!3?!=4!(&#!-4!G288!:&(&<&T!) 73<?:V!()37:?' 7:& (8(3T!?)!&8!3K747!/2:&4(&)!A?)) 7A3(?)4!(4! )?3!T73!&:7:&8(3T!?)!3K7!=!(GG7:7)3!47A3(?)4!8()V() \*!2/?:' 7!<(3K!-4(&\_!&)!)97)3?:T!?G!A2::7)3!A:?:44E; ?:=7:!:&(&<&T! ' &:&F737:4!4K?28=;! 7!78&; ?:&37=#!OK7!()37:)&3(?)&8!A?88&; ?:&3(97!?:\*&)(4&3(?)4!&)=!()9?897=!43&V7K?8=7:4!3K&3!42' ?:3!3K7!G:7(\*K3!3:&GG(A!3K&3!2)4!&8?) \*!3K747!()37:G&A74!K&97!; 77)!=74A:(; 7!=!()!&47' &:&37!47A3(?)#!-!?' 44!(; 87!()23!G?:!3K7!F?=788() \*!&)=!4A7)&:(?!; 2(&=() \*!G?:!&(&<&T!3:&)4' ?:3&3(?)!(4!&84?!=74A:(; 7!=!()!&4' 7A(G(A!AK&' 37:#!

### 3.3.2 Catalogue of railway interconnections

-88!:&(&<&T!()37:A?)) 7A3(?)4!K&97!; 77)!A?887A37=!&AA?:=() \*!3?I3K7(:!\*&7?\*:& ' K(A!=:(7A3(?)4!W!

E /&43; ?2)=!3?<&:=4!3K7!>244(&); ?:&=!:&(!\*&2\*7!)73<?:V#!!

E @?23K7&43!W3?<&:=4!3K7!02:V(4K!`MQ!\*&2\*7!)73<?:V#!!

E @?23K<743!W!()!3K7!=:(7A3(?)!?G!-G:(A&3K:&2\*K!&! ?:? 47!=!:&(&<&T!32)) 7!2)=7:I3K7!D(; .&83&:!43:&(3!HT73!3?; 7!; 2(83)#!

-!42F F:&T!=74A:(' 3(?)!' 7!:78&3(?)!K&4!; 77)!':?9(=7!=!()!&=73&(87=!3& 87!42' ?:37!=!; T!&==3(?)&8!)?374!?)!3K7! 9&:(?24!()G:&43:2A32:7! &:&F737:4#!!B!F243!; 7!)?37=!3K&3!4797:&8!; ?:=7:!A:?:44() \*8!()74!:&7! :747)38T!)?3!247=!G?;! G:7(\*K3!3:&GG(A!#-!g:&)V)!()=(A&3?!:K&4!; 77)!=7978?' 7!=!<K7:7; T!<7!A&37\*?: (47!=!3K7!A?)) 7A3(?)4!()!&AA?:=() \*!3?W!

E >W!K(\*K!9?82F7!G:7(\*K3!3:&GG(A#

E ?W!4?F7!G:7(\*K3!3:&GG(A!7U(434#

E @W!)?3!V)?<)!G!G:7(\*K3!3:&GG(A!(4!A?)=2A37=#!

Q:&: \*?I3T' 74!A&:(7!=!K&97!; 77)!A&37\*?: (47!=!4!G?88?<4W!

E A. +W!()37:F?==&8!H@1!A?)) 3&(!()7:4\_!?)EM@1!A?)) 3&(!()7:4\_!HA:&)7&; 87!47F(E3:&(87:4!&)=!4<& ' !; ?=(74!#!

E ?\*%<W!; 28V!A&: \*?I42AK!&4!3(F; 7:\_!A:2=7!?(8!&)=!7G()7!=!?(8!':?2A34\_!?:74\_!73A#!

!

OK7! G?88?<() \*! A?)4?8(=&37!=! 3&; 87! 42F F:&(a74! 3K7! G()=() \*4! ?)! 3K7! 3K:77! (=7)3(G(7!=! :&(&<&T! A?)) 7A3(?)4! H/&43; ?2)=!@?23K7&43!&=!@?23K<743!#!B!A?)) 3&(!()4!3K7!; &4(A!V7T!:&(&<&T!()G:&43:2A32:7! &:&F737:4!&GG7A3() \*!3K7! F?43!3K7!()37:?' 7:& (8(3T!?)G! 3K7!3:&()4! A(:A2&3(?) \*! ; 73<77)! /2:?' 7!&)=! -4(&#! -88! 3K747! 787F7)34! 4K?28=;! 7! ()37\*:&37=!(3?I3K7!4(F2&3(?)F?=78!&)=!(3?I3K7!=7978?' F7)3!?G!4' 7A(G(A!4A7)&:(?4#!

!

Table 5: Main parameter in railway corridor

<sup>6</sup> The items mentioned above will therefore be of particular importance for the PLANET project's conclusions and recommendations for future TEN-T development.

		4" C(: \$%%8"+%"#(			
! \$,9B\$C(&-%%,=-%()	@- * . +%,%"#(.. D-9D"=(	?%-\$_=(E\$*E"(	F9"+&%,G,&\$+, - . (	7%\$,.. (0". E+' (\$. . = (	>H9"(0-\$= (
Eastbound (Russia)	Finland, Estonia, Latvia, Lithuania, Poland, Slovakia, Hungary, Romanies	1 520 mm (even 1 524 mm in Finland)	YES	600m, 700 m or 1,100m	22.5 t
Southeast (Turkey)	Bulgaria, Greece	UIC gauge	Partially		
Southwest (Morocco)	Spain, Morocco, Algeria	New project (tunnel) – not relevant for PLANET			

### 3.3.3 Stakeholders involved and international organisations

OK(4!AK&'37:!()3:?=2A74!3K7!?'7:&3(?)&8!43&V7K?8=7:4!H&!'7:4?)!?:!87\*&8!7)3(3T\_!7#\*#!A?F'&)T!!&)=!()43(323(?)4!()9?897=!(!)3K7!F&)&\*7F7)3!?!G!()37:F?==&8!3:&)4':?3#^?:!7U&F'87\_!&G:7(\*K3!G?:<:&=7:!:?:!()37:F?==&8!3:&)4':?3!:?7:&3?:!4!3K7!(F7=(&37!:&3)7:!:?G!3K7!A?)4(\*):#!>&(<&T!()6:&43:2A32:7!?'7:&3?:4\_!?)!3K7!?:3K7!:!K&)=!':?9(=7!:?2374!E!3K(4!())=:(7A3!47:9(A7!(4!&!'7:7X2(4(37!G?:!3K7!?:\*&)(a&3(?)!?:!G!()37:F?==&8!3:&)4':?3#!- )!?:!97?9(7:<?!G!3K7!()37:&A3(?)!?:!G!3K7!()=(9(=2&8!&A3?:4!()!3K7!A?)37U3!?:!G!3K7!G8?<!?:!G!()G?:F&3(?)!&)=!8?&=()!\*12)(34!(4!\*(97!)!()!3K7!G?88?<()!\*G!(\*2:7#

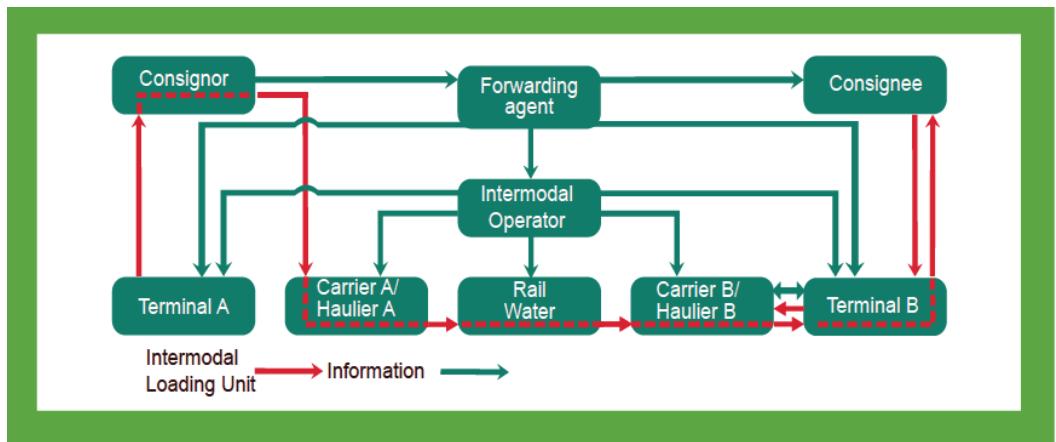


Figure 7: Stakeholders involved

6???:E3?E=???:! ()37:A?)3()7)3&8! 3:&)4' ?:3! ()9?8974! F 2AK! F?:7! ?' 7:&3(?)&!! ' &:3(74! &=! ?GG(A&!! ()43(323(?))4! A?F' &:7!=!3?&!F?:7!A?)97)3(?)&!/2?:' 7&)!()37:F?==&!!3:&)4' ?:3!!3:&()4!=7' &:3() \*!6?F!&!/2?:' 7&)!)?=7!3?&! QK()747!=743()&3(?)!<(88!\*&!3K?:2\*K!F 2AK!F?:7!A?2)3:(74!&)=!<(88!3K24!; 7!42; F(337=!!3?&!!&: \*7!:&) \*7!?!G!=!(GG7:7)3! ' ?:A7=2:74!&)=!<2874!H797)!()!3K7!A?2)3:T!3:&():!?' 7:&3(?)!4!F(\*K3!; 7!&==:7447!=!!3?&!!A&!!&23K?:3(74!8(V7!)!QK()&!! G?:!7U&F' 871#OK7!?:797H4!!&)=!3K7!3&4VH4!!?G!7&AK!43&V7K?8=7!:!7F&():\_!K?<797:H)7&:8T!!3K7!4&F7()!; ?3K3:&)4' ?:3! 47\*F7)34#OK7!)7U3!42; AK' 37:4!<(88! ?()3! ?23!9:&(?24!43&V7K?8=7:4!)()3(&3(974!3?!) ?F?37!:&(8<&T!3:&)4' ?:3&3(?))3?!!QK() &!!

### 3.3.3.1 The EU-China Connectivity Platform

OK7! 2/? 7&!)`)(?)! H/^ !&)=! 3K7! +7? 87]4! >7' 2; ?(A! ?QK() &! HOK() &! &:7! A?FF(337=! 3? F&() 3&() 0 \*! &)=! =7978? ( ) \*!43:?) \*!&)=!G:2(3G2! 78&3(?) 4!() 3K7!&:7&!?G!3:&) 4' ?:3#M!&)=!7GG?:3!3?!(F' :?97!3:&) 4' ?:3!A?) ) 7A3(9(3T\_ 3K7! 2/? 7&) !Q?FF(44(?) !H6D!% 1 [ /!&)=!3K7!. 3&?) &67978? F7) 3!&)=!>7G?:F!Q?FF(44(?) !?G!QK() &H. 6>Q! 743& 8(4K7=!&Q?)) 7A3(9(3T!+8&3G?:F!() !J\$N#

OK7!F&() !?; c7A3(97! ?G!3K7!+8&3G?:F!F!&4\*&:77=I; T!; ?3K!4(=74!F!(43? !7U' 8?:7!?' ' ?:32) (3(74!G?:!G2:3K7!:A??' 7:&3(?) !) 3K7!&:7&!?G!3:&) 4' ?:3!<(3K!&!9(7<3?!) K&) A7!4T) 7:\*(74!; 73<77)!3K7!/^ ]4!& ' ?:&AK!3?!) A?) ) 7A3(9(3T\_!() A82=() \*! 3K7!0:&) 4E/2/? 7&) !0:&) 4' ?:3!. 73<?:V!H0/. E01\_!&)=!OK() &]4!L783!&)=!>?&=!M) (3(&3(97!H>M#!OK7! 8&3G?:F!(4!&4?!) 247=!3?<?:V!3?<&:=4!\*:7&37:3:&) 4' &:7) AT! 7A( :?A(3T!() !F&:V73!&AA744!&)=!&87978! 8&T() \*!G(78=!G?:!; 24() 74474! () !3K7!&:7&!?G!3:&) 4' ?:3!() G:&43:2A32:7!=7978? F7) 3#

%?>7!4' 7A(G(A&8T\_!3K(4!A??' 7:&3(?) !) A82=74!&A3(?) 4!3?#

- @K&:7! () G?:F&3(?) \_! ' ?F?37! 47&F8744! 3:&GG(A! G8?<4! &)=! 3:&) 4' ?:3! G&A(8(3&3(?) \_! &)=! =7978? ! 4T) 7:\*(74! ; 73<77)!3K7!(!:7879&) 3!() 3(&3(974!&)=!>?7A34#
- M=7) 3(GT! A?E? 7:&3(?) !? ' ?:32) (3(74! ; 73<77)!3K7!(!:74' 7A3(97! ' ?8(A(74\_!() A82=() \*! 3K7! 0:&) 4E/2/? 7&) !0:&) 4' ?:3!. 73<?:V4!&)=!OK7!L783!&)=!>?&=!M) (3(&3(97#
- /U' 8?:7!; 24() 744!&)=!() 9743F7) 3!?' ?:32) (3(74!?' 7) !?3!; ?3K!QK() &!) =!3K7! 2/? 7&) !4(=7#
- Q:7&37! &! G&9?2:& 87! 7) 9(:?) F7) 3! G?:! 4243&() &:87! &)=! () 37:E? 7:& 87! A:?44E; ?:=7!:() G:&43:2A32:7! ) 73<?:V4!(!A?2) 3:(74!&)=!>7\*(?) 4!; 73<77)!3K7!/^ !&)=!OK() &#!

### 3.3.3.2 GETO

D/01!E!D:??' !?G/2/? 7&) !0:&) 4!/2:&4(&1' 7:&3?:4!&)=!^?:<&:=7:4!E!<&4G?2)=7=!( ) !L&478!() !\$R5B#M4G?2)=&3(?) !&(F7=!3?!) 4&G7\*2:&=!3K7!() 37:7434! ?G!/2/? 7&) !0:&) 4E@(); 7:(&)!? ' 7:&3?:4!&)=!3?!) 42' ' ?:3!3K7!() A:7&47! ?G!3:&GG(A!?) !3K7! 2/&4(&):&(&8<&T!A?::(=?:#M) !3K7! 43\_!3K(4!':(F&:(8T!; 7G7::7=!3?!) 0:&) 4!@(); \_!<K(AK!<&4!3K7!?:(\*() &!) &F7! ?G! D/01!sQ?FF2) (3T! ?G!/2/? 7&) !0:&) 4E@(); 7:(&)!1' 7:&3?:4!&)=!^?:<&:=7:4s#

D/01!(4!3K7!b 7437:) !/2/? 7&) !' (8&: !?G!3K7!() 37:) &3(?) &8! 73<?:V!G?:!3K7! ' ?F?3(?) !?G!0:&) 4E@(); 7:(&)!3:&) 4' ?:3# M!4!?) 7?G!3K7!() 3(&3?:4!&)=!G?2)=7:4!?G!3K7!M) 37:) &3(?) &8!Q??:=() &3() \*!Q?2) A(8!?) !0:&) 4E/2:&4(&) !0:&) 4' ?:3&3(?) !HQQOO!() !%?4A?<#M!42' ' ?:34!3K7!&A3(9(3(74! ?G!3K(4!A?2) A(8!?) !&A?) 43:2A3(97!&)=!A?FF(337=!F&)) 7:#!OK7!c?() 3! 7GG?:34! ?G! QOOOO!&)=! D/01!3?!) ' ?F?37!() 37:) &3(?) &8! 3:&) 4' ?:3! ?) !3K7! 2/&4(&) !8&)=!>?>7! <(3K! &!9:& (73T! ?G! () 3(&3(974!K&97!F&=7!&4(\*) (G(A&) 3!A?) 3:(; 23(?) !3?!) 3K7!=7978? F7) 3! ?G!3K747!3:&) 4' ?:34#

### 3.3.3.3 CCTT

OK7!M) 37:) &3(?) &8!Q??:=( ) &3() \*!Q?2) A(8!?) !0:&) 4E/2:&4(&) !0:&) 4' ?:3&3(?) !HQQOO!() !%?4A?<#M!42' ' ?:34!3K7!&A3(9(3(74! ?G!3K(4!A?2) A(8!?) !&A?) 43:2A3(97!&)=!A?FF(337=!F&)) 7:#!OK7!c?() 3! 7GG?:34! ?G! QOOOO!&)=! D/01!3?!) ' ?F?37!() 37:) &3(?) &8! 3:&) 4' ?:3! ?) !3K7! 2/&4(&) !8&)=!>?>7! <(3K! &!9:& (73T! ?G! () 3(&3(974!K&97!F&=7!&4(\*) (G(A&) 3!A?) 3:(; 23(?) !3?!) 3K7!=7978? F7) 3! ?G!3K747!3:&) 4' ?:34#

• OK7!%() (43:T! ?G!>(&8<&T!Q?FF2) (A&3(?) !?G!3K7!>244(&) !^7=7:&3(?) !H&G37: !3K7! 743:2A32:() \*! ?G!"JJC!f!1j@Q! >k6!H>244(&) !>(&8<&T4!#

• 67234AK7!L&K) !H6L!-D!#

• D:??' !?G!/2/? 7&) !0:&) 4E/2:&4(&) !^?:<&:=7:4!&)=!1' 7:&3?:4!HD/01!#

• \?:7&) !M) 37:) &3(?) &8! ^:7(\*K3!^?:<&:=7:4!-44?A(&3(?) !H\M^&-!#

+:747) 38T!3K7!QOOO!K&4!F?:7!3K&) !R\$!F7F; 7:4?A(73(74!G?:F!?"\$!A?2) 3:(74\_!() A82=() \*!:(&8<&T4! ?G!/2/? 7\_!-4(&!) =! 3K7!Q!&143&374\_!87&=() \*!4K(' ' () \*!A?F' &)(74\_!?' 7:&3?:4!&)=!G?:<&:=7:4\_!' ?:34!&)=!43797=?:( ) \*!A?F' &)(74\_!43&37! ?:\*&)(a&3(?) 4\_!&=F() (43:&3(?) 4!&)=!F2) (A(' &&3(74\_!3787A?F!&)=!F&:V73() \*!A?F' &)(74\_!47A2:(3T!47:9(A74\_!&)=!F&44! F7=(#^?:!F?:7!3K&) !"J!T7&:4!K(43?:T!3K7!QOOO!K&4!&AK(797=!=!K(\*K!() 37:) &3(?) &8!43&)=() \*!&)=!K&4!; 7A?F7!&) 7GG(A(7) 3!() 37:) &3(?) &8!G?:2F!G?:!) 73<?:V() \*!&)=!>7&!A??' 7:&3(?) !; 73<77)!&8! &:3(74!() 9?897=!=() !0:&) 4E@(); 7:(&) G:7(\*K3!3:&) 4' ?:3&3(?) #

OK7! F&c?:! \*?&8! ?G! 3K7! M) 37:) &3(?) &8! Q???:=( ) &3( \*! Q?2) A(8! ?) !0:&) 4E/2:&4(&) !0:&) 4' ?:3&3(?) !HQQOO!! &:7! H\$!! &33:&A3(?) !?G!3:&) 4(3!&) =!G?:7(\*)!3:&=7!A&: \*?!) !0:&) 4E/2:&4(&) !:2374! &44() \*!3K: ?2\*K!3K7!37::(3?:T! ?G!>244(&!) ( ) A82=( ) \*!?) !3K7!M0Q!&/43E b 743\_! . ?:3KE@?23Kd!&) =!H"!A???:=( ) &3(?) !?G!&A3(9(3(74! ?G! &:3(A' &) 34! ) !3K7!A&::(&\*7! ?G! \*??=4! ; T! &) =!&) =!47!&47A3(?) 4! ?G!&) 4E/2:&4(&) !:2374!&) =!( ) 37:) &3(?) &8!3:&GG(A!3?!) 742:7!3K7!X2&(3T! ?G! =78(97:T! &) =!=7978? ' F7) 3! ?G!7A?) ?F(A! :78&3(?) 4! ; 73<77) !A?2) 3:(74! ?G!+&A(G(A! :7\*(?) \_!Q7) 3:&8! -4(& !Qm@\_!L&&3(A!@3&374\_!&) =!=2:?:' 7!24() \*!3K7!() G:&43:2A32:7! ?G!>244(&) !>&(&T4#)

### 3.3.3.4 OSJD

OK7!1. \*&) (4&3(?) !G?:!Q?E?' 7:&3(?) !?G!>&(&8<&T4!() !&437:) !/2:?' 7!&) =!=4(&H1@j6! (4!&!\*?97:) F7) 3&8T!() G827) A7=!=!)?) E\*?97:) F7) 3&8!?:\*&) (4&3(?) !?G!&/437:) !/2:?' 7&) !&) =!=4(&!) &(&8<&T!2) =7:3&V() \*4!G?2)=7!=!() !\$RNS!&) =!; &47!=!() !b&:4<#! OK7! 1@j6! K&4! A2::7) 38T! "N! F7F; 7:4! ' 824! 4! F7! <7437:) !/2:?' 7&) !:&(&8<&T! 2) =7:3&V() \*4! K&9() \*!?) ; 47:97!:143&324#OK7!43:&37\*(A!?) ; 7A3(974! ?G!3K7!1@j6!&:7!3K7!G?:F&3(?) !?G!3:&) 4' ?:3!4T437F4!&) =!3K7!43:2A32:&8! :7G?:F! ?G!3:&) 4' ?:3!&(F7!=&3! ; 7337!:A?F' 73(3(?) !; 73<77) !3:&) 4' ?:3!7) 37:':(474\_!() !&:3(A2&:&3K7! :7=2A3(?) !?G! =78(97:T!3(F74!&) =!&AA787:&3(?) !?G!\*??=4!3:&) 4' ?:3#!!

### 3.3.4 Research Gaps

^2:3K7!:!747&:AK!&A3(9(3(74!4K?28=!=!A24!?) !3K7!G?88<() \*!A&37\*?: (74! H

- Q&37\*?:T! M! f!@3&3(43(A&8! F?:7!=73&(84!&) =!&AA2:&37!=&3!?) !3K7!A2::7) 3!3:&) 4' ?:3!9?82F74!H1Z6!F&3:(U!\_3K7!3T' 74! ?G!47:9(A74!&) =!\*??=4!3:&) 4' ?:37=\_!97:&\*7!3:&) 4(3!3(F7\_!':(A7!() =(A&3(?) !=78&T4#)
- Q&37\*?:T! M! f! G:&43:2A32:7!W\*&' !&) =!(F' &A3!&) &8T4(4!HO/. EO!97:424!-4(&) !A?::(=?4!\_!() 9743F7) 34!) 77=!=() !:&(&8<&T8() 74!&) =!=!) ?=74!H7) 3: T! ' ?() 34!\_!G288!787A3:(G(A&3(?) #)
- Q&37\*?:T! M! f! /A?) ?F(A4!W79?823(?) !?G!3K7!3&:(GG4! ?G!3K7!=!(GG7:7) 3!3:&) 4' ?:3!F?=74!H:&8!F&:(3(F7\_! :?&=I\_42; 4=(74\_!/2:?' 7&) !&:!=4(&) !42; 4=!=T!4AK7F74\_!F&(&:7&4?) 4!G?:!2) ; &&) A7=!=!3:&GG(A!G?<4\_!A?88& ; ?:&3(?) !' 8&3G?:F4\_!A?43!&) &8T4(4#)
- Q&37\*?:T! M! f! 1' 7:&3(?) 4!W ; 7337!:! 2) =7:43&) =() \*! ?G! 3K7! A2::7) 3! V7T! ; 24() 744! K2:=874\_! (F' :?97!=!A?88& ; ?:&3(?) !F?=784\_!() 37:?' 7:& ; (8(3T! ?G!) ?=74#)
- Q&37\*?:T! [!f! M!) ?9&3(?) !() 37AK) ?0?\*T! &) =!=&4473! 37AK) (A&8! () 37:?' 7:& ; (8(3T! ?G! <&\*?) 4! &) =!=! M, ` 4\_! 4' 7A(G(A&3(?) 4\_!M?0\_!=&3!(&0\_!37:?' 7:& ; (8(3T! &) =!=(\*3&8(4&3(?) !) 77=!=#)

### 3.3.5 Model description & scenarios

OK7!=(&\*) ?43(A! F?=7!3?!. 7!=7978? ' 7!=<(3K() !3K7!+, -. /0! ' :?c7A3!4K?28=!=! ; 7!247!=!&4!&) !() 43:2F7) 3!3?!. 7337!: A?F' :7K7)=!=3K7!A?F' 87U! 7A?4T437F! ?G!&(&8<&T3:&) 4' ?:3! <(3K() !37: F?=&8!8!&=(\*) !2) (34! ; 73<77) !/2:?' 7!&) =!=244(&ZQK() &#!OK7!=(&\*) ?43(A! F?=7!4K?28=!=! ; 7!43:2A32:7!=?) !&3K:77E&T7!:=(F7) 4(?) W

- E M! G:&43:2A32:7!W&T7!: <(3K!=73&(87!=! :237!=74A:( ' 3(?) 4!H() A82=( ) \*!&!F&!' !9(42&8(4&3(?) ) W4(F&8:&3?!) 3K7!>&(&^:7(\*K3! Q?::(=?4! 6?A2F7) 3!&) =!=Q243?F7:!M! G?:F&3(?) !+8&3G?:F!HQM+!!=7978? ' 7!=! ; T!>. /\_!3K7! F?=7!4K?28=' :?' 244!& !9(42&8(4&3(?) !?G! 3K7!4787A37!=! :23(?) \*! <(3K! &8!8! 74\_!37: F() &84\_!3:&AV! \*&2\*74\_! :&(&8<&T! ' :?G(874!#)
- E 1' 7:&3(?) &8!8!T7!: <(3K!=73&(87!=! :7:&3(?) &8! ' :?A7=2:74!&3!=!(GG7:7) 3!V7T!K&) =?97!:!' ?() 34!H) ?=74\_!A?244E ; ?:=7!:!' ?() 34!#OK(4!8797!4K?28=!=!(GG7:7) 3(&37!3K7!:2874! ?G!3K7!0/. EO!A?::(=?4!G?:F!3K7!3:&) 4A?) 3() 7) 3&8! :78&3(?) 4!H3K7!A?) ) 7A3(?) 4! ; 73<77) !/2:?' 7!&) =!=>244(&!) =!=&8!4787A37!=! :2374!&() V() \*!2:?' 7!<(3K!QK() &#!OK(4!8!T7:14K?28=!=! A82=7!3K7!7UAK&) \*7! ?G!A243?F4!&) =!=A?F F7:A(&8!=?A2F7) 34!&4! <78!H3(F() \*!) 77=!=!G?:!3K7!A7&:&) A7!G?:!7U&F' 87!#)
- E , 7\*&&P! ?8(AT!&T7:13K&3!F(\*K3!(F' &A3!3K7!3<?!)& ; ?97!F7) 3(?) 7=&8!T7:4!&) =!=<?28=&87=&!=!3?!)H\$!1!4(\*) (G(A&) 3! AK&) \*74! () 37: F4! ?G! () G:&43:2A32:7! A&' &A(3TZ&9(& ; (8(3T! &) =!=H"! (F' ?:3&) 3! F?==(G(A&3(?) 4! ?) ! 3K7! ?' 7:&3(?) &8! ' :?A74474! ?G!H() 37: F?=!=&8!G:7(\*K3!3:&) 4#!!

^?!=7&AK!&T7:1?G!3K7!F?=78!A87&:!X2&) 3(G(& ; 87! \+M!4K?28=!=! ; 7!=7978? ' 7!=!) =!=() 37\*:&37!=!() 3?!) 3K7!F?=78!OK747! \+M!4K?28=!=47:97!&4!& ; &4(4!3?!(=7) 3(GT!&) =!=&44744!3K7! ?37) 3(&8! ?G!3K7!7F7: \*7) 3!: ?2374!3K&3! <(8! ; 7!=7G() 7!=!)

3K7!9&:(?24!, , 4!()! &:3(A28:&!()!, , "!=7&8() \*!<(3K!:&(&8<&T!3:&)4' ?:3&3(?) #!OK7!(F' &A34!?)!3K7!:&(&8!3:&)4' ?:3!9?82F74! 4K?28=!: 7!G(:43!A&8A28&37=!' 7:!+M&)=! 7:!8&T7:!&)=!3K7)!F(U) \*!&8!+M!<(3K!&8!&T7:4!()!F?:7!A?F' 87U!4A7)&:(?4!# 0K7!F?=78!4K?28=!: 7!9&(&37=!F &()8T!; T!3K7!' :?c7A3! '&:3)7:4!&A3(97!()!3K7!8(9) \*!8& !!"!H&8!247!A&474!#0K7!,,,"! '&:3)7:4!K&8!3&V7!A&:7!G!3K7!G?88?<() \*!F &()!3&4V4#

- M=7)3(GT!&)=!4787A3!3K7!F?43!(F' ?:3&)3!7F7: \*7)3!:?2374#
- ,(43!&8!#?37)3(&8! '&:&F737:4!3?!, 7!()37\*:37=!(?)3?3K7!F?=78!&)=!3K(4!G?:&8!3K:77!8&T7:4!H477!AK&37!:!0#"?!
- G?::!=73&(84!#)
- @787A3!&)=!':?:(3(47!3K7!:7879&)3! '&:&F737:4!&)=!A:(37:(&!(F' &A3) \*!3K7!F?43!3K7!:&(&8!3:&GG(A!\*:?<3K!?)!3K7!4787A37=!7F7: \*() \*!#:?2374#
- M=7)3(GT!3K7!3T' 74!?G!\*??=4!3K&3!K&97!3K7!F?43! ':?F(4() \*!\*:?<3K!:&374!?)!3K7!9&:(?24!7F7: \*7)3!:?2374#
- 67G()7!G?:!7&AK!4787A37=!' &:&F737:3K7!:(\*K3!<+M!H7&4T3?!)X2& 3(GT!&)=!A&8A28&37!#
- [&8(&37!&8!#?23' 234!; T!7U37:)&&43&V7K?8=7:4!H?A247=7U' 7:3!?:?2' !?:!7U' 7:3!<7; ()&:!#
- Q?)4?(&37!&8!:742834!&)=!':?9(=7!G77=; &AV!3?!)&+\$!3&4V!87&=7:!:74' ?)4( 87!G?:!3K7!4(F28&3(?)!F?=78!#

0K7!F&(&!(F!?)G!3K7!F?=78!4K?28=!: 7!3?&44744!3K7!(F' &A3!?)G!3K7!4787A37=!' &:&F737:4!?)!3K7!A2::7)3!3:&)4' ?:3!9?82F74!?G!3K7! (=7)3(G(7=7F7: \*() \*!#:?2374#0K7!A:7=:(8(3T!?)G!3K7!F?=78!4K?28=!: 7!A?)3()2?248!T!F?) (3?7!=!)=!=&447447=!: T!,,,"! '&:3)7:4!&)=!3K7(:!42; A?)3:&A3?:4#!M!&===(3?)\_<K7)797!: )7A744&:T!\_3K7!:742834!F(\*K3!; 7!=4A2447=&)=!&==:7447=!(?)4' 7A(G(A!, , "!<7; ()&:4!&)=Z?:!<?:V4K? '4#

0K7!F73K?=8?\*T!247=3?!=7G()7!3K7!:(\*K3!4A7)&:(?4!G?:!, , "!(4!; &47=!)?3K7!A?)3:(); 23(?)4!G!^?2)=&3(?)!++\$!()!<K(AK!&!)7(\*K3E437' ! :?A744!K&4!; 77)!=73&(&7!=!)0:&)4' ?47=3?3K7!, , "!)9(:?)F7)3!3K7!G?88?<() \*!F &()!787F7)34!K&97!; 77)!7U3:&A37=!

- ^?A&!(4427!#In?<!<(8!3K7!247!?G!:&(&8<&T!3:&)4' ?:3!79?897=!(?)3K7!)7U3!37)!3?!)N!T7&:4!()!=??:E3?E=??:!42' '8T!AK&(&4!; 73<77)!/2?7!&)=!>244(&ZOK()&Ym!1bK&3!&:7!3K7!F&()!; ?3387)7AV4!?)!3K7!0/. EO!&)=!3:&)4A?)3()7)3&8!A?::(=?4Ym!OK7!4K(' 7:4!, @+4!7)3:T!)=?74!Q0!?' 7:&3?4!&:7!3K7!43&V7K?8=7:4!G?F!<K(AK!<7!9(7<3K7!G?A&!(4427#)
- \7T!G&A3?:4#M3T' 74!?G!\*??=4!&)=!8?&=() \*!2)(34!9?82F7!3K:??\*K' 23!7G(A(7)AT!?G!':?A74474!3:&)4(3!3(F7\_!:&(&8<&T!()G:&43:2A32:7!=(\*3&8!(a3(?)!?)G!=?A2F7)34#
- /U37:)&8!G?:A74#M7A?)?F(AH3:&A3(?)!':(A74.!7<!)3:&)34!\_!' ?8(3(A&8!HO/. EO!\*&97:)&)A7\_!42; 4(=T!4AK7F74!()!OK()&!A?F7:7A(&8!3:&7!&\*;77F7)34!; 73<77)!/2?7!&)=!OK()&!L\_!7)9(:?)F7)3&8!HD:77)!67&8!3:&)4' ?4(3?)\_!OK()747! ' ?4(3?)!?)! \*8?; &8!<&:F() \*!\_!37AK)?8?\*(A&8!H<&\*?)4\_!7F7: \*7)A7! ?G! ' 8&3G?:F! ' :?9(=7:4!()37\*:3(?)!?)G!+M&)=!M!0!F7AK&)(4F4!#
- Q:(3(A&8!2)A7:3:&()3(74!&)=!A?)43:&()34M&)!&44744F7)3! ?G!7&AK!7U37:)&8!G?:A7!4K?28=!: 7!2)=7:3&V7)!)! ?:=7:3?!)37\*:37!3K747!: (4V4!()3?3K7!F?=7#0!OK7!&44744F7)3!A:(37:(&4K?28=!: 7!:&)\*7!=!: 73<77)!\$!H97:T!8?<!!3?!)N!H97:T!K(\*K!#0K747!A?)43:&()34!K&97!; 77)!A&37??: (a7=!)3?!)O!F &()! \*!?:?2' 4#
  - D1 16@!H3:&)4' ?:3! ?G!6&)\*7:224!D??=4!#3K7!:743:(A3(?)4!?)!3K7!3:&)4' ?:3&3(?)!?)G!=&)\*7:24! \*??=4!3K7!22\*K!OK()&!K&97!; 77)!&F &c?:!AK&887)\*7!G?:!3K7!AK7F(A&8!47A3?:!OK(4!(4!&: ??F() \*!F &:V73\_!&)=!3K(4!F &:V73!(4!7\*7:3?!)477!3K7!:743:(A3(?)4!8!G37=#!
  - M. 0/ > 1/ > -L, M, M!H!H()G:&43:2A32:7!#M3K7!)77!=!G?:!=??:E3?E=??:!3:&()!()37?:?7:&:87! '&:&F737:4!; 73<77)!/2?7!&)=!-4!(&4!&:7:7X2(4!37!G?:!3K7!2:7?7&!)Q243?F4!&:7&#!OK(4!(4!)?3!T73!&!:7&#(3!&3!&8!G?:!3K7!-4(&)47A3(?)!?)G!&!)()37:A?)3()7)3&8!:&(&8<&T!3:&)4' ?:3#!!
  - ^ . 6M. D#42; 4(=74!E!=???:E3?E=??:!42; 4(=T!4AK7F7!?)!3K7!7F7: \*7)3!:?2374#M3K7!A2::7)3!QK()747!G2)=() \*!4AK7F74!&:7!V?<)!797)!G!3K7!&==:744!F &()8T!3K7!QK()747!7U' ?:37:4!; 23!&:7!)?3!43&:87!()37:F4!?G!3(F7#!

### 3.3.6 Conclusions

OK7! '& 7!:&AA2:&378T! (=7) 3(G(74!3K7!A?) ) 7A3(?) 4!; 73<77) !3K7!/2:?' 7&) !H` MO!\*&2\*7!) 73<?:V!&)=!3K7!\$N"JFF! >244(&) !H; :?&=!!\*&2\*7!:&(8<&T!) 73<?:V\_!<K(AK!&: 7I&:&\*78T!() K7:(37=I!&:F!3K7!@?9(73! 7:(?=!!1) 7!7UA7' 3(?)!(4!3K7! /&43E!& 743! D&7! 07: F() &! () . ?:3K7&43! n2) \*&:T\_! <K(AK! (G! A?F' 8737=! () ! "J""\_! <(8! F &3AK! () A& ' &A(3T! 3K7! %&&4a79(Aa7EL: 743!3:&) 4K(' F 7) 3!= (43:(A34! <K(87!?G67:() \*!43&37E?GE3K7E&:!7GG(A(7) AT#0K7!@?23K7&43!A?) ) 7A3(?) 4! ; 73<77) !L28\*&:(&!)!=!02:V7T!':?9(=7!& MO!\*&2\*7!A?) ) 7A3(?) !G!:&(&8<&T4!; 73<77) !/2:?' 7!&)=!-4(&!!OK7!3K(:=! L?4' K?:24!; :=(\*7!?' 7) 7!=!()!-2\*243! "J\$S\_!&)=!3K7!-:24!>&(0' ?:3!3K&3!<(8!42' ' ?:3!(34!62) A3(?)() \*!':7F(474!3?!) &=!=!42; 43&) 3(&!) 7<!A' &A(3(74!G: ?F! "J""F"C#, &43T\_! 3K7! ' & 7!: (=7) 3(G(74! 3K7! F 7AK&)(4F4! G?!:() 37:.) &3(?) &! A?88& ; ?:&3(?) !3? !?:\*&)(47! 3K7! &=F() (43:&3(97! 3:&8! 3K7! A243?F4! ' :?A7=2:74\_! &4! <78! &4! 3K7! :&8! 4&G73T! () 37:? 7:& ; (8(3T!&)=!A?F 2)(A&3(?) !8() V4!; 73<77) !3K7!/:!() G:&43:2A32:7!&)=!?' 7:&3?:4!&)=!3K?47!() !3K7!>244(&) ! &4!<78!&4!3K7!02:V(4K!:(7A3(?) !&8!3K7!<&T!3?!)Q() &!

OK7! :747&:AK! \*& 4! K&97! ; 77)! (=7) 3(G(7!=! <(3K! 3K7! =7G() (3(?) ! ?G! N! A&2437:4! H@3&3(43(A&&! M) G:&43:2A32:7! \*& ' ! 7A?) ?F(A4! ?! 7:&3(?) 4!&)=!() ) ?9&3(?) !!3K&3!4K?28!=; 7!G2:3K7!:() 9743(\*&37=!=!) !3K7!8(9) \*!8& ; 4\_!() !' &:3(A2&:&3K7! 8(9) \*!8& ; !?) !:&(&8<&T!3:&) 4' ?:&3&3(?) ##!

-!=(&\*) ?43(A! F?=78!(4!3?!) 7!=7978?' 7!=!3?!) 7337:!A?F' :7K7)=!3K7!A?F' 87U!7A?4T437F! ?G!3K7!:&(&8<&T!3:&) 4' ?:3! <(3K!() 37: F?==&8!8?&=() \*!2)(34!; 73<77) !/2:?' 7!&)=!>244(&ZQK() &#!OK(4! F?=78!4K?28!=; 7!43:2A32:7!=!) !&3K:77E &T7!:!= (F 7) 4(?) !H() G:&43:2A32:7\_!?' 7:&3(?) &8!&)=!87\*&8!P! ' ?8(AT!&)=! 7A?F F 7)=&3(?) 4!3?!)3K7!, , "!' &:3) 7:4!K&97! ; 77)!178& ; ?:&37=!=3?!)9&8(=&37!(3#!OK7!&23K?:4! ?G!3K7!A2: 7) 3!G?2)=&3(?) !' & 7!: ' ? 47!3?!)247!3K7! ?23' 234!G?:!3K7! b+\$!HF?=78() \*Z4(F 28&3(?) !&)=!b+C!H, , "!)!:&(&8<&T!3:&) 4' ?:&3&3(?) !?) !/2:&4(&):!22374!&A3(9(3(74#^?:!b+\$!3K7! =(&\*) ?43(A! F?=78!&)=!3K7! 78&37=!=4A7)&:(?4!4K?28!=; 7!A?) 4(=7:7!=!) !3K7!4(F 28&3(?) !7) 9(:?) F 7) 3!&)=!G?!:!b+C!3K7! &)&8T4(4! ?G!3K7! :?2374!&)=!3K7!= (G67:7) 3!4A7)&:(?4!4K?28!=; 7!G2:3K7!:() 9743(\*&37=!=!) =!9&(&37=!=!) !3K7!, , "!' &:3) 7:4! &)=!7U37: ) &8! &:3(74#

!



OK7! +!A?) A7' 34! &:7! 7F ; 7==7!=! () !3K7! +, - . /0! & ' ! :?&AK! 3?!) () 9743(\*&37! +!K2; !AK&:&A37:(43(A4! ' :?9(=() \*! 3K7! () 37:G&A7! ; 73<77) !\*8?; &8!&)=!K(0 37:&)=!?' 7:&3(?) !G! ?F! ; ?3K!4K(' ' !) \*!&)=! 8!A7) 3:7!=! 2?2374#M! (4! <(3K!() 3K7! ?; c7A3(974! ?G!+, - . /0! ' :?c7A3!3?!) &44744!K? <!3K7!3:&) 4(3?) !3?!) +!M' &:&=(\* F!A&):! ; 7!&AA787:&37=!=! , - . /0! <(8!4! 77!= 2' ! 3K7! ' :?A744! &)=! 3:&) 4(3(?) ! 3?<:&=! 3K7! +!M' &:&=(\* F\_! ; T! H(! ! ' :?9(=() \*! 79(=7) A7! ?G! 3K7! (F' &A3! ?G! +!M! () 3:?:=2A3(?) !) !: 7&E<:&8!=; 24() 744!A&474dH((!!&44744() \*!3K7!& ' 8(A& ; (8(3T! ?G!3K7!+!M!4!4T) AK: ?F?= &8(3T!A?) A7' 34dH((!! =7G() () \*! ; 24() 744! &)=! \*?97: ) &A7! F?=784!G? :!?' 7:&3(?) \*!2)=7!& +!M!D8? ; &8!3:&=7! < 7; d!H(9!) !' :?9(=() \*!3:&) 4(3(?) ! \*2(=78) 74!P!3?!) ?84!3? <:&=4!7F' 8?T() \*!3K7! +!M' &:&=(\* F!() !A' & ; (8(3TE: (AK!&)=!A' & ; (8(3TE' ??:!@Q!H@2' ' 8T!QK&() !) 7) 9(:?) F 7) 34dH9!17) K& ) A() \*!43&V7K?8=7: !A' &A(3T!() !7GG7A3(978T!&)=!A?88& ; ?:&3(978T! \*?97: ) () \*!& +!M!D8? ; &8!3:&=7! < 7; #!-AA787:&3() \*!3K7! +!M <(8! ; 7!&AK(797=!=3K: ?2\*K!4(F 28&3(?) !?G! +!M!2; 4!&)=!A?::(=?4! <(3K!=7F?) 43:&3(?) !&)=! &44744F 7) 3! ?G! +!M&A(8(3&3) \*!37AK) ?8?\*(74!() !3K: 77!8?; &8!3:&=7! :?237!, (9) \*!, & 4#

### 3.4.1 Physical Internet background

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M! : 74' ?) 47!3?!)3K7!+&:(4!- \*:77F7) 3!F?:7!&)=!F?:7! \*?97: ) F 7) 34\_!&44?A(&3(?) 4\_!&)=! ; 24() 74474!&: 7!4733() \*! ; ?8!= A(&F &37!3:& \*734#!7! "(\$8! , +, - . , #!(G-%(F\*&:- "(-!( I " (+ " (G,%#&(&8\$+"J. " \*+%%\$(&- , +, " . +, . (+ " (B-%= (I C(KLMLN!OK(4! <(8! ; 7!&AK(797=!=<(3K!&3<?E437' !& ' :?&AK\_!= "#, E. " =(-(%=" \*& (" @OK(" 8, #, - . #!(I C(MLP!(G, - +MMP!(I C(. - (9\$+"% +' \$. (KLRL(STU#!OK7!+&:(4!- \*:77F7) 3!2)=7:8() 74!3K7!(F' ?:3&) A7! ?G! F 773() \*!3K7!" JCJ!3:& \*734!G? :!3K7! /~ \_! ; 23\_!c243! &4!(F' ?:3&) 38T\_! 3!(=7) 3(G(74!& ) !?97: &88!F ; (3!) ?!G!8(F(3) \*!8?; &8!<&:F() \*!3? < 78! ; 78? <! "uQ\_!&)=!3? ! 2:427!7GG? :34! 3? !8(F(3! (3!3? !#\$NuQ\_!& ; ?97! :7E() =243:(&8!879784!V" #!OK(4!(F' 8!(74!3K&3! / !' :?\*: &F F 74!4K?28!=!) A82=7!&G?A24!?) !

G(:438T\_!A?K7:7)A7!?!G!&!(9743F7)34!<(3K!3K7!:7X2(:7!=!-. EJ+%"%8("+\$%I - . ,#\$+,- . (+%\$V" &+-%C\_!8)=!47A?)=8T\_!?)! F7&42:74!8(V78T!3?G&A(8(3&37!?:!2)8?AV!F?:7!&F ; (3(?24!=7A&: ; ?)(4&3(?))! ?37)3(&8\_!8)=!?)!3K7!=7978? F7)3!?!G!&!)7<!F&:V73!G?:!8?<!A&: ; ?)!\*??=4!&)=!47:9(A74##!

*It is expected that the increase in efficiency and productivity of freight transport and logistics will bring the savings and value needed to enable companies to pay for the required asset transition i e towards the greening of all transport assets*

h73\_!8?\*(43(A4!) 73<?:V4! &:7! 43(88! K(\*K8T!G:&\*F7)37=\_! F&()8T!=7=(A&37!=3?\_!&A?F' &)T!?:!&4' 7A(G(A! F:&:V73\_!&4! ' :?F?37!=! T!3K7!42' ' 8T!AK(&)A7' 3!8)=!97:3(A&8!A???:=()&3(?))#!OK7!+KT4(A&8!M)37:()73!H+M!(4!A?)4(=7:7!=3?\_!; 7! 3K7!9(4?\_!&:T! &:&(\*F!42' ' 8T() \*!&)!0 37\*:37!=!& ' :?&AK!3?\_!&==:744!8?\*(43(A4!) 37\*:33(?\_!&)=!A?88& ; ?:&;3(?))!(44274! &)=!3?\_!&97!3K7!?:&=!G?:<:&=!3?\_!=7' 8T() \*!7GG(A(7)3!42' ' 8T!AK(&)4#!OK7!+M(4!&\*&F7EAK(&) \*() \*!9(4?\_!3K3!A&247!=&\*(3&3(?))!()!3K7!8?\*(43(A4!)=243:T#!M)=77=\_!(&1!4A7)&:(?!)!<K(AK!&88!+KT4(A&8!M)37:()73!\_!37?3(8&7GG(A(7)A(74!&:7! &AK(797!=!3K7!G?:7A&437=ICJJi !()A:7&47!()3:&)4' ?:3!=7F&)=!A?28=!; 7!&AK(797!=<(3K!?)8T!NJi !()A:7&47!()!&44734! vCw#!OK7!-8(A7!&3G?:F!K&4! 2; 8(4K7!=!&=?A2F7)3!<(3K!&A?F' :7K7)4(9!?:&=F' &!3?\_<:&=4!3K7!+KT4(A&8!M)37:()73#! OK7!?:&=F' &!4V73AK74!&!&3K!G?:F!)?<3?\_!&J0J!4K?<()\*(F' ?&3!)F(8743?)74!:7X2(:7!=37AK)?8?\*(74!&)=!G(:43! (F' 87F7)3&3(?)!?\_!?:32)(3(74!G?:!3K7!+M!- =9&)A7=!' (8?3!(F' 87F7)3&3(?))4!?G!3K7!+KT4(A&8!M)37:()73!A?)A7' 3!&:7! 7U' 7A37!=!3?\_! 7! ?\_! 7:&3(?\_!&8!&)=!A?F?!)!()!&=243:T! :&A3(A7! ; T! "JCJ!A?)3:();23() \*!3?\_!&CJi !:7=2A3(?!)!() A?) \*743(?\_.!7F(44(?))4!&)=!7)7: \*T!A?)42F' 3(?)\_!G?:F!3K7!3:&)4' ?:3!47A3?:#

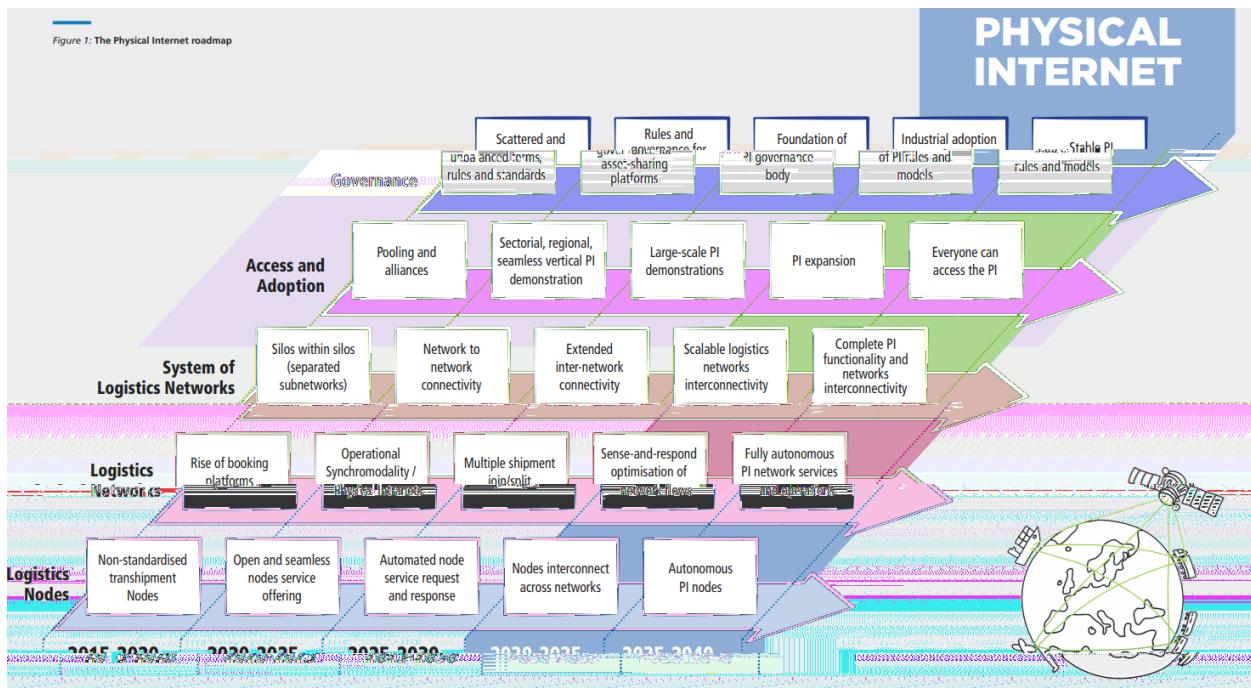


Figure 8: Physical Internet roadmap (SENSE project [4])!

!M)4' (:7!=! T!3K7!F738' K?:!?G!6(\*(3&8!M)37:()73!3K7!+KT4(A&8!M)37:()73!H+M!&(F4!3?\_!()37\*:37!=?\*(43(A4!) 73<?:V4!()3?\_!&!)?\_!7!)&=!()37:A?) 7A37!=! \*8? ; && 4T437F!3K:??\*K!43&)=:&=!A?)3:&();7:4!&)=! :?23() \*! ' :?3?A?84!H!&8?3!&)=!%?)3:72(\_!J\$0!vNw#!OK7!+KT4(A&8!M)37:()73! (4!& \*8? ; && 8?\*(43(A4!)4T437F!()!<K(AK! ' :?2A34!&:7!3:&)4' ?:37!=!()43&)=:&=!(a7=\_!F?\_=2&:\_!A?)3:&();7:4!&4! 7GG(A(7)38T!&)=!7GG?:387448T! ; 73<77)!A?)3:();7)34!&4!()!3K7!A&47! ?G!6(\*(3&8!M)37:()73!3:&)467::() \*!G?:F&3(?);73<77)!47:97:4##!

+KT4(A&8!M)37:()73!(4!&!)?\_!7!)!G:&F7<?:V!&4?G?:F!3K7!\_?()3!\_?G!9(7<!?G!3K7!247!\_?G!3K7!74?2:A74#!OK7!247!\_?G!\_?!)!<:&7K?2474!&)=!3:&)4' ?:3! )73<?:V4!8?\_?V4!G?:!& 4T437F(A!8?&:\_!A?)4?8(&3(?\_!&)=! ?' 3(F(a&3(?))!()!<K(AK!3K7!A&:\_!A(3T!()!3K7!8?\*(43(A4!)4(374!&)=!3:&)4' ?:3!)73<?:V4!A?28=! ; 7!F?:7!&9&(\_!87!G?:!3K7!247!\_?G!43&V7K?8=7:4!()!&F?:7?\_!3(F(a7=\_!<&T!M:7=2A() \*!7)7: \*T!A?)42F' 3(?)\_!7)9(:?)F7)3&8!7F(44(?))4!&)=!7A?)?F(A!A?43#

OK7:7!&:7!=!(GG7:7)3!A?)A7'34!2)=7:!:+M3K&3!A&)!(F' :?97!3K7!' :?=2A3!G8?<4!&=:7447!=()!+, -. /0#!^?:!7U&F' 87\_!?)7! ?G! 3K7! A?)A7'34!3K&3!+M ; :() \*4!3?3K7! (F' :?97F7)3! ?G! 3:&)4' ?:3! 7GG(A(7)AT! (4! 3K7! 43&)=&:=(a&3(?))! &)=! F?=28&:(3T! ?G! 3:&)4' ?:3! ' &AV&\*() \*! G?A24() \*! ?!)3K7! :7=74(\*!) ?G! ' ?:2A3! ' &AV&\*() \*! 3:&)4' ?:3! ; ?U74! &)=! A?)3&()7:4!G?:!?' 3(F&8!G(3!3?!)?:2A3!&)=!G??:!F?=28&:(3T!3?&8?<!7GG(A(7)3!K&)=8() \*!A?)4?8(&3(?))!&)=!':??8() \*#!OK(4!A&!)! 7!A?F; ()7=!=<(3K!:7E24&; 87!A?)3&()7:4!H>Q41\_!()!&)3(A' &3(?))!?G!3K7!(F' 87F7)3&3(?))!?G!3K7!G288!+KT4(A&8!M)37:()73!A?)A7'3#!

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### 3.4.2 Research questions

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OK7!G?88?<() \*!&:7!3K7!F&():747&:AK!X2743(?)4!3?; 7!79&82&37=()!3K(4!:747&:AK!<?:VW

- >x\$W0?<K&3!7U37)3!(4!3K7!=7978?' F7)3! ?G!3K7!' KT4(A&0!&)=!=(\*3&8!()G:&43:2A32:74!3?<&:!=/D0. !()4' (:7!=; T!&)=!()42' ' ?:3! ?G! ' ?:744(97!F&32:(3T!879784!?G!+M!M)!?3K7!:<?:=4!<K&3!A&!)!+, -. /0!87&:!)G?:?F!3K7!+M>?&=F&' !&)=!K?<!A&)!3K7!7U'7:(7)A74!()3K7!+, -. /0!' ?:c7A3!()G?:F!&?23!3K7!9(& (8(3T! ?G!3K7!+M>?&=F&' Y!

  - /U&F' 87W3K7!=7978?' F7)3! ?G!L?AVAK&()!37AK) ?8?\*T!()!A?)c2)A3(?)!<(3K!M?0!&)=!4F&:3!A?)3:&A34!A?28!=42' ' ?:3!43&)=&:=(a7=Z' :7=(A3&; 87!47:9(A7!:74' ?)474!3??:7X2743#!

- >x" Wn?<!A?28!=3K7!9&:(?24!&4' 7A34! ?G!3K7!+KT4(A&8!M)37:()73!A?)3:(; 237!3?!(F' :?90 \*!3K7!?' 7:&3(?))&!:7;G?:F&)A7! ?G! (37:A?)3()7)3&8!A?:;(:=7:4! 3K&3! ()A82=7! 3K7! 0/. EO! A??:;(:=7:4! \*37<&T! ' ?:34! &)=!(37:A?)3()7)3&8!3:&=7!8&)74Y!

  - /U&F' 87W&23?F&37=3:&)4' ?:3!?' 7:&3(?))4!&)=!; 7337!:23(8(a&3(?))!?G!3:2AV4!A?)43(3237!&!' ?37)3(&!)4<7:13?3K7!=7G(A(3! ?G!=(97:4!+M()A:7&474!A?)3&()7:!=743()&3(?))!9(4(); (8(3T!3K&3!K78' 4!(F' :?97!' ?:3!?' 7:&3(?))4#

- >xCW0?<K&3!7U37)3!=?1\*7?E7A?)?F(A!&4' 7A34!(F' &A3!3K7!&=?' 3(?))!?G!+M!M!
- >x0W bK&3! (4! 3K7! (F' &A3! ?G! +, -. /0! 8?\*(43(A4! &)=! 3:&)4' ?:3! A?)A7' 34! &)=! 37AK) ?8?\*(74! 42AK! &4!@T)A?:F?==&(3T!-M-:3(G(A(&8!M)3788(\*7)A71\_M?0!L8?AVAK&()!&4!A?)3:(; 23() \*!3?3K7!+M?&=F&' !?)!A??:;(:=7!:7978?' F7)3Y!n7:7!<7!F&T!=!(97!()3!4' 7A(G(A!X2743(?)4!42AK!&4!M!

  - H(! bK(AK! &:7! 3K7! ; 7)7G(34! H&)=!=:&< &AV4! !?G! K&9() \*! ?' 7)Z4K&:7!=! :74?2:A74! H<&:7K?2474\_!3:&)4' ?:3!A' &A(3T! t!&4!+M47:9(A74!()3K7!()37:A?)3()7)3&8!A??:;(:=7:4Y!!
  - H(! bK&3! &:7! 3K7! ; 7)7G(34! &)=!=:&< &AV4! !?G! ()3:?:=2A() \*! G87U(); 87!=7' 8?TF7)3! &)=! :?23() \*! ?G!3:&)4' ?:3!F7&)4!8&?) \*!A??:;(:=7:4!; &47!=!?)!':?\*)?43(A4Y!

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### 3.4.3 PI Literature review

OK7!+M8(37:&32:7!(4!A?)43&)38T!\*&?:<() \*!OK7!97:T!G(:43! 2; 8(A&3(?))!?)!3K7!+M=&374!G?:?F!"JJS!<K(87!3K7!A?)A7'3!G!

&A32&8!+M<&4!()3(&8T!()3:?:=2A7!=!()!"J\$J!; T!%?)3:72(8!73!&8!()!vNw!<K?&8(=!(34!G?2)=&3(?))4!&)=!:7A7(97!=3K7!&337)3(?))!?G!&A&=7F(A4!&)=!':&A3(3(?))7:4#

OK7!F&():?; c7A3(97! ?G!+KT4(A&8!M)37:()73!(4!3?!)F&V7!G:7(\*K3!3:&)4' ?:3!F?:7!7GG(A(7)3!&)=!4243&(); 87!vSw#!+MA:7&374!&IA?88&?:&3(97!3:&)4' ?:3!)73<?:V!; T!=7978?' () \*!43&)=&:=(47=\_!F?=28&:IA?)3&()7:4!A?F F?)!':?3?A?84!&)=!3?84!&)=!4K&:7!=3:&)4' ?:3!&)=!37AK) ?8?\*(A&8!44734!v5W#!0K7!+M&(F4!3?!)&(a7!3K7!3:&)4' ?:3&3(?))!?G! KT4(A&8!\*&??=4!()!&F&))7:4!(F(&8!3?!)3K7!<&T!()!<K(AK!&3&!&AV&\*74!&:7!F?97!=!?)!3K7!=(\*3&8!M)37:()73#!LT!4K&():\*!74?2:A74!42AK! &4!97K(A874! &)=!=&3&\_!&)=!=74(\*)()!\* 3!A7)3:74! <K(AK! 7)& 87! 47&F8744! (37:?:7:& (8(3T! 3K7!3:&)4' ?:3&3(?))!?G! \*??:=4! <(88! 7!?)3(F(a7!=!7\*:&=() \*!A?43\_!4' 77=\_!7GG(A(7)AT!\_&)=!4243&(); (8(3T! 0?&AK(797!3K(4!?)3(F(a&3(?))\_3K7!+M4734!A?F F?)!&)=!2)(97:4&8T!&77=E2' ?)43&)=&:4!&)=!=!':?3?A?84!3?G&A(8(3&37!K?:(a?)3&8!&)=!97:3(A&8!A??7:&3(?); 73<77)!?:\*&)(a&3(?))4#H!OK7! KT4(A&8!()37:()73!&4!&)7<!42' ' 8!AK&():!&:&=(\*F W&#!M!#M!

-AA?:=() \*!3?!)3K7!+M4733() \*!\*??=4!&: 7!G(:438T!7) A&' 428&37=!( )!43&)=&:=!F?=28&:!A?)3&()7:4\_!&F7=!=!+MEA?)3&()7:4\_!<K(AK!A&); 7!?G!9&:(7=!4(a74!vBw!&)=!; 7!()378(\*7)3!vRw#1 1)7!?:!4797:&!A&::(7:4!3K7)3!:&4'?:!3K747!A?)3&()7:4!6:&F!K2; 3!?:!3K7!=743()&3?!)#0K7!K2; 4!()!+M!?:!+MEK2; 4!v\$Jw\_!&:7!?'7)3?!)4K('7:4!?:!A&::(7:4\_!<K(AK!F7&)4!3K&3!4K('7:4!?:!A&::(7:4!F&T!G:778T!l?!)!?:!87&97!&)T!K2; 4#!

OK7!/2:?7&)!0?FF(44?)\_G?88<() \*!3K7!3:&)4'?:3!?'8(AT!)A82=7=!( )!3K7!OK(37!+&7:!:?G!"J\$\$!v\$\$w\_!&(F4!&3!)7&:!ga7:?:E7F(44?)!2:;&)!8?\*(43(A4!)T! "JCJ#OK7!?:c7A3(97!(4!3?!(F'87F7)3!&)=!=7F?)43:&37!3K7!A:?:44E/2:?7&)!(F'87F7)3&3?!)?G!3K7!. 73<?:V4\_!()!<K(AK!M!

- ; ??V() \*4!; T!4K('7:4!<(88!7!A?)4?(&37=!( )!37:F()&84!&)=!=!(43:(23?)!A7)3:74#
- '8&)())!\*&!<(88!7!7&8E3(F7\_!&37=3!?:!3K7!A2::7)3!&9&(&8(3T!?:!A&::\*!47:9(A74\_!&)=!=74?2:A74#

%&324(7<(Aa!)!v\$"w!3K7:7!(4!&!=74A:(3?!)?G!3K7!AK&)A74!3K&3!3K7!+KT4(A&8!M)37:)73!:() \*4!3?!)3K7!&\*(43(A4!)7GG(A(7)AT!6:&F!&!)!/^!7:4'7A3(97!OK7!:&3(A87!=74A:(74!3K7!G?:F&!/^!7:&:&3?!)G?:!3K7!+MA?)A7'3!&4!<788!&4!3K7!4787A37!=G(:43!'?:c7A34\_!97)32:74\_!&)=!=3?!)84!3K&3!&8:7=&T!G2)A3?!)!4!':?3?3T'74!?G!3K7!+MA?)A7'3#OK7!&23K?:]4!)?<E A?)A82=7!=42:97T!4K?<4!43&V7K?8=7:4!]:782A3&)A7!3?<&:!=4K&:&!)G?:F&3?!)!&=!(A?))7A3() \*!3?!)3K7!A?F?!)!&83G?:F#.!?!?)7!K&4!797!=74(\*)7!=!A?K7:7)3!\*&8; &8!3:&)4'?:3!4T437F#Q2::7)3!4?823?!)4!:78T!?)!&!A?F; ()&3?!)?G!)&3?!)&8!\_7?!)&=!=8?A&8! )73<?:V4!<(3K!)?!A?FF?)!43:2A32:7!7:74283() \*!()!&AK&?3(A!&)=!=()7GG7A3(97!3:&)4'?:3!F?=78#!

-AA?:=() \*!3?!)8(A7!"J\$S!v\$Cw!()!3K7!9(4?)!G?:!&3:&)4'?:3!4T437F!42'?:3!() \*!4243&(&87!&)=!=7GG(A(7)3!8?\*(43(A4!)3?<&:!=4!3K7!+KT4(A&8!M)37:)73\_!()=(A&374!3K&3!3K7!V7T!/&); 8() \*!G&A3?:4!G?:!+M&:7M

- >7&AK() \*!A?)47)424!&)=!=42'?:3!G?:F!&88!3:&)4'?:3!&)=!=8?\*(43(A4!)43&V7K?8=7:4\_!()A82=() \*!/2:?7&)!Q?FF(44?)!&)=!=%7F; 7!:@3&374!?)!3K7!)77!=3?!)&AK(797!3K7!3:28T!()37\*:37=!=3:&)4'?:3!4T437F!G?!=4243&(&87!&)=!=7GG(A(7)3!8?\*(43(A4!)!&=!=?)!3K7!&97:&8!9(4?)!?)!3K7!4T437F#
- Q2::7)3!=7978?'F7)3?!)!?:?3?!)?G?:!8?\*(43(A4!)&=!=23?)?F?24!?:7:&3?!)4#
- -23?)?F?24!3:&)4'?:3#
- M)37:)73!?:!OK() \*#
- L(\*!6&3&#
- Q?:<=4?2:A() \*!&)=!=4K&:&!)!7A?)?FT#
- ^&43!79?823?!)?G!)37?:7:&(&3T!3?<&:!=4!7&4(7:!)A?)7A3(9(3T!?)G!()=7'7)=7)3!MQ0!4T437F4#
- ,7&=7:4K('!&)=!=7)3:7':7)72:4K('#

M!):7A7)3!T7&:4!4797:&!/2:?7&):747&:AK!':?c7A34!K&97!; 77)!=7978?'7!=3?!)&8T47!=!(GG7:7)3!&4'7A34!?:!3K7!+KT4(A&8!M)37:)73!@?F7!?:!G!3K7F!&:7!%?=!=2824KA&!v\$O!H&!)&A:&)TF!G?:!%?=!=28&:,?\*(43(A4!)34!()!@K&:7!=!Q?E%?=!=8!. 73<?:V4!G?A247!=?)!G&43EF?9() \*!A?)42F7!?:!=4!^%QDI!&?\*(43(A4!)@/0>M@v\$NwH@3:7)\*3K7)() \*!/2:?7&)!0:&4'?:3!>747&:AK!&=!=M!)?9&3?!)@3:&37\*(74!<K?47!?:c7A3(97!<&4!3?!=78(97!:!&A?K74(97!&)=!=A??:=!=37!=&'?:&AK!3?!)747&:AK!&=!=()?9&3?!)43:&37\*(74!G?:!88!3:&)4'?:3!F?=74!()!/2:?7#Q,`@0/>@!"#J!v\$S!H1'7!)73<?:V!KT'7:EA?)7A37!=!=8?\*(43(A4!)A82437:4!3?<&:!=4!+KT4(A&8!M)37:)73!#MB!:78(7!=?)!&!)1'7!)73<?:V!?,?\*(43(A4!)Q82437:4!?:7:&3!) \*!()!3K7!G:&F7!?:!G!07)E0:&)=!=42'?:3!) \*!8?A&8!7\*(?)&8!&)=!=/2:?7&)=!=7978?'F7)3!<K(87!V77'()!)723:&!3K7!8?A&8!(F'&A34!42AK!&A?) \*743?!)!?)?47!8&)=!=8?A&8!7?823?!)879784#MQ1./0!+>1j/Q0d!(34!\*&8!(4!3?!)743&:8(4K!&!)A8?2=E; &47!=+MG:&F7<?:V!&)=!=8&3G?:Fm!v\$5w\_!<K(AK!; 2(8=4!2'?)!3K747!&337!:87&=() \*E7=\*=7!37AK)?8?\*(74\_!&!)&3K<&T!3K&3!()37\*:374!+M=:(97)!A&:&(&3(74\_!T!F7&)4!?:!G!&)!A:7F7)3&8!&)=!=97:(G(&87!&':?&AK!3K&3!7U'8?(34!':?\*744!()!)=!=

5\$%+,8"(&-.+\$,. "%(8-=%"#(\$#(\$. (., +,\$9(WA%"G%"'. &"(8-=%"(OK7! \*8?; &8!4T437F! ?G!A?) 3&() 7:!8?\*(43(A4!4!&!' :78(F() &:T!97:4(?) !?G!3K7!7) 9(4(?) 7=!=+M! b!7!A&!) 87&:!) G? F!3K7! A2::7) 3! F&:(3(F7!A?) 3&() 7:!4T437F! &)=!(3! <(8!K78! 24!3?!) ?4(3?) !@T) AK: ?F?=&8!3:&) 4' ?;3! &4! &!' :78(F() &:T! A?) A7!3!G?!=+M!

!^?88?<() \*!3K7!- ,M0/I>?&=F&!' 3?<&:=!+M! <7!?; 47:9713K&3M\$!!A?) 3&() 7:!37: F() &84!&:7! :78(F() &:T!97:4(?) 4! ?G!+M! . ?=74!&4!3K7T!K&)=87!A?) 3&() 7:4!(&1!43&)=&:=(a7!=!<&T!&)=!242&88T!&:7!4K&:7!=&F?) \*!&() T!) 2F; 7:!G!4K(' ' 7:4# -F?) \*!?3K7!3K() \*4!) ?=74!K&97!; 77)!&23?F&37!=&)=!43&)=&:=(a7!=!74! ?) 47!3?!) 47:9(A7!7X27434!(4!2)=7: <&T! H!"!!A?) 3&() 7:13:&) 4' ?;3!) 73<?:V4!&:7!&8:7&=T!; &4(A&88T!?' 7) !3?!) F283(' 87!4K(' ' 7:4!&)=!&8?<!(?;!A?) 4?!(=&3(?) !() !() 37: F?=&8!3:&) 4' ?;3!) 73<?:V4d!HCl!A?) 3&() 7:13:&) 4' ?;3! &8:7&=T!=7' 8?T4!&4!4T437F! ?G!9&:?(24!) 73<?:V4!&A:&?44! F?=>74!&)=!3?!) 4?F7!7U37) 3!, @+e4!() !K?:(a?) 3&8!&)=!97:3(A&8!A?88& ?;&3(?) d!H0!3K7!() =243:T!K&4!&?' 37=!3K7!247!?G!43&)=&:=(a7!=8?&=!(\*12) (34!&)=!K&4!43&:37=!3?!) &AA7' 3!=(\*3&8!43&)=&:=4!&4!<788d!HNI!4&F7!K?8=4!3:27!G?;!\*?97:() &) A7! :2874!&)=!43&)=&:=4#!

n?<797: !3K7!7!(4! :?F!G?; !G2:3K7!=7978?' F7) 3!() !3K7!A?) 3&() 7:!4T437F!M\$!!A?) 3&() 7:!37: F() &84!&:7!) ?3!T73! 4T) AK: ?(a!) \*!3K7(!? 7:&3(?) 4!<(3K!(); ?2)=!&)=!23; ?2)=!3:&) 4' ?;3&3(?) !&A3(9(3(74!3?!) 3K7!G288!7U37) 3!' ?44( 87! H!"!!( 37: F?=&8!3:&) 4' ?;3!) 73<?:V4! ) 77!=3?!=7978?' F?; 7! G87U( 87! =7' 8?T7) 3! ?G! &44734\_! A&' & (8(3(74! &)=! :74?2:A74!; T! F?9() \*!3?<&:=!4T) AK: ?F?=&8!47:9(A74d!HCl!A&:(7:4!&)=!, @+e4!A&!) F?97!G?;<&:=!() !' :?\*:744(9787! 4K&:7!3K7(:!&44734\_!A&' & (8(3(74!&)=!74?2:A74d!H0!3K7!&=? 3(?) !?G!&2) (97:4&8!473! ?G!=(\*)3&8!43&)=&:=4!(4!2)=7:<&T! ; 23!A7:3:&() 8T!) ?3!&AK(797=d!HNI!4&F7!K?8=4!3:27!G?;!\*?97:() &) A7!:2874!&)=!43&)=&:=4#!

!& !& !<&T!743& 8(4K() \*!3K7!+M: ?&=F&!' !&3!3K7!87978! ?G! F&:(3(F7!A?) 3&() 7:4!A?28!=!; 7!&!\*&:7&3!7U7:A(47!3?!) :?\*:744! 3K7!+M G?; ! =??:E3?E=??!: !8?\*(43(A4! AK&() 4#! -=F(337=8T! 3K7! 4A?; 7! ?G! 3K7! A?) 3&() 7:!) 73<?:V! (4! 8(F(37=#! 0K7! =7978?' F7) 3! ?G!=(\*)3&8!; ??V() \*! 8&3G?: F4!&)=!4T) AK: ?F?=&8!47:9(A74!G?; !A?) 3&() 7:!8?\*(43(A4!() =(A&37!3K&3!3K7! :?&=F&!' !(4!; 7() \*!(F' :?97=#!

### 3.4.4 Research gap

!

OK7!8(37:&32:7!?) !3K7!+KT4(A&8!M) 37:) 73!(4!7U37) 4(97#!OK7!G?88?<() \*!47A3(?) !K(\*K8(\*K34!4?F7! ?G!3K7!\*& 4!(=7) 3(G(7!=() !3K7!8(37:&32:7!G?; !3K7!=7978?' F7) 3! ?G!+KT4(A&8!M) 37:) 73M!

- M!%&324(7<(Aa!v"J!3K7!&23K?:4!() A82=7!&42:97T!3K&3!4K?<4!43&V7K?8=7:4!] :782A3&) A7!3?<&:=4!4K&:() \*! (G?; F&3(?) &=!A?) ) 7A3() \*!3?!) 3K7!A?F F?) !' 8&3G?: F#! . ?!?) 7! K&4! 797!: =74(\*) 7=!=&!A?K7:7) 3! \*8?; &8! 3:&) 4' ?;3!4T437F#!
- M!?:=7:G?; !3K7!+KT4(A&8!M) 37:) 73!3?<?:V! <7!) 77!=!) 7<!() G:&43:2A32:7!&)=!) 7<!7) 3(74#!%?) 3:72(8!() ! v"!\$!7A?F F7)=4!&KT!7:EA?) ) 7A37!=8?\*(43(A4!() G:&43:2A32:7!A?) 3&() ) \*M!
  - A7:3(G(7!=? 7) !8?\*(43(A4!47:9(A7!) :?9(=7:4#!
  - ? 7) !8?\*(43(A4!=7A(4?!) &8!&)=!3:&) 4&A3(?) &8! 8&3G?: F4!\*8?; &8!8?\*(43(A4!F?) (3?:() \*!4T437F#!
  - A7:3(G(7!=? 7) !8?\*(43(A4!G&A(8(3(74!&)=!<&T4#!
  - 43&)=&:=8?\*(43(A4! :?3?A?84#!
  - A?) 3&() 7:(a7!=8?\*(43(A4!7X2(' F7) 3!&)=!37AK) ?8?\*T#!
  - ) (G(7!=473! ?G!43&)=&:=!F?=&8!&8?\*(43(A4#!
- -AA?:=(\*)3?!=8(A7!"J\$S!v"!W?) !3?!) !?G!3K7!7) & 87:4!&)=!3:(\*\*7:4!A2::7) 3!; &::(7:4!&:7!(F' 7=(\*)!3K7!3:28T! ) 37\*: &37!=3:&) 4' ?;3!4T437F!G?; !4243&() & 87!&)=!7GG(A(7) 3!8?\*(43(A4!M
  - %&:V73!=T) &F(A4#, ?\*(43(A4!K&4!3:&=(3?) &88T!; 77)!&47A3?<(3K!8?<!) ) ?9&3(?) !() 9743F7) 34!=27! 3?!) F&887!F&:\*(4!&)=!K(\*K!G:&\*F7) 3&3(?) #!
  - , &AV! ?G! <788E:7A?\*) (a7!=!() =243:T! ; 24() 744! &)=! ? 7:&3(?) &8! F?=&784! (F' 87F7) 3() \*! K?:(a?) 3&8! A?88& ?;&3(?) #
  - , &AV! ?G! F?=&8!&8?&=!2) (34!G&A(8(3&3() \*!() 8&)=!&)=!&(:3:&) 4' ?;3#!
  - 0??!F&() T!7\*28&3(?) 4!3K&3!K() =7:() ) ?9&3(?) #!

- , &AV! ?G!& ' :?' :(37!3:&) 4K(' F7) 3!37AK) ?8?\*T#!
- , &AV! ?G! MQO! 3?\_& (' (=8T! A?)) 7A3! 3?\_! &=!= (4A?)) 7A3! G: ?F\_! 42' ' 8T! ) 73<?:V4! &3! 3<?! 879784! 3K7!
- , &AV! ?G!3:243!()!4K&:() \*!() G?:F&3(?)!47:9(A74!&)=!4T437F4#!
- , &AV! ?G! &' ' :?' :(37! 43&)=&:=4! G?\_! =&3&! A?887A3(?)\_! =&3&! A?887A3(?)! 4T437F4! G?\_! :7' ?:3() \*!
- A?F F7:A(&8T!&)=!4?A(&8T!9&2&; 87!() G?:F&3(?)!&4!<788!&4!=&3&!X2&8(3T!F?) (3?:() \*#)
- -AA?:=() \*!3?%&324(7<(Aa!()!v" Cw! 3K7:7!&:7!43(88!4?F7!K?: (a?) 4!3?\_! ; 7!7U' 8?\_7=\_!8(V7! F73K?=4!?G!) 73<?:V!
- A?)) 7A3(?)! ; 73<77)!A&::(7:4!&)=!4K(' ' 7:4!) 7<! ; 24() 744!F?=784!&)=! 73<?:V!47A2:(3T#)
- -AA?:=() \*!3?\_+; ?G744?\_!/: (A! L&88?3!()! " JS!v" Ow! 3K7:7!(4!3:28T!8(3387! :747&:AK!?)!=T)&F(A! ' :(A() \*!()! , 0, !H, 744!
- 3K!)! 0:2AV8?&=!! 3:&4' ?:3! ()! 3K7! 8(37:&32:7\_! 3K7:7! &:7! ?3K7!:47A3?\_! 4! A?) A7:) 7=! ; T! 3K7! =T)&F(A! ' :(A() \*!
- ' ?:; 87F\_!42AK!&4!&(:!A&: \*?\_!8() 7!:4K(' ' () \*!\_!&(&8<&TIG:7(\*K3!&)=!^0, !3:&4' ?:3#!
- !
- M! \*7) 7:&8\_!(3!(4!) ?37=!3K&3!3K7:7!&:7!43(88!\*& ' 4!G?\_! :747&:AK!&AA?:=() \*!3?!= (GG7:7) 3!&23K?:4#!@?F7! ?G!3K7!3K7F74!
- &:7! :7' 7&37!=()!3K7:!:=(4A244?\_!4W@3&)=&:= (4&3(?) !?G! ' &AV&\*() \*!&)=!() G?:F&3(?)!3?\_!G&A8(3&37!()37:?' 7:& ; (8(3T\_!
- :782A3&)A7!3?\_<&:=4!4K&:() \*!() G?:F&3(?)!&)=!A?) ) 7A3() \*!3?\_!3K7!A?F F?) !' &8G?:F\_!8&AV! ?G!MQO! 8&3G?:F\_!3?\_!& (' (=8T!
- A?) ) 7A3! G: ?F!H' 82\*!&)=! ' &8T!\_!&)=! ) 77=!3?\_!&44744!3K7! 7A?) ?F(A! &)=!4?A(&8!(F' &A3! ?G!3K7!
- (F' 87F7) 3&3(?)! ?G!+M!
- !

### 3.4.5 Relevance to the living labs

!

- +KT4(A&8!()37:) 73!(4!&43&)=&:=! ?G!3:&) 4' ?:3!A?88&; ?:&3(97!&)=!?' 7) #!b(3K()!3K7!\_!\_!(3!(4!' ?44( ; 87!3?\_!79&82&37!3K7!
- ; 7) 7G(34! ?G!3K7!\_! :?\*:744(97!&=? 3!?) !?G!+M!()!37: F4! ?G!(F' :?97!=! :?A744!7GG(A(7)AT\_!()A:7&4!=!G:7(\*K3!3:&)4' ?:3!
- A&' &A(3T!&)=! :7=2A7!=!7) 9!() F7) 3&8!(F' &A34!\_! 1) 7! ?G!3K7!F(&!)&=9& 3&\*74! ?G!+M!(4!3K7!A?88&; ?:&3(?)! ; 73<77)!
- = (GG7:7) 3!&A3?\_!4!()!3K7!42' ' 8T!AK&:()!&)=!3K7!A?::(=?#!OK: ?2\*K?23!3K(4!A?88&; ?:&3(?)\_!= (GG7:7) 3!=7A(4!?)4! F243!
- ; 7!F&=7!3K&!< (8!(F' &A3!?)!3K7!\_! :?A74474! ?G!3K747!&^7) 34#!0K7!F?=788! \*!&)=!4(F28&3(?)! ?G!3K7!\_! :?A74474!< (8!
- F&V7! (3!\_?44( ; 87!3?\_!79&82&37!3K7!(F' &A3! ?G!3K747!=7A(4!?)4!?)!3K7!9&:(?24!&4' 7A34! ?G!3:&)4' ?:3#! :74?2:A7!A&' &A(3T\_!
- &::(9&8!3(F 74\_!A?) \*743(?)\_!73A#!!

0K7!\_! , \$!<?:V68?<!A&!) ; 7!247!=&4!&) !7U&F' 87!3?\_!7U' 8&() !3K7!\_!7879&) A7!G?\_!8(9() \*!8&; 4#!

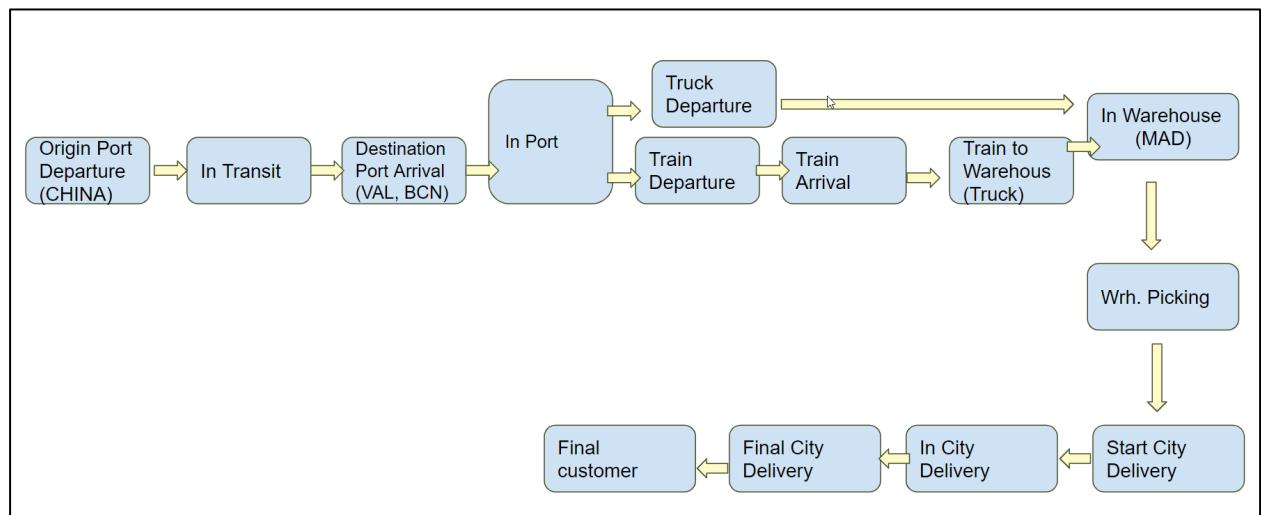


Figure 9: Main process representation in end-to-end corridor transport process

||!3K747!(F\*&\*74!Figure 9!!; &47!=?)!3K7!, , \$!=74A:(`3(?)!3K7!7' :747)3&3(?)!?G!3K7!F&()!` :?A74474!3K&3!3&V7!` &A7! ()!3K7!A?)37U3!?G!G:7(\*K3!3:&)4' ?:3&3(?)!A&!)!; 7!477)\_!=2:() \*!3K7!c?2:) 7T!G: ?F!3K7!` ?()3!?G!?:(\*)!H#(7#\_!&` :?=2A3(?)! A7)3:7!()!QK()&I!3?I3K7!G()&8!=743()&3(?)!H#(7#\_!&!A243!F7:!)!3K7!A(3T!?G!%&=:=(=I#!

MB!A&!)!; 7!?: 47:97!=I3K&3!3K7:7!&: 7!&!8?3!?G!797)34!&)=!=7A(4(?)4!3K&3!K&97!3?!)!; 7!3&V7!)!; T!3K7!&\*7)34!?G!3K7!AK&()# 0K7!A??:=(?)!K&4!3?!)!; 7!7UA7887)3!4?I3K&3!3K7!` ??:=4!&::(97!<(3K?23!=78&T!3?I3K7!G()&8!=743()&3(?)#0K7!4787A3(?)! ?G!&87!:)&3(974!(4!<=(7!&)=!&!\*:7&3!&F?2)3!?G!()G?:F&3(?)!&)=!9&:(&; 874!F243!; 7!A?)4(=7:7=\_!)!?:=7:13?I4787A3! 3K7!&` :?` :(&37!74?2:A74!&3!7&AK!F?F7)3#!

!

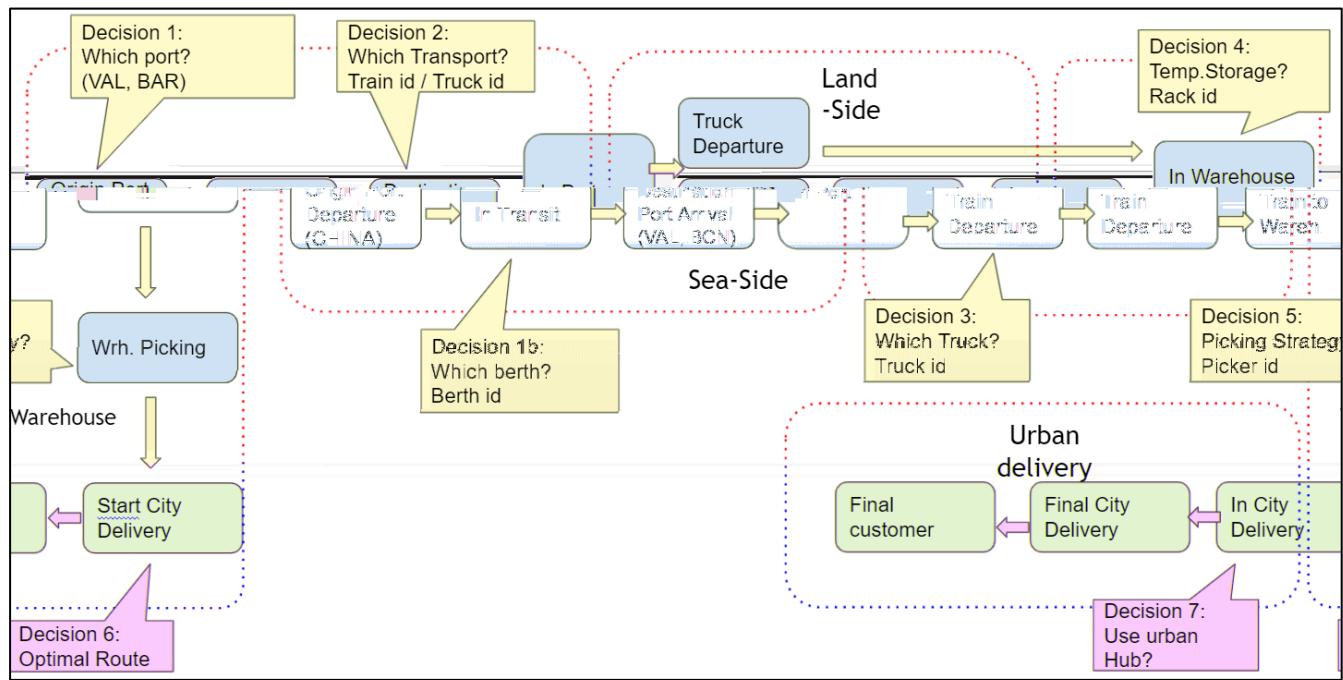


Figure 10: Main decisions in end-to-end corridor transport process

0?!A&::T!23!&I!`KT4(A&8!A?88&; ?:&3(?)\_!&3!3K7!` :747)3!3(F7!4K&() \*!74?2:A74!42AK!&4!3:&)4' ?:3!?:!43?:&\*7!&:7&4\_! (3!(4!)7A744&:T!3?I!A&::T!23!&I!=(\*3&8!A?88&; ?:&3(?)!<(3K!3K7!A?F` &)(74!; 7G?7K&)=!()!?:=7:13?!)!; 7!&; 87!3?!)!3?!=7' 8?T!&)=!3?!)F&)&\*7!&8!3K7(!A?88&; ?:&3(?)!` :?A74474#Q?88&; ?:&3(?)!F243!; 7!A&::(7=!=23!()!3<?E3(F7!&:7&4\_! 6:?:F!3K7!` ?()3!?G!9(7<!?G!` 8&))() \*!7!&:3!&3(?)4!&)=!G?F!3K7!` ?()3!?G!9(7<!?G!7U7A23() \*!7!&:3!&3(?)4#!!

-A3(9(3(74!:78&37!=I3?I3K7!` 8&))() \*!K?:(a?)#

- >747:97!4` &A7!()4(=7!&A?)3&()7:#!
- >747:97!` 7:3K!()!&!` ?:3#!
- L??V!3:&()!<&\*?)#

-A3(9(3(74!:78&37!=I3?!(F` 87F7)3&3(?)!K?:(a?)#

- !%?=(G!&!:?237!=27!3?I!A?) \*743(?)!&3!&I` 7A(G!A` ?()3#!!
- !QK&)\*7!?G!3:&)4' ?:3!=27!3?!)!; 87F!=737A37!=()!3K7!8?&=!H9(&IM?0!47)4?;I#
- !QK&)\*() \*!3K7!F?=7!?G!3:&)4' ?:3!=27!3?!)!&=78&T!()!&` :?A744#

-88!3K747!` 8&))() \*!8)=!7U7A23(?)!&A3(9(3(74!:7X2(:7!A???:=()&3(?)!&)=!7UAK&)\*7!?G!G?:F&3(?)!; 73<77)!=!(G7:7)!&A3?!)!3K7!A?::(=?4!OK7!37AK)?8?\*(74!?G!M?0!\_M&)=!L8?AVAK&()!A&!)K78` !3?!)?; 3&()!G?:F&3(?)!G?:F!3K7! 7U7A23(?)!?G!3K7!` :?A74474!4K&:7!3K7!(` ?!:F&3(?)!()!&47A2:7!&)=!2)AK&)\*7&:87!<&T!&)=!F&V7!3K7!` F?43! &` :?` :(&37!=7A(4(?)4!&AA?::() \*!3?I3K7!G?:F&3(?)!&9&(&&; 87!&)=!3K7!` 2874!?G!; 7K&9(2:!:?G!3K7!` :?A74474#

!

### 3.4.6 Towards the Physical Internet

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OK7!+KT4(A&M)37: ) 73!(4!&)!?' 7) !A?88&; ?:&3(97!G:&F 7<?:V\_<K(AK!A&)!K78' !(F' :?97!3K7!247!?G!3K7! :74?2:A74!3K&3!A(:A28&37!&?) \*!3K7!()37:A?)3()7)3&8!A?::(=?4!0?;!7!&87!3?A&:T!23!s'KT4(A&8!A?88&; ?:&3(?)\_!4K&:() \*!:74?2:A74!42AK!&4!3:&)4' ?3!?:!43?&\*7!&7&4\_!(3!(4!)7A744&:T!3?A&::T!23!s=(\*3&8!A?88&; ?:&3(?)!; 73<77)!A?F' &)(74!()!?:=7!3?!' ?3!7:8T!4732' !&)=!?:AK743:&37!3K7!A?88&; ?:&3(97!) ?A74474##!

@2AA744G28!A?88&; ?:&3(?)!F 243!; 7!A&::(7=?23!?)!3<?!879784\_!H&IIG: ?F!3K7! ?()3!?G!9(7<!?G! 8&))() \*!?' 7:&3(?)4!&=H; !IG: ?F!3K&3!?G!7U7A23() \*!?' 7:&3(?)4#!

OK7!+KT4(A&M)37: ) 73!8(37:&32:7!42:97T!A?)A82=74!3K&3!3K7!=7978?'F 7)3! ?G!+M<?28!=K&97!F& )T!; 7)7G(34\_!74'7A(&8TIG: ?F!3K7! ?()3!?G!9(7<!?G!&V() \*!&=9&)3&\*7!&G!&9&(&8; 87!:74?2:A74!&)=!7=2A() \*!7F(44(?)4!3?3K7! 8&)73#!OK7!247!?G!43&)=&:=!F&:(3(F7!A?)3&()7:4!A?28!=; 7!A?)4(=7:7=&4!&43&:3() \*!' ?()3!()3K7!+MG:&F 7<?:V#!

OK7!4&F 7!; (8?\*:& K(A!79(7<!K&4!&84?!=7)3(G(7!=!(GG7:7)3!; &::(7:4!8(V7!43&V7K?8=7:4]!782A3&)A7!3?<:&=4!4K&:() \*!()G?:F&3(?)!&)=!A?) )7A3() \*!3?3K7!A?F F?)!&8&3?&F\_!&AV!&G!A7:3(G(7=?'7) !8?\*(43(A4!47:9(A7!) ?9(=7:4!?:!8&AV!&G!&' ? :?(&37!43&)=&:=4!G?:!&3&A?87A3(?)#!

OK7:76?7\_!&A?88&; ?:&3(?)!; 73<77)!&\*7)34!F&T!; 7!)7A744&:T!G?:!3K7!=7'8?TF7)3! ?G!+KT4(A&8!()37:)73!&)=!3!4K?28!=; 7!; &47!=?)!3:243!3K(4!(F'8T() \*!3K&3!3K7:7!&:7!(44274!3?; 7!3&AV87=13?3K7!-A744!&)=!-=?'3(?)!&)=!3K7!D?97:)&A7!879784\_!&4!(3!K&4!; 77)!(&7)3(G(7=1; T!3K7!I>?&=F'!3?!=+KT4(A&8!M)37:)73!/U7A23(97m!(4427=1; T!-; M! /H\$"Z"J"J!#!

0?13K(4!7)=!47A2:(3T\_! :?97)&A7!&)=!78(& (8(3T!7)K&)A) \*!37AK)?8?\*(74!4!M!0\_!-M&)=!L8?AVAK&()\_!F&T!<?:V! ' ?4(3(978T!3?K78'!; 2(8=13:243!; 73<77)!A?88&; ?:&3() \*!&A3?&4#M)!+, - . /0!<7!<(88!7U'8?; 7!K?<!3K7!&' ?(A&3(?)!&G!3K747!37AK)?8?\*(74!A&)!K78'!3?G?437!:A?88&; ?:&3(?)!; 73<77)!&\*7)34!&' 8T() \*!+KT4(A&8!()37:)73!A?)A7'34#!

C

!

+2:'?47!&G!3K7!0!G?2)=&3(?)&&+?4(3!)!+&7:4!&G!3K7!+, -. /0!' ?c7A3!(4!3?!)!&?9(=7!&A?F'7)=(2F!&G!3K7! :747&:AK!&)=!432=T!742834!78&37=13?3K7!F&()!4!7A34!&G!3K7!=7978?'F 7)3! ?G!3K7!/D0. !&)=!3K24! !:&?9(=7!&) !()3(&8!9(7<!?G!(3!OK747!&4!7A34!)&F 78T!()A82=7!3K7! \*7?E7A?)?F(A!=F7)4(!<K(AK!=:(974!3K7!7F7: \*7)A7!&G!)7<!\*&?; &&3:&=7! :?2374\_!3K7!(F'&A3!&G!3K747!:?2374!)?13K7!7U(43() \*! /&3:&4' ?&3&3(?)! )73<?:V!HO/. EO!\_!3K7!7U(43() \*!8&)=!()37:A?) )7A3(?)!(44274!&G!3K7!0/. EO!<(3K!)73<?:V4!2?34(=7! /&7\*&:=() \*!:&(8!3:&4' ?&3&3(?)!&)=!G()&&T\_!3K7!7F7: \*() \*!G!3K7!+MA?)A7'3!&)=!3K7!A?::74'?)=(\*) \*!+M7)&8() \*!() ?9&3(97!&)=!(4:2'3() \*!37AK)?8?\*(74!<K(AK!K&97!3K7! ' ?37)3(&0!3?\*2(=7!3K7!4K&() \*!&G!3K7! /D0. !3?<&:=4!&\*77)!&)=!3:&4' ?&3!7G(A7)3!G232:7#0K7!F&()A824(?)4!G?:F!3K7!G?2)=&3(?)&&13K(4!AK&37:#

TNU(X" B(+%\$="(: \$++%#. #

@3:&3() \*!G?:F!3K7!A?)37)3!&)&T4(4!&G!3K7!G!(4!&)=!47A?)=!' ?4(3!)!&7:4\_!(3!; 7A?F 74!?: 9(?24!3K&3!3:&=7!&337:)4!3?ZG?:F!&)=!3K:&2\*K! /2:?'7!&:7!7U'7A37=13?1AK&)\*7!4(\*)(G(A&)38T!97!:3K7!)7U3!T7&:4!OK7!:7&4?4!G?:!3K(4!=7978?'F 7)3! (A82=7!4797:&8! \*7?E7A?)?F(A!AK&)\*7!4(<K(AK! )=2A7!3K7!=7978?'F 7)3! ?G!)7<!3:&=7! :?2374!A?) )7A3() \*!2:?'7!3?&4!(<(3K!&)!7F'K&4(4!?)!3K7!A?)) )7A3()!<(3K!QK()&#!-F?) \*!3K747!AK&)\*74\_!3K7!3:7)=!G?:!AK&)\*7!(&13K7!A2::7)3!F?=78!&G!\*8?; &&(a7!=!:&=2A3(?)!3?<&:=4!3K7!:7\*(?)&&(a&3(?)!&G!:&=2A3(?)!74'7A(&8T!G?!)F(=87EK(\*K!7)=743:&37\*(A!:&=2A34!; 23!&84?7)9(:?)F 7)3&8!&:&F 737:4!78&37=13?13K7!A&(F&37!AK&)\*7!H&F783() \*!?G!-A3(A!(A7!8?) \*7:!'7:(=?=4!&G!=:&2\*K3!&:7!7U'7A37=13?1'8&T!&4(\*)(G(A&)3!:&87!()!3K7!7F7: \*7)A7!&G!3K77!)7<!3:&=7! :?2374#!

-4! :7\*&:=4! <(3K!3K747! :?2374!QK()&4!=74(:7!3?!(F' :?97!3K7!A?)) 7A3(?)! <(3K!3K7!/2:? 7&)!A?) 3()7 3!&)=!3K7! (0 37) 3(?)!3?F?97! :?=2A3(?)!3?<&:=4!3K7!7&43!&)=!8744!=7978? 7=!' &:3!?G!3K7!A?2) 3:T!K&4!87!=!3?3K7!1) 7!L783! 1) 7!>?&=!() (3(&3(97!<K(AK!A?) 4(434!?G!4(U!7A?) ?F(A!A?::(=?4!&)=!() A82=74!; ?3K!&F&:(3(F 7!&)=!&!8&)=!A?)) 7A3(?)! 3?/2:? 7#!!

^2:3K7: F?:7!3K7!X2743!G?:!8?<7:3:&) 4' ?3!A?434!&)=!G&437!3:&4' ?3!()!78&3(?)!3?3K7!3:&=(3(?)&8!; 23!A?) \*7437!=!&)=!3(F 7EA?) 42F() \*!F&:(3(F 7!:?237!3K: ?2\*K!3K7!@27a!Q&)&\_3?\*73K7!:<(3K!3K7!&F; (3(?)4!?G!>244(&:7\*&:=() \*!3K7! 7U' 8?(3&3(?)!?G!3K7!-:A3(A! :7\*(?)!K&4!87!=3?3K7!A?) 4(=7:&3(?)!G?:!&F&:(3(F 7!:?237!3K: ?2\*K!3K7!-:A3(A! :7\*(?)#!OK(4! A?) 4(=7:&3(?)!(4!G2:3K7!7) K&) A7!=; T!F?=784! :7=(A3() \*!8! :7!A7EG:77! 7:(?=4!()!3K7!7\*(?)!; 23!&4?; T!3K7!) 77!=!G?!:!42' '8T!AK&()!: 74(8(7)A7#!OK7!) 77!=!G?:!3K(4!: 74(8(7)A7!(4<788!=7' (A37!=!()!3K7!@27a!Q&)&8!() A(=7)A7!()!%&:AK!"J"!<K7!)3K7!A&)&8!<&4!A8?47!=!G?:!S!=&T4!; 7A&247!?G!&)!&AA(=7)3!A&24() \*!&4(\*) (G(A&)3!=4:2' 3(?)!3?3K7!42' '8T!AK&()4!<?:3K!?G!F(8!?)4!?G!=?88&:4#!!

^()&88T!3K7! (0 37) 3(?)!?G!>244(&!&)=!M)=(&!3?A?) 7A3!K&4!87!=3?3K7! (0 37) 3(?)!3?!=7978? !3K7!M 37:)&3(?)&8!. ?:3KE!@?23K!A?::(=?!&44() \*!3K: ?2\*K!A7) 3:&8!-4(&!<K(AK!&84?; T' &4474!3K7!@27a!Q&)&8!&)=!K&4!4(\*) (G(A&)3! ' ?37) 3(&8!()!37: F4!?G!3:&) 4' ?:3!7G6(A7)AT#

K!J!A8: \$&+(-. (7FXJ7(Y(8- . ,+-%,. E(& \$. E"#+

OK7!3K:77!) 7<!7F7: \*() \*!8?; &8!3:&=7!:?2374!A?) 7A3() \*!3K7! /`!&)=!-4(&HQK()&!K&97!3K7! ?37) 3(&8!3?A!K&)\*7!3K7! F(&)!7) 3:T! ' ?() 34! ?G!3:&=7!&)=!3K7!G?<4!&8?)\*!3K7!0/. EO!A?::(=?4!3K24!&837:() \*!3K7!A&' &: (8!3T! ?G!3K7!A2::7) 3! )73<?:V!3? !47:97!3K747!G?<4!OK7!A2::7) 3!43:2A32:7! ?G!3K7!0/. EO!(4!473!2' !3?<&:=4!47:9() \*!3K7!G?<4!7&AK() \*! /2:? 7! G?:F! 743&; 8!4K7!=; ?2374\_! G?A24() \*! F&:(8T! ?) !3K7! K()37:8&)=!A?)) 7A3(?)! ?G! F&:(3(F 7!) ?=74#!OK7! ; ?3387) 7AV4!3K&3!<(8!7F7: \*7!&)=! ?44(87!A' &A(3T!4K?:3&\*74!<(8!&G67A3!3K7!47:9(A7!879784!&)=!3K7!:78(& (8!3T! ?G!3K7!A?::(=?4! :7X2(:) \*!&A3(?)4!3?&=!3!3?3K7!) 7<!A:(A2F43&)A74#!!

-3!3K7!4&F 7!3(F 7!3K7!3:7)=!3?<&:=4!\*8?; &8(a&3(?)!G! :?2A3(?)!K&4!3K7! ?37) 3(&8!3?!:7=2A7!F&:(3(F 7!G?<4!<K(87! &84?&837:() \*!3K7! ' &337:) 4! ?G!G?<4!<(3K()!3K7!0/. EO!F?9() \*!3K7!G?A24!G??:!()G:&43:2A32:7!=7978? F7) 3!G?:F! K()37:8&)=!A?)) 7A3(?)4! ?G!3K7!F&:(!) 3:T!HF&:(3(F 7!) ?(34!3?!(8&)=!A?)) 7A3(?)4!; 73<77)!= (G67:7)3!:7\*(?)4!?G! ' ?:?2A3(?)&)=!A?)) 42F' 3(?)#!OK(4!<(8!8&A7!G2:3K7!1:7442:7!?)!3K7!0/. EO!<K(AK!<(8!7X2:(7!4243&)7!=!7G? :34!3?&AA?FF?= &37!3K7!) 7<!G?<4#!!

n?<797: !3K7!A&)\*74!&7!) ?3!7U' 7A37!=3?K&' 7)!&3!3K7!4&F 7! ' &A7#!OK7:7!(4!&4(\*) (G(A&)3!= (G67:7)A7!()!3K7! F&32:(3T!879784!&)=!3K7!2)A7:3& (3(74!:78&37!=3?3K7!=7978? F7) 3! ?G!3K7!3K:77!7F7: \*() \*!?:2374\_!<(3K!1)7!L783!1)7!>?&=!() (3(&3(97!&' 7&:() \*!3?; 7!3K7!F?:7!=7978? 7!=&F?) \*!3K7!:?2374!2)=7!:A?)) 4(=7:&3(?)#!!

OK7!3K7!:3<?:?2374\_!3K7!-:A3(A! :?237! &)=!3K7!M 37:)&3(?)&8!. ?:3KE@?23K!A?::(=?4! :74' (37! ; ?3K!K&9() \*! 4(\*) (G(A&)3!&=9&3&\*74!42AK!&4!3K7!; T' &44() \*! ?G!3K7!@27a!Q&)&8!3K24! :?9(=() \*!:74(8(7)A7!3?3K7!42' '8T!AK&()4!&)=!&84?&3K7!4K?:37) () \*! ?G!3K7!= (43&)A7!3?/2:? 7!<K(AK!(4!3:&)4&37!=3?4(\*) (G(A&)3!3(F 7!&)=!A?43!4&9() \*4!3K7!7!&:7!G?:! ?3K!(F' ?:3&)3! &:F 737:4!<K(AK!()A:7&47!3K7!2)A7:3& (3T! ?G!3K7(:!G232:7!&)=!F?:7!4' 7A(G(A&8T!3K7!3(F 7!K?:(a?)! ?G!3K7(:!7&(a&3(?)#!!

!M!4K?:3!3K7!2)A7:3& (3T! :78&37!=3?3K7!:&37! ?G! \*8?; &8!<&:F() \*!<K(AK!<(8!()A:7&47!3K7!)&9(\*&:87! 7:(?=4!()!3K7!-:A3(A!&8?)\*!<(3K!3K7!7)9(:?)F7) 3&!A?)) 4(=7:&3(?)4! :78&37!=3?3K7! 7U' 8?(3&3(?)! ?G!3K7!-:A3(A! :7\*(?)!&)=!3K7! \*7? ' ?8(3(A&8!78&3(?)4!&:7!4!F7! ?G!3K7!F&:(!) 2)A7:3& (3(74!:78&37!=3?3K7!=7978? F7) 3! ?G!3K(4!:?2374!M) !3K7!A&47! ?G!3K7!M 37:)&3(?)&8!. ?:3KE@?23K!A?::(=?4! :74( A:&43:2A32:&8!=7G(A7)A(74!&)=!3K7!G()&A(&8! ' 7:4' 7A3(97!&4!&F 283(E! 43&V7K?&=7!&A3(9(3T!&F?) \*!3K7!3:&)4(3A!2)3: (74!:7!3K7!F&():44274!&G67A3() \*!(34!=7978? F7) 3#!n?<797: !=74' (37!3K7!(F' ?:3&)3!2)A7:3& (3(74!:3K&3!<(8!&G67A3!3K7!879784!&)=!3(F 7! ?G! =7978? F7) 3! ?G!3K747!3<?:?2374\_!<K7!) ?7:3&(?&8!3K7!<(8!&==!4(\*) (G(A&)3!G?<4!3?!. ?:3K7!:&2374\_!&:8!A?::(=?4!?G! /&43!2:?7!HM. @>I#!!

Q?) A82=(\*)!G?:F!3K7!&; ?97!3K7!=7978? F7) 3! ?G!3K7!) 7<!3:&=7!:?2374!&)=!3K7!A?::74' ?)=() \*!(F' &A3!?)!3K7!0/. E 0!<(8!7!&=T)&F(A!':?A744!()!3K7!G?88<() \*!T7&:4!OK(4!<(8!7X2:(7!&!)7X2&8T!&=T)&F(A!F73K?=?G?&F?) (3!():3K747!AK&)\*74!&3!&!)?=7!&)=!7\*(?)!87978!3??:?9(=7!()4(\*K3!3!3K7!A?F' 737) 3!&23K?:(3(74!G?:!3K7!8&)) () \*! ?G!3K7!=7978? F7) 3! ?G!3K7! /DO. #!OK(4!A&)!; 7!&AK(797!=3K!2\*K!3K7!=7978? F7) 3!&)=!(F' 87F7) 3&3(?)! ?G!()=(A74!3K&3!

<(8!A& 32:7!&3:&)4' ?:3!)?=7]4!87978!&?G()37\*&:3(?)!()!3K7!0/. EOZ\*8?; &8!)73<?:V!&4!<78!&4!()!3K7!\*8?; &8!F&:(3(F7!3:&)4' ?:3!)73<?:V! 4()A7! &AA744( (8(3T! &)=!A?))7A3(9(3T! &:7! ()=(A&3?:4!G?:!3K7! 7G67A3(97)744! ?G!3K7! 3:&)4' ?:3!)73<?:V!&4!&)!7)&; 87!G?:!3:&=7#1^2:3K7:F?:7!\_3K7!?' 7:&3(?)&8!7GG(A(7)AT!?!G!)?=74!&)=!A?::(=?4!&4!<78!&4!3K7(!:78(& (8(3T!G! 7:G?:F&)A7!)77=4!&84?!3?; 7!A& 32:7!=!&)=!F?) (3?:7!=!97:13(F7#

@797:&8!F 73K?=4!&8:7=&T!7U(43!3K&3!F 7&42:7!3K7!A?))7A3(9(3T!&G!8?\*(43(A4!&?A&3(?)4!&)=!7U' :744!3K(4!<(3K!&)!)=7U!42AK!&4!3K7!b?:8=I+?&3!M)=7U!&)=!3K7!, (0?\_!@K( ' ()\*!Q?))7A3(9(3T!M)=7UH@QM#\_n?<797:\_!3K747!()=(A74!&:7!?)8T!G?A24() \*!?)!3K7!G?:78&)=!&)=! ?&3!4(=7\_!<K7:7&4!3K7!A2::7)3!)77=!(4!?)!3K7!A?))7A3(9(3T!&G!A?::(=?4ZK()37:&8)=!<(3K!H7F7:\*) \*!I3:&=7!:?2374#0?!.?74' ?)=!3?&3K(4!)77=\_!3K7!Q?::(=?!.?Q?))7A3(9(3T!M)=7U!HQQM!<(8!; 7!=7978? 7!=!)!3K7!A?)37U3!&G!3K7!+, -./0!':?c7A3\_!A& 32:() \*!3K7!A?))7A3(9(3T!&G!&)?=7!&4!F&)(G7437=!.!T!(34!)?4(3(?)!:&7\*&:=(?) \*!'.?&3!A& &A(3T!\_!7GG(A(7)AT!&)=!7&47!&G!' ?:A74474\_!47:9(A7!G:7X27)AT!47:9(A7!X2&!(3T!&)=!=(\*3&8!A?))7A3(9(3T!&OK7!AK&)\*74!&G!3K7!QQM& 32:7!=!97:13K7!T7&:4!<(88&88?<!3?!(=7)3(GT!3K7!AK&)\*74!&G!)?=74!&=!797):!7\*(?)4!:7\*&:=(?) \*!3K7(!A& & (8(74Z4A&87Z&AA744( (8(3T!&)=!3K24!; 7!& ' 8(7!=&4!&!: &?F 737\_!&G!AK&)\*() \*!3:&=7!G?<#4!

RNU(5\$, . (+%" . =#(G-%(, . G9\*%" . &, . E(+%"("D"9-: 8%" . +(-G(FZ7X((

>7\*&:=(\*)!3K7!1L1>!!&)!=!&)!=!F&:(3(F7!A?::(=?4!3?/2:?7\_!3K7!8&337!:!&'7&:4!3?;!7!3K7!?)7!3K&3!K&4!&8:7&=T!  
>\_77)!=7978?'7\_=!3?!!&)(F'?:3&)3!=7\*:77!A?))7A3()!\*!-4(&!P!-6:(A&!3?/2:?7!;23!&84?!)3?3K7!7&43!A?&43!?G!.?3K!  
>-F7:(A&!3K:?2\*K!F&:(3(F7!3:&)4K('F7)3!K2;4#OK(4!(4!79(-7)3!G:?F!3K7!4(\*)G(A&)3!()9743F7)34!;T!OK())&!()!  
>()G:&43:2A32:7!()!2:?7!<K(AK!F&()8T!()A82=7!?'34!&)=!37:F()&84!;23!&84?!)3K7!:!44734!&(F()!\*3?!)K&)A7!'?:3E  
>K()37:8&)=!A?))7A3()4#!>7\*&:=(\*)!3:&)4K('F7)3!?'7:&3?()4\_!3K7!%7=(37:::&)7&)!'?:34!&'7:&:3?!)K&974!(\*)(G(A&)3!  
>=7978?'F7)3!()3K(4!G(78=\_!33:&A3()!\*G8?<4!G:?F!3K7!.?3K7:)!2:?7&)!47&'?:34!&4!K?<)!;T!3K7!()A:7&47!()3K7!  
>)2F;7!:!G!A&84!;7A7(97!=;T!?'34!?)G!3K7!.?3K!-F7:(A&!7\*(?)!6?:F!4K('4!A?F()!\*!G?:F!3K7!%7=(37:::&)7&)#!

1)!3K7!?!3K7:!K&)=!3K7!/2:&4(&)!:&(8!8&)=!A?::(=?!:!<K(AK!(4!3K7!8&)=!&:3!?!G!3K7!1L1>!) (3(&3!97!(4!8'! 7&:() \*!3?!.! 7!3K7!:?237!<(3K!3K7!F?43!4(\*) (G(A&)) 3! 7:4' 7A3(97!3?!=7978?!.!&)=!&G!7A3!3K7!G232:7!?!G!0/. EO!G?!.!&47:(74!?!G!:7&4?!) 4!:78&37!=F&()8T!3?!.!7?E7A?)?F(A4##

0K7!37)=7)AT!?: 47:97!=?<:&=4!F?90) \*!' :?=2A3(?)!3?!3K7!` 743!&)=!8744!=7978?' 7!=! &:3!?:G!QK()&!8?) \*!<(3K!3K7! 7F7: \*!)!7A?) ?F(74! ?G! -4(& 7U' 7A37!=3?!) =2A7!=7F&)=!G?:!3:&)4' ?:3&3(?)! ?G! F(=87!3?!K(\*KE7)=! ' :?=2A34! 3K: ?2\*K!&!G&43!&)=! :78(& 87! <&T!HA?) 4=7(: \*!&84? 3K7!3:7)=!G?:! :7\*(?)&&(a&3(?)! ?G! ' :?=2A3(?) !!(4! 7U' 7A37!=3?!) A: 7&47!4(\*)(G(A&) 38T!3K7!8&)=!H:&(8!G8?<4!3?!3K7!7&437:!)!; ?:=7:4!?:G!3K7! /`#0K(4!()!32:!)<(88! ' ?44(; 8T!: 7=2A7!3K7! 9?82F74! 3:&)4' ?:37!= 3K: ?2\*K! 3K7! F&:(3(F7! 4(8V! ?:237\_! &! ' ?44(; (8(3T! &84? 7) K&) A7!=! ; T! 3K7! 7) 9(:?) F7) 3&8! :743:(A3(?) 4!(F' ?47=! ; T!3K7! /` !&)=!F&T!F?97!3:&)4K(` F7) 3!() (3(&8T!G: ?F!. ?:3K7:!)! /2:?' 7!3?13K7!%7=(37::&) 7&) !&)=!3K7!)!&<&T!G: ?F!/2:?' 7&) !? :34##

Q2::7) 38T!3K7!F&c?: (3T!?G!:&(8G:7(\*K3I3:&GG(A!; 73<77)!)3K7!/^!&)=!-4(&!(4!47:97=!3K:2?\*K!3K7!< (=7E\*&2\*7H\$N!JFF!I! :&(8<&T! )73<?:V! ?G! 3K7! G?:F7!:@?9(73! `)(?)\_!7)37:() \*Z7U(3() \*!3K7! /`!G?:F!3K7! ;?:=7!:A: ?44() \*4! ()!, &39(&! , (3K2&)(&!n2)\*&T!&)=!+?8&)=#!0K7!8&337!()A82=74!3K7!F&()!7&43; ?2)=!:(&(8<&T!A?))7A3(?)4!&)=!&84?3K7!F?43! (F' ?:3& )3!8()V!; 73<77)!)3K7!/^!&)=!3K7!< (=7E\*&2\*7!)73<?:V!()3K7!%&y&4a7<(Aa7!3:&)4K(' F7)3!&:7!< K7:7!3:&()4! &:::(97!G?:F!%()4VZL:743#!MB!A&)!K&)=87!F?:7!3K&)!"J!3:&()4! 7!:=&T!HONJ!3K?24&)=!0/^ 4ZT7&:!!&)=!(34!A&' &A(3T!(4! 7U' 7A37=?!X2&=:2' 87!; T!"J" "#

^2:3K7:F?:7\_!3K7!A?) ) 7A3(?)!?:G!3K7!/2:? 7&):&(!) 73<?:V!3?\_!3K7!02:V(4K!` M!\*&2\*7!) 73<?:V!&` 7&:4!3?\_!K&97!3K7!` ?37) 3(&!3?\_!42` `?:3!() A:7&47!=G:7(\*K3!G?<4\_=27!3?\_!F&c?\_!() G:&43:2A32:&8!() 9743F7) 34!:7&8(47!=; T!02:V7T!&)=!<K7)!&) 7<!037;F?=&8!37;F)&8!<(88! 7A?F7!` 7;&3(?)&8!()!`J`"#!

n?<797:!3K7!()37:A?)?)7A3(?)!?G!3K7!/2:?7&)!:&(8!3:&)4'?:3!A?::(=?4!3?13K7!\*8?;&8!)73<?:V!(4!)?)3!<(3K?23!  
'?:87F4#!OK7:7!(4!\*:7&3!2)A7:3&()3T!:7\*&:=()!\*&4'7A34!3K&3!K&97!3K7!'?37)3(&8!3?!)&GG7A3!4(\*)G(A&)38T!3K7!=797?!)F7)3!?)G!3K7!()37:A?)3()7)3&8!&8!A?::(=?4!8!=13K7!:&8(3T!3?!)&33:&A3!68?<4#!

OK7! '??:!()37:? 7:& (8!3T! ?G! :&(8! ()G:&43:2A32:7!A&2474!?' 7:&3(?)&8! ' :?; 87F4! &)=! &) !()A:7&47! ()!K&)=8! \*! &)=! 3:&) 4(3!3(F7!3K24!:7=2A() \*!3K7!A?F' 73(3(97) 744! ?G! :&(8!OK(4!(4!&84?!3K7!:74283! ?G!3K7!8? <!=(\*3&(a&3(?) !879784!3?=&T! ()! 37: F4! ?G! 3K7! F&)&\*7F7) 3! ?G! A243?F4! &)=! A?F7:7A(&8! =?A2F7) 34! 3?\*73K7!: <(3K! 3K7! 8&AV! ?G! =&3&! K&: F?) (a&3(?) !8?)\*!3K7!7) 3(7! \*8? :&8!A?::(=?4#!!

^() &&T\_! ' ?8(3(A&8! (44274! <(3K! F?43! ' :?F() 7) 3! 3K7! \*:&) 3() \*! ?G! 42; 4=(74! 3? !QK() 747! A?F' &) (74! G? :!3:&) 467::() \*! A?) 3&() 7:4! 3K: ?22\*K! :&(8! &= !3K24! A: 7&3() \*! A?) =(3(? 4! ?G! 2) 7X2&8! A?F' 73(3?) !<(3K! / 2:?' 7&) !A?F' &) (74! 3K7! 7U(43() \*! 743: (A3(?) 4! 3? !3K7! 3:&) 4' ? :3&3(?) !?G! =&) \*7: ?24! \*? =4! 3K: ?22\*K! 3K7! QK() 747! 73<?: V! &= !3K7! A?F' 8(A&37= !A243? F4! ' :?A7=2: 74! ' ?47! &= (3(?) &8! ?; 43&A874! 3? !3K7! =7978? ' F7) 3! ?G! 3K7! / 2:&4(&) !8! &= !A? : : (=? : 4#!

@?89() \*!3K7! :&() ! (37: A?) ) 7A3(9(3T! (44274! 4! &!A?F' 8(A&37= !3&4V! :7X2(:) \*!A?) A7) 3:&37= !7GG? :34! () !F 283(' 87! 879784! () A82= () \*!3K7! =7978? ' F7) 3! ?G! K&: = !() G:&43: 2A32: 7! &= !3K7! (F' 87F7) 3&3(?) !?G! ?' 7:&3(?) &8! 4?823(?) 4! <K(AK!) 77= !3? !; 7! 42! ' ? :37= !; T! 87\* &8! &= !' ?(AT!) (3(&3(974! &= !&84? ! (37: ) &3(?) &8! &\* :77F7) 34#!

[NU(7 ' (%-9" (-G(+ " (+" & . -9-EC(

-4!) ?37= !() !3K7! 47A?) = !+ ?4(3(?) !+& 7: !3K7! 4243&() 7= !7GG? :34! 3? !AA? F F? = &37! 3K7! &837: 7= !G? <4! ?) !3K7! 0/. EO! ) 73<?: V\_! ' &:3! ?G! <K(AK! <(8! ; 7! A?F ; () () \*! (0 3:&! &= !() 37: A?) 3() 7) 3&8! F? 97F7) 34\_! <K(AK! <(8! &84? !K7&9(8T! :78T! ?) !37AK) ?8? \* (A&8! &= != (\* (3&8! 4?823(?) 4! ; 74= (74! 3K7! () G:&43: 2A32: 7! =7978? ' F7) 3#! 0K(4! (4! 3K7! A&47! G? :! &8! F? =74! ?G! 3:&) 4' ? :3! <(3K! &:3( A28:& !7F' K&4(4! ?) !:& (8! 3K7! =7978? ' F7) 3! ?G! <K(AK! (4! 7U' 7A37= !3? !; 7! ?) 7! ?G! 3K7! F&() !3: 7) =4! () !3K7! G232: 7! ?G! 0/. EO##!

OK7! (F' 87F7) 3&3(?) !?G! 3K7! +KT4(A&8! M) 37: ) 73! A?) A7' 3! &= !?G! 3K7! 7) &: 8() \*! () ?9&3(97! = (4: 2' 3() \*!37AK) ?8? \* (74! (4! 3K7! +, - . / 0! & ' :?&AK! 3? <:&= !: 7&AK() \*!3K7! D: 77) !&= !? 7:&3(?) &8! 7UA7887) A7! &4' 7A34! ?G! 3K7! / D0. #

OK7! (0: A: 7&47! () !' :? =2A3(9(3T! &= !7GG(A(7) AT! ?G! G: 7(\*K3! 3:&) 4' ? :3! <K(AK! 3K7! +M&4! 3K7! ' ?37) 3(&8! 3? !; :() \*! <(8! 2337: 8T! AK&) \*7! 3K7! 42! ' 8T! AK&() !? 7:&3(?) 4! &8? \*!3K7! 3:&4' ? :3! A? ::(=? :4\_! ' :?9= (7! &4?823(?) !? 4?7977: &8! (=7) 3(G(7= !A2:: 7) 3! &= ! G232: 7! (44274! &= ! 3K24! G&A(0(3&37! 3K7! ' :?A744! ?G! =74(\*) () \*! 3K7! / D0. ! 3? <:&= !: 4! 3K7! \*?&84! ?G! \*:77) 7!: 3:&) 4' ? :3&3(?) !&= !? 7:&3(?) &8! 7UA7887) A7#!

n? <797: !3K7! 4' 7A(G(A! :747&:AK! X2743(?) 4! ' ?47= !() !3K7! G? 2: 3K! ' ?4(3(?) !' & 7: !: 7\* &: = () \*!3K7! (F' &A3! ?G! +, - . / 0! 8? \* (43(A&8! &= !3: &) 4' ? :3! A?) A7' 34! &= !37AK) ?8? \* (74! &4! A?) 3: ( 23? :4! 3? !3K7! +M: ?&= F' & \_!3K7! <&T4! () !<K(AK! 3K7! 9&: ( ?24! &4' 7A34! ?G! 3K7! +KT4(A&8! M) 37: ) 73! A& ) A?) 3: ( 237! 3? ! (F' :?9() \*! 3K7! ?' 7:&3(?) &8! ' 7: G? :F&) A7! ?G! () 37: A?) 3() 7) 3&8! A? ::(=? :4! &= !G() &8T! 3K7! 7U37) 3! ?! <K(AK! 3K7! \*7? E7A?) ?F(A&4' 7A34! F&T! (F' &A3! 3K7! &= ?' 3(?) !?G! +MA&) ?3! ; 7! T73! &= !0K747! <(8! ; 7! 7U&F() 7= !() !3K7! A?) 37U3! ?G! 3K7! ' :?c7A3! () !? := 7: !3? !' :?9= (7! 3K7! &= !4<7: 4! &= !&84? !3? !K&97! &!X2&) 3(3&3(97! 743(F&3(?) !?G! 3K7! (F' &A3! ?G! 3K747! 37AK) ?8? \* (74! ?) !3K7! =7978? ' F7) 3! ?G! 3K7! / D0. #

MNU(; &". \$%, -(I \* , 9=,, E(G- % + ' " (G\* + \*%" (

Q?) A82= () \*! G? :?F! 3K7! &: ?97! 3K7! &: 8T4(4! ?G! 3K7! A?) 37) 34! ?G! 3K7! +?4(3(?) !+& 7: 4! F &V74! A87&: !3K&3! 3K7! G? <4! () !3K7! 0/. EO! &: 7! 7U' 7A37= !3? ! AK&) \*7! 4(\*) (G(A&) 3T! ?97: ! 3K7! ) 7U3! T7&: 4! =27! 3? ! & 4(\*) (G(A&) 3! ) 2F; 7: ! ?G! = (GG7: 7) 3! ' &: &F 737: 4! 3K7! F&c? : (3! ?G! <K(AK! K&97! &) ! (A: 7&47= != 7\* :77! ?G! 2) A7: 3& ( ) 3T# !0K(4! (4! 7977: !F? :7! ' :?) ?2) A7= !() !3K7! A&47! ?G! ' &: &F 737: 4! 42AK! &4! 3K7! \*7? !?8(3(A&8! &= !7) 9(:?) F7) 3&8! ?) 74! <K(AK! &: 7!) ?3! 2) =7: !3K7! = (7A3! A?) 3: ?! ?G! 3K7! / ^ ##!

OK7! 4A7) &: ( ?4! ; 2(8= () \*! 7U7: A(47! <K(AK! <&4! ' 7: G? :F7= !() !&8! G? 2: !+?4(3(?) !+& 7: 4! K&4! F&) &\*7= !3? !A& ' 32: 7! 3K7! F&c? : (3T! ?G! 3K747! 2) A7: 3& ( ) 3(74! &= !3K7! ( :!9&: (3(?) 4! . !7&AK! + +! () ! (34! G(7= !?G! (0) 37: 743! &= !4&47447= !3K7F! 87&= () \*!3? !3K7! =: &< () \*! G! &473! ?G! ' 8&24( ; 87! G232: 7! ) &: : &3(974! M) !+ +\$! 3K747! ) &: : &3(974! <7: 7! 3K7! ) F&3AK7= !<(3K! 3K7! (F' ? :3&) 3! 7&: 8T! () = (A&3? :4! &= !3K7! A? :: 74! ?) = () \*! (F' 8(A&3(?) 4! ?3! 3K7! / 2: ?' 7&) !3: &) 4' ? :3&3(?) !) 73<?: V#!

n? <797: !3? !; 7! &: 87! 3? !; 3& () !&A? F' 8737! (A32: 7! ?G! 3K7! G232: 7! 3K747! = (GG7: 7) 3! A7) &: ( ?4! ) 77= !3? !; 7! A? F; () 7= ! &= !G? :F! 4?7977: &8! A?) 4?8= !37= !' ?44( ; 87! G232: 7! 4A7) &: ( ?4! 3K7! <(8! A?) 4= (7! &8! 3K7! A?) (3(A&8! () = (9= 2&8! 2) A7: 3& ( ) 3(74! ?G! 3K7! G? 2: !' ?4(3(?) !' & 7: 4! &= !3K24! () A82= 7! 3K7! \*7? E7A?) ?F(A\_3K7! () G:&43: 2A32: &8! &= !3K7! 37AK) ?8? \* (A&8! &4' 7A34! &8! < () \*! G? :! &: 7337: !& ' :?&AK! ?G! 3K7! G232: 7#!

OK7! ?23A? F7! ?G! 3K747! 4A7) &: ( ?4! <(8! ' :?9= (7! 3K7! () 4(\*K3!) 77= 7= !3? !3&V7! A?) 3: ?! ?G! 3K7! 2' A? F() \*! AK&) \*74! &= !4K& ' 7! 3K7! / D0. ! &4! 3K7! G232: 7! ?G! 3K7! 0/. EO! 3K: ?2\*K! & ' 8T() \*! AK&) \*74! <K(AK! <(8! &GG7A3! ' ?8(AT! &= !87\* &8! 6: &F 7<?: V4! \*?97: ) &: A7! ' 8&) ) () \*! &= !F? ) (3? : ( ) \*! ?G! ) 73<?: V! =7978? ' F7) 3! &= !3K7! 37AK) (A&8! 4' 7A(G(A&3(?) 4! ?G! &8! &4' 7A34! ?G! 3K7! () G:&43: 2A32: 7#!

!

## 4 Simulation scenarios

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! 10!3K7!G?3KA?F() \*!437' 4!<(3K()!3K7!8(0) \*!8&; 4!<7!':?'?47!3?!<?:V!?23!3K7!G?88?<() \*!G:&F7<?:V!G?::! \*7?E7A?)?F(A!4A7)&:(?4#OK(4!F73K?=?8?\*T!(4!=7978?'7!=!;T!@3:&3G?:!v"!Nw!&!\*7?'?8(3(A&8!()3788(\*7)A7!'8&3G?:F!&)=!(4!3&: \*737!=&3!A?F'&)(74!3K&3!<&)3!3?!.;2(8!=&43:&37\*(A!8&)!<(3K?23!K&9!) \*!A7:3&()3T!&;?23!3K7!G232:7#IM!3K7!8(9!) \*!8&;4!<7!<(8!247!3K(4!F73K?=?8?\*T\_!;23!3K7!)G: ?F!3K7!'7:4'7A3(97!)?G!3K7!0/.EO!)73<?:V!()437&=!=?G!9(7<() \*!6: ?F!&!A?F'&)(T! '7:4'7A3(97#

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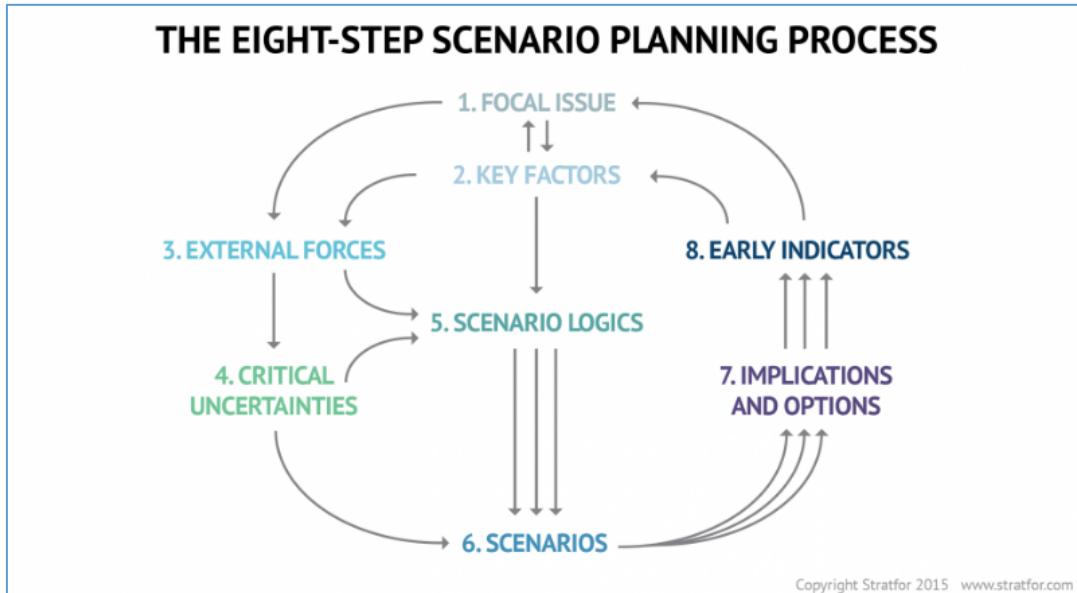


Figure 11: Steps for scenario planning process

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-AA?:=() \*!3?!=3:&3G?:\_3K7!=74A:( '3(?)!?G!3K7!7(\*K3E437' ' :?A744!3K&3!K78' 4!3?!=473!2' !3K7!4A7)&:(?4!(4!&4!G?88?<4#^?A&8!(4427#<K(AK!43&V7K?8=7!=!7:4'7A3(97!)?!AK??47Y!bK&3!(4!3K7!43:&37\*(A!X2743(?)!3K&3!T?2!<&)3!3?!=7978?'!T?2!:4A7)&:(?!=&?2)=Y!bK&3!(4!3K7!3(F7!K?:(a?)!?G!3K7!4A7)&:(?!=

"#\!7T!G&A3?:4#bK&3!&:7!3K7!V7T!G&A3?:4!?G!3K7!43&V7K?8=7:4!3K&3!&:7!(F'&A37!=!;T!3:7)=4!&)=!G?:A74Y!

C#/.U37:)&8G?:A74#6737:F()7!7U37:)&8@//+0G&A3?:4!H@?A(&8!A?/?F(A\_!/)9(:?)F7)3&8!+?8(3(A&8!07AK)?8?\*T!3K&3!(F'&A3!3K7!V7T!G&A3?:4!&)=!G?A&8!(4427!()437'4!\$!&)=!"#

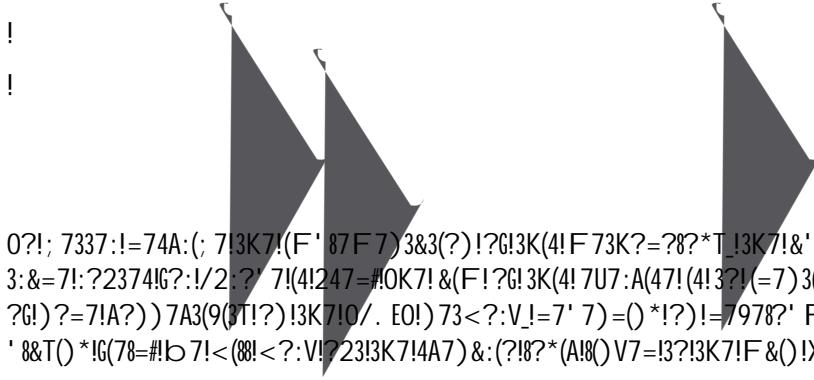
0#O:(3(A&8!2)A7:3&()3(74#K?<!F2AK!(F'&A3!=?74!7&AK!7U37:)&8G?:A7!K&4!?)!3K7!G?A&8!(4427Y!n?<!H2)IA7:3&()!(4!3K&3!(F'&A3Y!

N#H@A7):(?!=?\*(A4#&:?:<!=?<)G?:F!3K7!9(:32&8T!()G()37!)2F;7:!=?G!?44(;87!G232:74!3?!=473387!?)!243!3<?!=?G(97!3K&3!<(8!87&=!3?!=43:&37\*(A!()4(\*K34#!!

!S#H@A7):(?!=?\*(A4#&:?:<!=?<)!3K7!43?:74!3K&3!7U'8&()!K?<!=:(9() \*!G?:A74!()37:&A3!&)=!<K&3!7G6A34!3K7T!K&97!?)!3K7!?'7:&3?!)?!=43:&37\*(A!=:(7A3(?))#

5#MF'8(A&3(?))4#^?A24!?)!3K7!43:&37\*(A!(F'8(A&3(?))4!&)=!?'3(?))4#67G()7!3K7!A?)47X27)A74!?G!3K7!9&:(?24!4A7)&:(?4!3?!=K7!0/.EO!)73<?:V!&)=!43&V7K?8=7:4!<(3K()!3K7!)73<?:V#

B#/.&:8T!()=(A&3?:4#8?V!&:?)!=G?:7&:8T!()=(A&3?:4!3K&3!3788!()!<K(AK!=:(7A3(?))Z4A7)&:(?!=7&8(3T!3K7!G232:7!(4!F?9() \*#



0?1; 7337!:=74A:(; 7!3K7!(F' 87F7)3&3(?)!?G!3K(4!F73K?=?8?\*T!3K7!&' ' 8(A&3(?)!3?13K7!A&47!?G!&) &8T4(4!?G!3K7!) 7<! 3:&=7!; ?2374!(G?1/2; ?' 7!(4!247=?0K7! &(F! ?G!3K(4! 7U7:A(47!(4!3?!(=7) 3(GT! F 283(' 87! ' &3K<&T4! G?13K7! =7978?' F7) 3! ?G! ?=7!A?)) 7A3(9(T!?)!3K7!0/. EO!) 73<?:V!\_!7' 7)=(\*)!?)!-7978?' F7) 34!(?)!3K7!\*7? ' ?%3(A&0&) =! \*7?E7A?)) ?F(A! ' &8T() \*!G(78=?!b 7!<(88!<?:V!\_?23!3K7!4A7) &:(?!)?\*\*(A!8() V7=13?13K7!F &()!X2743(?)!?G!3K(4!G?2) =&3(?) &8! ' ?4(3(?)! ' & 7:W

*What is the relation between geo economics and new trade routes what are the dynamics of these trade routes and how can we measure and monitor the impact on existing TEN T corridors !*

! ! !

\$# A=". +,GC(+ " (G-&\$9(,##\*"/!M)!3K(4!437' !3K7!3?' (A!?)!<K(AK!3K7!4A7) &:(?!)& &8T4(4!(4!3?!) 7!=!(4!AK?47) # b:(3() \*!3K7!) &F7! ?G!3K7!&A3? :!<K?1F243!F&) &\*7!3K7!=T) &F(A4!&) =!79?823(?)!?G!3K7!F &:V73#

OK7! G?A&8! (4427! A&) ! ; ! G?: F 28&37= ! &4! G?88? <() \*W gK? <! <(88! \*7?E7A?) ?F(A! =7978?' F7) 34! &) =! ) 7<! 3:&=7! :?2374!(F' &A3! :() A(' &8!7) 3:T!) ?=74!& =!()& =! ) ?=74!?) !3K7!0/. EO!) 73<?:VY!]OK(4!A&) !; 7!<?:V7=!?23!G?13K7! 3K7!77!F&()!3:&=7!G8? <! =7978?' F7) 34W!L783!& =!>?&=\_!-:A3(A!>?237!H. @>!!3:&) 4K(' F7) 3!()!3K7! %7=(37::&) 7&) ! &) =!3K7!M) 37:) &3(?) &8!. ?:3KE@?23K!0:&) 4' ?:3!Q?::(=?:\_&) =!(3!8&=4!3?G?2:!G?A&8!(44274W

- L783!&=!=>?&=W K? <! <(88!3K7!L783!&=!=>?&=!=!() (3&3(97!79?897!&) =!K? <! <(88!(3!(F' &A3! :() A(' &8!7) 3:T!) ?=74!& =!()& =! ) ?=74!?) !3K7!0/. EO!) 73<?:VY!
- -:A3(AW K? <! <(88!3K7!=7978?' F7) 3! ?G!3K7!. @>!(F' &A3! :() A(' &8!7) 3:T!) ?=74!& =!()& =! ) ?=74!&?\*) !3K7!0/. EO!) 73<?:VY!
- n?<! <(88!3K7!7U' &) 4(?)!?G!3:&) 4K(' F7) 3!K2; 4!()!3K7!%7=(37::&) 7&) !(F' &A3! :() A(' &8!7) 3:T!) ?=74! &) =! ()& =! ) ?=74!?) !3K7!0/. EO!) 73<?:VY!
- M) 37:) &3(?) &8!. ?:3KE@?23K!0:&=7!Q?::(=?:\_&n?<! <(88!3K7!M. @OQ!() (3&3(97!79?897!&) =!K? <! <(88!(3!(F' &A3! :() A(' &8!7) 3:T!) ?=74!& =!()& =! ) ?=74!?) !3K7!0/. EO!) 73<?:VY!

! ! !

"# A=". +,GC(<"C(G\$&+-%#/!<K&3!&:7!()37:) &8!V7T!G&A3?:4!3K&3!K&97!&) !(F' &A3!?) !3K7! ' ?4(3(?)!?G! ' :() A(' &8!7) 3:T!) ?=74! & =! ()& =! ) ?=74!?) !3K7!0/. EO!) 73<?:VY!

OK747!A&) !; 7!=74A:(; 7!=&4!3K7!()37:) &8! 7:G?: F&) A7!() =(A&3?:4!?G!42AK!) ?=74! <(3K()!3K7!) 73<?:V# /U&F' 874! A&) !; 7!G?2) =!()!3K7! F?=78! &4! =74A:(; 7!=!()!C#N#\\$!H' ?:3!A& ' &A(3T!\_7GG(A(7)AT!?G! ' :?A74474\_47:9(A7!G:7X27)AT\_ 47:9(A7!X2&0(3T!\_=\*(3&0A?)) 7A3(9(3T!\_AT; 7:47A2:(3T!#!

C# A=". +,GC("H+"%. \$9(=%,D,. E(G-&% "#/!OK7! \*?&?G!3K7!4A7) &:(?4!(4!3?!) 3(A(' &37! ' ?44(87!&) =! ' 8&24(87!G232:74! &) =! (=7) 3(GT!43:&37\*(A!?) 3(?) 4!G?:!3K7!43&V7K?8=7:#Q:2A(&8!K7!7!(4!&) 2) =7:43& =! \*!G!K? <!3K7!7) 9(:?) F7) 3! &F?) \*! 3K7!8?\*(43(A4!) 73<?:V!(4!AK&) \*() \*!& =!3?A?)) 4(=7:G?:A74!& =!3:7) =4!3K&3!&:7!G?37!) ?3!A?)) 4(=7:7!=()! 3K7!; 24() 744! ' && #@3:&37\*(A!&8!) 4!3K&3!=4:7\*&:=!42AK!\*7? ' ?8(3(A&8!7A?)) ?F(A!4?A(&8!&) =!37AK) ?8?\*(A&8!H//+0!! G?:A74!&:7!G?37!) 87G3!?23!G?37!) G&8!

! ! !

\7T! 7U37:) &8! =:(9() \*!G?:A74! &:7! &F?) \*! ?3K7!:() 9743F7) 34! ?G!3K7! QK() 747! \*?97:) F7) 3! ()!3K7! L>M! 3 K 7 !

= ( 4 & ' ' 7 & : & ) A 7 !?G! - :A3(A!(A7\_!A:(3(A&8!&33(32=7!3?<&:=4! - :A3(A!4&(8) \*4\_!3K7!=7978?' F7) 3!?G!=(4:2' 3(97! 37AK)?8?\*(74\_! 7A?)?F(A! \*?:<3K\_! ) 7&:4K?:() \*Z:7E4K?:() \*! &)=! H7) 9(:?) F7) 3&8! 87\*(48&3(?)# @?F7! ?G! 3K74! =:(9() \*!G?:A74! F(\*K3! ; 7!A?2) 37:' :=2A3(97!3?<&:=4!3K7!=7978?' F7) 3!?G!A7:3&() !3:&=7!:?2374#!

O# A=". +,GC( &%,&\$%(\* . &"%+\$,, +,"#/! &G37!:K&9() \*! G?88?<7!= 3K(4! 43:2A32:7!= 437' E; TE437' !' :?A744! (3! (4! 3(F7! 3? (=7) 3(GT! 3K7! V7T! 2) A7:3&() 3(74#OK&3(4\_!:&) V() \*!3K7! V7T! 2) A7:3&() 3(74! ?)! ' ?37) 3(&!(F' &A3! H8?<EK(\*K! &)=! 2) A7:3&() 3T!H8?<EK(\*K! &)=! 8?33() \*! (3! () !&! \*:& K#!OK7! D?&!(4!3?G() =!3K7!3<?! F?43!(F' ?:3&) 3!2) A7:3&() 3(74\_! <K(AK! <(8!K&97!3K7!&: \*743! ' ?37) 3(&!(F' &A3!?) !3K7!) ?=7!&)=!3K7!K(\*K743!87978!?G!2) A7:3&() 3T#!

Q:(3(A&8! 2) A7:3&() 3(74! <(8! ; 7! =737: F() 7!= <(3K() !3K7! 8(9() \*! 8&: 4\_! () !A8?47! A?88&: ?:&3(?) ! <(3K! 3K7! ' &:3) 7:4! H' :() A(' &8! 7) 3:T!) ?=74!&)=!() 8&)=!)=74!

N# ; &". \$%,-(9-E,&#/!M! 437' !G(97!3K7!X2743()! (4! K?<13?!) &::?<!=?<) !G: ?F!3K7!9(:32&8T!() G() (37!) 2F; 7!:?G! ' ?44(; 87! G232:74!3?1473387!?) !c243!3<?13?G(97!3K&3!<(8!87&=!3?143:&37\*(A!() 4(\*K34#!OK7!3<?!A:(3(A&8! 2) A7:3&() 3(74! (=7) 3(G(7!=!) ! 437' !0!47:97!&4!3K7!&U74!?G!&!E; TE"!F&3:(U# 1 ; 9(?248T\_!"!G&A3?:4!A&)! (F' ?44(; 8T!7U' 8&!) !3K7!G288! ' (A32:7!?G!3K7!G232:7#n?<797:\_!; T!24() \*!3K7!G&A3?:4!<(3K!3K7!K(\*K743!87978!?G!2) A7:3&() 3T!&)=!(F' &A3!<7!G?:A7! ?2:478974!3?13K() V!?G!O!A?F' 87378T!= (G67:7) 3!<?:8=4#^&A3?:4!3K&3!K&97!; 77) !G(837:7=!=?23!; 23!) ?3!() A82=7!=?) 3K7!&U(4\_!K?28!=; 7!247=!=?G77=!=7&AK!?G!3K7!G?2:!G232:7!43&374#!!

L78?<!G?88?<4!&) !7U&F' 87!?G!&!4A7) &:(?!43:2A32:7!?238() 7\_!24() \*!3K7!G?A&8!(4427!&: ?23!3K7!. ?:3K7:) !@7!>?237#!!

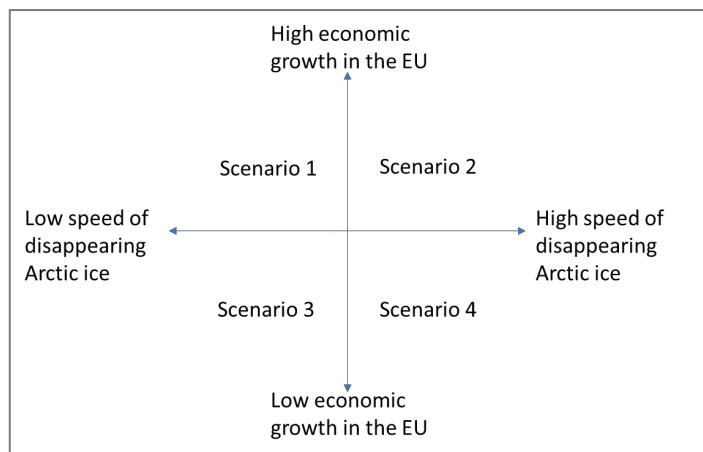


Figure 12: Scenario structure outline example

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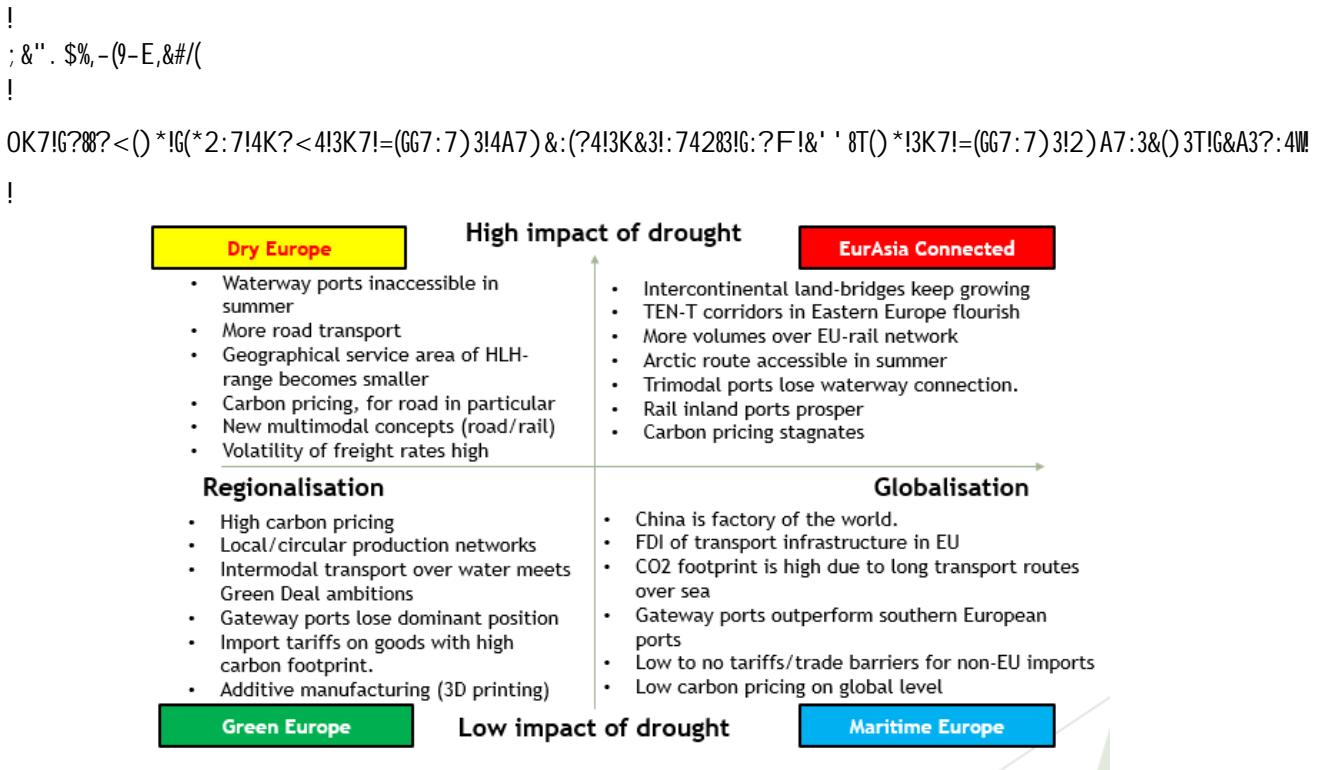
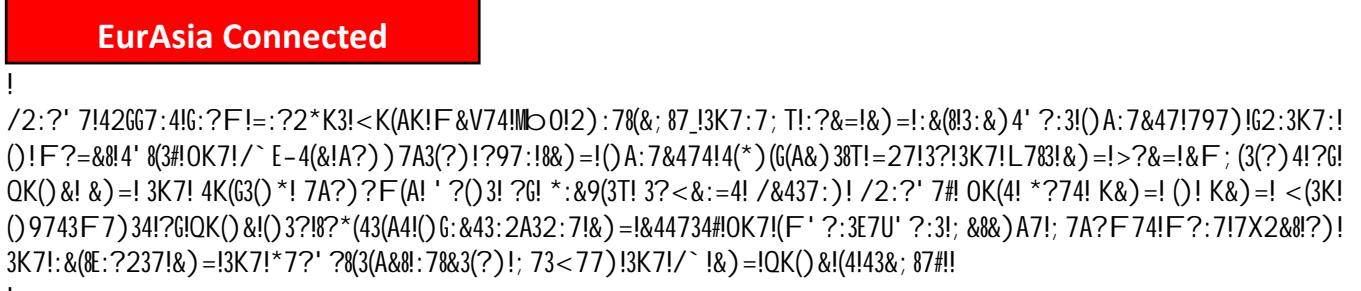
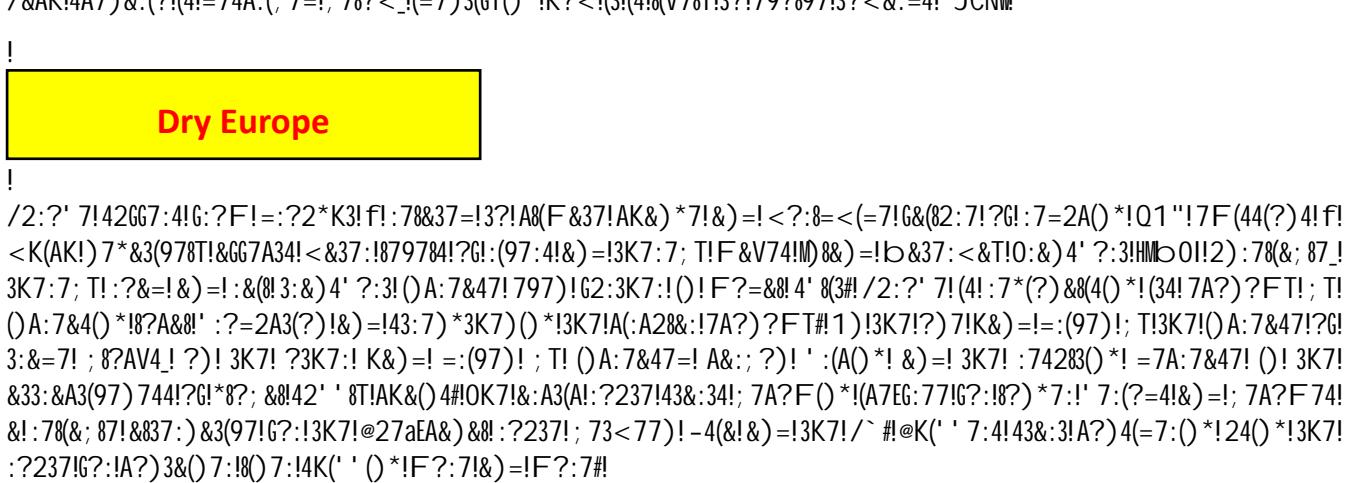


Figure 13: Scenario logics



## Green Europe

! /2:? 7!K&4!42AA77=7=!( )!(34!A&(F&37!&F ; (3(?)4!G?!"JCJ!&)=!(4!?)!3K7!<&T!3?!.7&AK!(34!"JNJ!&F ; (3(?)4#-84?\_! ?234(=7!/2:?' 7!A?2)3:(74!&:7!=?)!\*!<78!()!=:&43(A&8T!:7=2A() \*!Q1"!7F(44(?)4#Q&:;?)!':(A() \*!(4!=?)7!&3!&88: \*7! 4A&87!\_! ?3K!()4(=7!&)=!?234(=7!/2:?' 7#OK7:7; T!\*8?; &8!<&:F() \*!(4!G&337)() \*\_!&)=!3K7!(F' &A3!&G!=?2\*K3!(4!F(37=\_! &)=! :97!:4T437F4!&:7!:78(&:87!7)2\*K!3?!.AA?FF?=&37!\*:?<3K#\_!A?)?F(74!; 7A?F7!F?;7!:7\*(?)&&(47!=!)=! A(:A2&:(3T!; 7A?F74!3K7!):F#!OK(4!:742834!()!F?;7!:7\*(?)&8!)=!8744!()37:A?)3(7)3&8!3:&4' ?;3!G8?<4#D8?; &8! 3:&4' ?;3!AK&()4!&:7!)?!8?)\*7!:3K7!43&)=&:=!&)=!\*&37<&T! ?;34!()!3K7!n, nE:&)\*7!8?47!3K: ?2\*K' 23!9?&2F7!()! A?)3(&0 7:4#!

!

## Maritime Europe

! /2:? 7!43(88!:7A7(974!F&)T!()37:A?)3(7)3&8!G8?<4!&)=!QK()&!(4!43(88!3K7!G&A3?:T!&G!3K7!<?:8=&#>7\*(?)&&(4&3(?)!K&4! )?3!\*&()7=&T!3:&A3(?)!&)=!3:&4' ?;3!F?97F7)34!&:22)=!3K7!<?:8=&T!43:?) \*8T!()A:7&4() \*!T7&:!; T!T7&:#!OK(4!(4! 3K7!:74283!&G!3K7!<?:8=< (=7!&AV!&G!A&:;?)!':(A() \*!&)=!3K7:7; T!3K7!&AV!&G!()A7)3(974!3?!.AK&)\*7!3?!.F?:7!:7)7<&; 87! <&T4!&G! ?;2A3(?)!&)=!3:&4' ?;3&3(?)#OK(4!4A7)&:(?A?28!=!; 7!A?)4(=7:7=&4!3K7!43&324!X2?!.4A7)&:(? <K7:7! A(3(a7)4\_! ?8(3(A4!&)=!A?F' &)(74!&:7!)?3!<(88() \*!3?!.AK&)\*7!3K7(:!; 7K&9(2?:#!

!

!

MF' 8(A&3(?)4!&G!3K7!4A7)&:(?4!4K?28!=!; 7!=737:F()7=!.T!3K7!F?=788() \*!37&F#^?;!7U&F' 87W

- n?<!=?74!3K7!F?=8!4' 8(3!()!/2:?' 7!AK&)\*7!()!7&AK!4A7)&:(?Y!
- bK&3!<(88!:7!3K7!:78&3(97!\*:?<3K!AK&)\*7!&G!@?23K7:!)!/2:?' 7&)!':34!A?F' &:7=3?!. bE /2:?' 7&)!':34Y!
- bK(AK!()8&)=!3:&4' ?;3!)?=74!\*&()!3:&A3(?)!2)=7!:7&AK!4A7)&:(?Y!
- n?<!<(88!3:&)4' ?;3!3&:(GG4! 7:!%0Z0\%!AK&)\*7!<K7)!)88)=!<&37:<&T4!A&))?3!; 7!247=& )TF?:7Y!

!

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@A7)&:(?4!?GG7!()4(\*K3!()3?!.?44(; 87!G232:7!=7978?' F7)34!@A7)&:(?4!A&)!; 7!247=3?!.&()!0 4(\*K3!()3?!.3K7!F?43! 8(V78T!=:(7A3(?)!3K7!G232:7!<(88!3&V7\_!; 23!T?2!A&)&&4!247!4A7)&:(?4!3?!.&()!0 4(\*K3!()3?!.<K&3!3K7!G232:7!<(88!8??.V! 8(V7!<K7)!A7:3&()!AK?(A74!&:7!F&=7#

bK&3!(4!3K7!(F' &A3!&G!)7<!&)=!7F7:\*(0 \*!3:&=7!:?2374Y! bK&3!&:7!3K7!2)=7:8T() \*!3:7)=4Y!n?<!A&)!3K7!/\_! &)3(A' &37!F&)&\*(0 \*!3K747!:?2374Y!

OK7!4A7)&:(?!.F73K?=!A?)4(434!&!)2F ; 7!:?G!437' 4\_!3K7!G(43!&G!<K(AK!(4!&=74A:(3(?)!?G!3K7!4T437F!2)=7!: ()9743(\*3(?)!&)=!3K7!G&A3?:4!()G827)A() \*!3!G?88?<7!=!; T!&)!?238()7!&G!3K7!=7978?' F7)3! ' ?44(; (83(74!&)=!& c243(G(A&3(?)!&G!&!\*97)!=7A(4?)!4(32&3(?)#!-4!&:74283!F&)T!' ?37)3(&8!(F\*&74!&G!3K7!G232:7!&:7!?: 3:&()7!=#!

OK7!&=9&3&\*7!&G!4A7)&:(?!.&8T4(4! (4!3K7! ' ?44(; (83T!&G!7U&F() \*!3K7!7GG7A34!&G!=7A(4(?)4! ()!AK&)\*() \*! A(:A2F43&)A74!@A7)&:(?!.&8!)() \*!4!&)(F' ?;3&)3!3??.G?:(=7)3(GT() \*!:(4V!G&A3?:4!&)=!&:7&4!&G!2)A7:3&()3T!& ?23!A7:3:&()!=7978?' F7)34#!



- /GG(A(7)3!; ?:=7:!A:?44() \*4#!
- %?:7!37:F() &4!A?) ) 7A37=()!/2:?' 7!&)=!QK() &#!

!M!&=(3(?)!3?&14A7)&:(?!()!<K(AK!:&(8<&T4!&:7!247=!F?:7!()37)4(978T!G?:!G:7(\*K3!3:&)4'?:3\_!<7!&:7!&84?!)&?V() \*!&!

&4(32&3(?)!()!<K(AK!3K(4!=74!)?3!K&' '7) #M!3K(4!4(32&3(?)\_3K7!F&?:3T!G!G:7(\*K3!3:&)4'?:3!;73<77)!/2:?'7!&)=!

-4(&!<(8!\*&?;T!47&#!OK(4! :?9(=74!()4(\*K3!(3?3K7!A?)47X27)A74!?G!3K7!2)=7:=7978?'F7)3!?G!:&(8!G:7(\*K3!3:&)4'?:3#!

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### Disadvantaged regions

!/&437:)!/2:?'7!(4!3K7!\*&37<&T!G?:!:&(8!3:&)4'?:3!3?&)=!G?:F!-4(&#!M!3K(4!4A7)&:(?\_!<7!8??V!&3!<K&3!K&' '7)4!(G!3K7!

=!(4=&9&)3&\*7!=!7\*(?)4!=7978?'!43:?) \*8T#!OK(4!()9?8974!()G:&43:2A32:&!=7978?'F7)3!?)!3K7!?)7!K&)=!&)=!4?A(?E

7A?)?F(A!=7978?'F7)3!?)!3K7!?)3K7:#!b7!&84?!)&?V!&3!<K&3!K&' '7)4!(G!3K(4!:7\*(?)!8\*4!;7K()=#!

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5-="%( \$%\$8"+%"#(

()

OK7!3&;87!;78?<!':?9(=74!&)!97:9(7<!?G!3K7!'&:&F737:4!()!3K7!F?=78!3K&3!A&)!;7!&=c2437=!'7!:4A7)&:(?#!@!(F(8&:!

'&:&F737:4!&:7!&9&(8!;87!3?!)F?=78!3K7!()37:E/2:?'7!3:&=7!G8?<4\_!(#7!3K7!3:&=7!G8?<4!G:?)F!3K7!'():A('&8!7)3:T!

)?=74!&)=!3K7!/:?'7&!)K()37:8&)=!=743()&3(?)4#M

Table 7: Model parameters for Europe-China trade flows

Parameter	Parameter adjustments
Trade data	Increase/decrease trade between countries
Rail terminals	Add or remove terminals
Rail routes	Add/remove routes
Rail services	Add/remove services
Rail costs	Increase/decrease rail costs
Terminal costs	Increase/decrease attractiveness of terminals
Sea ports	n.a. – all sea ports are included
Sea services	n.a. – all sea services are included
Sea costs	Increase/decrease costs

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!M!3K(4!':?c7A3!3K7!&(F!(4!3?!)':?9(=74(F28&3(?)!A'&:&(8(74!G?:!3K7!&44744F7)3!?G!3K7!7U'7A37=!(F'&A3!?G!7F7:\*)!

3:&=7!':?2374! )&3(?)&8!43:&37\*(74!&)=!37AK)?8?\*(A&8!A?)A7'34!?)!3K7!0/.EO!A?::(=?:4!&)=!+:(A('&8!/)3:T!

. ?=74Z()&=!)?=74!()37:G&A() \*!0/. EO!3?!\*8?; &&3:&=7!&=!=<(88!=76()7!3K7!>767:7)A7!@' 7A(G(A&3(?))4!?)37\*:37!=!/^ED8?; &&!. 73<?:V4!!/DO. !##!

0K7!F73K?=88\*T!247=3?!=7G()7!3K7!:(\*K3!4A7)&:(?4!G?:!,, "!(!4!; &47!=?)!3K7!A?)3:(; 23(?))4!?)G!^?2)=&3(?)!++\$!()!<K(AK!&)!7(\*K3E437'! :?A744!K&4!; 77)!=73&87!=H477!G(\*2:7!C#\$!#0:&)4' ?47=3?3K7!, "!7)9(:?)F7)3!3K7!G?88<()!\*F&()!787F7)34!A&)!; 7!7U3:&A37=!!

- ^?A&!(4427!!n?<!<(88!3K7!247!?)G!:&(&8<&T!3:&)4' ?:3!79?897=!(!)3K7!)7U3!37)!3?!)N!T7&:4!()!=??:E3?E=??:!42' '8T!AK&()4!; 73<77)!/2:?7!&=!=>244(&ZQK()&Ym! l o K&3!:&7!3K7!F(&)!; ?3387)7AV4!?)!3K7!0/. EO!&)=!3:&)4A?)3(7)3&8A?::(=?4Ym!OK7!4K('7:4!, @+4!\_7)3:T!)?=74!\_00!?'7:&3?4!:&7!3K7!43&V7K?8=7:4!G?F!<K(AK!<7!9(7<!3K7!G?A&!(4427#)
- \7T!G&A3?:4!!3T'74!?)G!\*?=?4!&=!=()!\*2)(34!9?82F7!3K:2?\*K'23!7G(A(7)AT!?)G!' :?A74474!3:&)4(3!3(F7\_!:&(&8<&T!()G:&43:2A32:7\_!=(\*3&!(a3(?))!?)G!-?A2F7)34!
- /U37():&8!G?:A74!!7A?)?F(A!!H3:&A3(?))!:(A74\_!)7<!7)3:&)34!\_!' ?8(3(A&8!HO/. EO!\*?97:)&)A7\_!42; 4(=T!4AK7F74!()!QK()&!A?FF7:7A(&8!3:&=7!&\*77F7)34!; 73<77)!/2:?7!&=!=QK()&!L!7)9(:?)F7)3&8!HD:77)!67&8!3:&)4' ?43(?))!QK()747!?'43(?))!?)!\*8?; &&.<&:F()\*!\_!37AK)?8?\*(A&8!H<\*&?)4!7F7:7)A7!?)G!'8&3G?:F!'?:9(=7:4\_!)37\*:3?!)!?)G!+M&)=!M!0!F7AK&)(4F4!#)
- Q:(3(A&8!2)A7:3:&)3(74!!&!)!&44744F7)3!?)G!7&AK!7U37:)&&G?:A7!4K?28!=!; 7!2)=7:3&V7)!()!?:=7:13?!)37\*:37!3K747!:(4V4!()3?!)3K7!F?=78!OK7!&44744F7)3!A:(37:(&14K?28!=!; 7!:&)\*7!=!; 73<77)!\$!H97:T!8<!13?!)N!H97:T!K(\*K!#^?!)7U&F'87!3K7!:(4V!3K&3!3K7!QK()747!?)F7)3!<?)]3!'2:427!3K7!42; 4(=T!':?\*&F!G?:!:&(&8<&T!3:&)4'?:3&3(?))!?)!4?F7!:?2374!(4!97:T!K(\*K#)
- @A7)&:(?4!!G?2:!=G67:7)3!4A7)&:(?4!A?28!=!; 7!7)9(4&\*7!=G?!)3K7!:&(&8<&T!3:&)4'?:3!?)!()37:A?)3()7)3&8!A?::(=?4!&)=!4K?28!=!; 7!G2:3K7!:!)9743(\*&37!=!; T!3K7!, "!!:&3)7:4!!
- D116@!H3:&)4'?:3!?)G!6&)\*7:224!D??=4!!3K7!:743:(A3(?))4!?)!3K7!3:&)4'?:3&3(?))!?)G!&=!=7:24!\*??:4!3K:2?\*K!QK()&!K&97!; 77)!& F&c??:!AK&87)\*7!G?:!9:&(?24!()=243:(74!!l o (3K!3K7!\*:?<()!\*=7F&)=!G?!)787A3:(A!A:&4!\_!3K7!7!4!&\*?!)?787A3:(A!A:&4!; 23!&4?!)G?!)787A3:(A!; (ATA874\_!8!3?4!?:!K?247K?8=4!OK(4!4!&; ??F()\*!F&:V73\_!&)=!3K(4!F&:V73!(4!7&\*7:1?!)477!3K7!:743:(A3(?))4!8(G37#=!!
- M. 0/>1+/-LM, MOh()G:&43:2A32:7!E!=???:E3?E=??:!A243?F4!&)=!A?FF7:A(&8!=?A2F7)3!!3K7! />1A243?F4!7\*28&3(?))4!8&T!=?<)3K7!.2874!G?:!3K7!/2:?7&!)Q243?F4!&:7#&OK(4!(4!)?)3!T73!&:7&0(3!&3!&8!G?:!3K7!-4!&!)47A3(?))!?)G!()37:A?)3()7)3&8!:&(&8<&T!3:&)4'?:3#!OK7! (F'&A34!?)G!3K7!&AA7!3!A7!?)G!8?)\*7!:&)=!K7&9(7:13:&(&4!?)!3K7!7)3(:7!3:&)4A?)3()7)3&8!0/. EO!)73<?:V!4K?28!=!; 7!&447447!=!&)=!737:F()7!=!!
- n->%1. M-0M1. !H=?A2F7)3!f!=???:E3?E=??:!A243?F4!&)=!A?FF7:A(&8!=?A2F7)3!!3K7! />1A243?F4!7\*28&3(?))4!8&T!=?<)3K7!.2874!G?:!3K7!/2:?7&!)Q243?F4!&:7#&OK(4!(4!)?)3!T73!&:7&0(3!&3!&8!G?:!3K7!-4!&!)47A3(?))!?)G!()37:A?)3()7)3&8!:&(&8<&T!3:&)4'?:3#!OK7! (F'&A34!?)G!3K7!&AA7!3!A7!?)G!8?)\*7!:&)=!K7&9(7:13:&(&4!?)!3K7!7)3(:7!3:&)4A?)3()7)3&8!0/. EO!)73<?:V!4K?28!=!; 7!&447447!=!&)=!737:F()7!=!!
- ^ . 6M. D!!42; 4(=74!E!=???:E3?E=??:!42; 4(=T!4AK7F7!?)!3K7!7F7:7)3!:?2374!!3K7!A2::7)3!QK()747!G2)=()!\*!4AK7F74!&:7!V?<)!797)!G!3K7!&=:744!F&()8T!3K7!QK()747!7U?>37:4!; 23!&:7!)?3!43&:87!()37:F4!?)G!3(F7!<K&3!<88!K&7!)!G!3K?47!42; 4(=74!&:7!&=3?!)?797)3!43?7!=!3K7!7&:G232:7!#
- MF'8(A&3(?))4!!
- D116@!!:?23()\*)&=!=3:&A()\*)!?)G!&=!=)\*7:224!\*)?!=4!?)!3K7!0/. EO!A?::(=?4!\_?)8(AT!AK&)\*74!()!>244(&!)=!QK()&H?!)!3K7!(&7)3(G7!=7F7:7)3!:?2374!#
- M. 0/>1+/-LM, MOh!!&(\*F7)3!?)G!0/. EO!; &4(A!:&F737:4!<(3K!-4(&!)=!
- n->%1. M-0M1. M&(\*F7)3!?)G!7:3&8!4!2874!?)!3K7!0/. EO!A?::(=?4!A?)7A37!=<(3K!-4(&!)=!
- &8T4(4!?)G!7879&3!-4(&!)!?)A7=2:74#
- ^ . 6M. D!!4'7A(&8!Q/^!G2)=()!\*!A&84!G?!)()37:A?)3()7)3&8!3:&)4'?:3!H()9743F7)3!()37:F()&84!G?!)7U&F'87!!f?7!)QK()747!42; 4(=T!4AK7F74!G?:!2:?7&E; &47=!=A?F'&)(74#)
- /&:8T!()=(A&3?:4!!

- D116@!4K&:7!?!G!=&)\*7:?!24!\*??=4!3:&)4(3!3(F7!)2F;7:?!G!A?)3&()7:4!<(3K!=&)\*7:?!24!\*??=4#!
- M. 0/>1+/-LM, !Dh! 2F;7:?!G!3:&()4!7:!=&T!K&)=8() \*!3(F7#!
- n->%1. M@-0M1. M)2F;7:?!G!=?A2F7)34! :?A7447=\_!=(\*)3&(a&3(?)!87978#!
- ^` . 6M. D!z!7:3VF!z!7:!A?)3&()7:\_)2F;7:?!G!K&)=87=!A?)3&()7:4#!

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L&47=!)!3K7!&;?97E=74A:(;7=!787F7)34!3K7!G?88?<() \*!4A7)&:(?4!A?28=!;7!F?=7887=!)!3K7!G;&F7<?:V!?!G!+,-./0!;T!F(U)\*!3K7!=!(G7:7)3!=()3(G7!=A?)43:&()34#!OK747!4A7)&:(?4!4K?28=!G(:43!;7!79&82&37=!)=(9=2&8T!&)=!A&)!;7!&G37:<&:=4!A?F;()7=!)!&F?:7!A?F'87U!4(F28&3(?)4!7A?4T437F#!

Scenario I RAILWAY INTEROPERABILITY	Scenario II POLITICAL FRAMEWORK	Scenario III DIGITALISATION
<ul style="list-style-type: none"> <li>• The railway corridors are not yet fully interoperable and thus limiting a smooth transfer of trains/wagons/intermodal loading units between Europa and Asia.</li> <li>• Three levels: <ul style="list-style-type: none"> <li>- Poor interoperability: AS-IS situation.</li> <li>- Medium interoperability: AS-SITUATION + partial interoperability (train length, axle load...) on some routes.</li> <li>- Full interoperability: all routes are fully interoperable.</li> </ul> </li> <li>• Initial key indicators: number of trains/day/route, transit times and cost per unit.</li> </ul>	<ul style="list-style-type: none"> <li>• The political context both in Europe and in especially in China, significantly affects the railway transport on the Eurasian routes.</li> <li>• Three levels: <ul style="list-style-type: none"> <li>- Degraded mode: the subsidies will only be allocated to Chinese companies, the dangerous goods are not accepted at all on the Chinese railway network – customs procedures are reinforced.</li> <li>- Status mode: AS-IS situation</li> <li>- Upgraded mode: open subsidy schemes for all companies transporting goods from/to China – dangerous goods are accepted – simplified customs' procedures.</li> </ul> </li> <li>• Initial key indicators are: number of trains/day/route, transit times and cost per unit., number of loading units with dangerous goods, subsidies received per loading unit and number of produced documents.</li> </ul>	<ul style="list-style-type: none"> <li>• The European railway sector is submitted to regulations regarding data exchanges and digital platforms (for example TAF TSI). This scenario should evaluate the impacts of digitalization on the management of documents (customs and commercial) on the Eurasian routes</li> <li>• Three levels: <ul style="list-style-type: none"> <li>- Low: current situation</li> <li>- Medium: partial digital document management</li> <li>- High: full digital document management</li> </ul> </li> <li>• Initial key indicators are: number of paper documents versus digital documents and number of community platforms (business &amp; authorities).</li> </ul>

Figure 14: Scenario options

0?!=76()7!4A7)&:(?4!78&37=!)3?!3K7! ' ?37)3(&!&=?' 3(?)!?G!+M!3K7!G?88?<() \*!F&()!747&:AK!X2743(?)!K&4!;77)!A?)4(-7:7=!

How could the various aspects of the Physical Internet contribute to improving the operational performance of intercontinental corridors in PLANET?

0?!A?)43:2A3!&4A7)&:(?!<K7:7!3K7!()G827)A7!?!G!3K7!=!(G7:7)3! '&:&F737:4!A&)!;7!&)&8T47=\_!3K7!F73K=?8?\*T! ' :79(?248T!=74A:(;7=!)K&4!;77)!G?88?<7=!)437' 4#!^(:43!3K7!':()A(' &8! '?()3!?!G!G?A24!(4!=7)3(G7=#!)3K(4!A&7!?)!K?<!3K7!=!(G7:7)3!+M&4!7A34!A&)!K78'!3?!(F' :?97!3K7! ' 7:G?:F&)A7!?!G!()37:A?)3()7)3&!A?::(=?:4!@7A?)=8T! (=7)3(GT)\*!3K7!F&()!G&A3?:4!3K&3!()G827)A7!3K7!=7G()3(?)!?G!4A7)&:(?4#!b7!7G7:3?G!A3?:4!42AK!&4!A?88;&:3(?)!43&)=&:=(4&3(?)!?:!3:243!()3K7!7UAK&)\*7!?!G?:F&3(?)#0K7)\_7U37:)&8!G?:A74!3K&3!F&T!K&97!&!)()G827)A7!G:?!F!&4!A?(&8!7A?)?F(A\_7)9(:?)F7)3&8! ?8(3(A&8!?:!37AK)?8?\*(A&8! '?()3!?!G!9(7<!&:7!=7)3(G7=#!OK7!F&()!2)A7:3&()3(7!

!<#^()&&T!3K7!8?\*(A!?)3K7!4A7)&:(?!(4!=7G()7=\_!<K7:7!3K7!F&()!&U74!3K&3!\*:?2'!3K7!=!(F7)4(?)4!?)4!?)&&T4(4!&:7!=7)3(G(7=#M)3K(4!A&47\_3K7!87978!?)G!&=?'3(?)!?)G!+M;T!A?F'&)(74!&)=!3K7!\*&97:)F7)3!'?8(A(74!3K&3!A&)!42' '?:3!3K7!=7'8?TF7)3!?)G!+M:&7!=43() \*2(4K7=#!-)!7U&F'87!?)G!&8!3K747!437'4!(4!4K?<)!()!3K7!AK&:3!;78?<#

Table 8: Steps definition for PI Scenario

S	E a a
1. Focal issue	How could the various aspects of the Physical Internet contribute to the improvement of the operational performance of intercontinental corridors in PLANET?
2. Key factors	Collaboration, Standard containers, Trust sharing information, Open Logistics Services (Supporting Policy).
3. External forces	<p><b>S</b> Trust in PI system; Open Collaboration between companies.</p> <p><b>E</b> Dynamic pricing; win-win for all players.</p> <p><b>E</b> CO2 pricing in shipping; increase of the fill rate.</p> <p><b>P</b> Incentives for Open collaboration; Supporting Policy (PI regulations).</p> <p><b>T</b> Digital visibility; Automated distribution systems.</p>
4. Critical uncertainties	<p>Stakeholders' reluctance toward sharing information. <b>ac</b></p> <p>Certified open logistics service providers. <b>ac</b></p> <p>Standard logistics protocols. <b>d</b> <b>ac</b></p> <p>Containerized logistics equipment and technology. <b>ac</b></p> <p>Physical interoperability between different load units. <b>ac</b></p> <p>Too many regulations that hinder innovation. <b>ac</b></p> <p>Lack of trust on sharing information services and systems. <b>d</b> <b>ac</b></p> <p>Lack of appropriate standards for data collection. <b>d</b> <b>ac</b></p> <p>Development of reference IT architecture. <b>d</b> <b>ac</b></p>
5. Scenario logics	High / Low PI Adoption Weak / Strong supporting policy

!OK7!4A7)&:(?!&:7!=7G()7=\_!;&47=!)3K7!F&()!=(F7)4(?)4!?)G!3K7!4A7)&:(?!8?\*(A!&?) \*!3<?!=7G()7=\_!&U74#!OK7!G(:43!&U(4!=7&84!<(3K!3K7!87978!?)G!&=?'3(?)!?)G!+M Hn(\*KZ,?<!)&=!3K7!47A?)!=!&U(4!<(3K!3K7!42' '?:3!) \*! '?)8(AT!Hb7&VZ@3:?) \*!#OK7!A?F;()&3(?)!?)G!3K747!G?2:!)879784!=7)3(G(74!G?2:!)?44(;87!4A7)&:(?4##



OK7! 43:2A32:7! <K(AK! <&4! 247!=! G?:! =:&<() \*! 3K7! A?) 4?8(&37!=! /D0. ! 4A7) &:(?4! () A82=74! 3K7! A?F ; () &3(?)! ?G! 9&:(&3(?) 4!>G!3K7!F&()!&:&F 737:4!3K&3!&:7!7U' 7A37=!3?&&G7A3!3K7!G232:7!=7F&)=!&)=!42' ' 8T!G?::3:&4' ?>3&3(?)\_! ; 2(8=() \*!?)!3K7! <?:V! ' 7:G?:F7=!( )!3K7! ++4!87&=() \*!3?>3K7!=7G() (3(?)! ?G!3K7!) &::&3(97! ?G! 7&AK! 4A7) &:(?#! 0K7! &44744F7) 3!>G!3K7!:742834!G:>F!3K7!4(F2&3(?)! ?G!3K7!3<?4A7) &:(?4!<(&8!; 7!F&=7!3K:22\*K!3K7!(F' 87F7) 3&3(?)! ?G! ' :? 7!:!>7T!+7:G?:F&) A7!M)=(A&3?:4!<K(AK!&:7!=7A:(; 7=!( )!3K7!) 7U3!AK&' 37!:!>G!3K(4!=?A2F7) 3#!

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Figure \$S: Consolidated scenarios structure

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OK7!=7F&)=!G?:!G:7(\*K3!3:&)4' ?>3&3(?)!4!7U' 7A37=!3?; 7!F&()8T!&&G7A37=!; T!&:&F 737:4!78&37=!3?7A?)?F(A!&)=! ?>3(A&8!=7978?>F7) 3#-AA?:=() \*!3?>3K7!2) A7:3&()3(74!247!=!()!3K7!++4A7) &:(?4!3K747!&:&F 737:4!() A82=7M

&gt; /A?)?F(A!&amp;:&amp;F 737:4M!

- /A?)?F(A!&)=! ?' 2&3(?)!\*>?<3K!H/`\_!QK()&\_!b?>=I#
- ,?A&3(?)!G!':?>2A3(?)!H>7\*(?)&&(a&3(?)!94!D8?; &&(a&3(?)!H#

&gt; +?&gt;3(A&amp;8!&amp;:&amp;F 737:4M

- ^2)=() \*!4AK7F74!H42; 4=(74!H:?F!QK()&!42' ' ?>3() \*!:&(&3:&)4' ?>3&3(?)#
- 0&:(GG!:7\*(F74#!
- >743:(A3(?)!?)!3K7!:&(&3:&)4' ?>3&3(?)! ?G!=&)\*7: ?>24!\*>=4!G:>F!QK() &#!
- Q?FF7:A(&8!&:77F7) 34!<(3K!QK())&#!

KN 2"G.. ,+,-. (-G(: \*: : 9C/

OK7! 42' ' 8T! :7\*&:=() \*!G:7(\*K3!3:&)4' ?>3&3(?)! () A82=74! 3K7! &9&(&8; 87! K&:=! () G:&43:2A32:7!3K7! 47:9(A74! &)=! 3K7! 37AK)?>?\*(A&8!() G:&43:2A32:7!G?:!47:9() \*!3K7!G?<4!; 23!&4?>3K7!7) 9(:?) F7) 3&8!&:&F 737:4!&&G7A3() \*!A&' &A(3T!&)=! 7A(4(?) 4!F&=7!>7\*&:=() \*!3K7!247!>G!3K7!&9&(&8; 87!() G:&43:2A32:7!-AA?:=() \*!3?>3K7!2) A7:3&()3(74!247!=!()!3K7!++4A7) &:(?4!3K747!&:&F 737:4!() A82=7M

- M)9743F7) 34! ()!3:&)4' ?>3! &)=! 8?\*>(43(A4! () G:&43:2A32:7! HA?) A7:) () \*! &&8! F?=74! ?G!3:&)4' ?>3! <(3K! 4' 7A(&8!G?A24!?)!()9743F7) 34! ()!&(&8!() G:&43:2A32:7!3?!( )A:7&47!7GG(A(7) AT!&)=!&33:&A3(97) 744!>G!:&(&8!

- 67978?' F7) 3!?! 7<!)?=74##
- ,7978!?!G!+M&=?' 3(?)!&=!(F' 87F7) 3&3(?)!?!G!3K7!7) &; 8() \*!() )?9&3(97\_!=4:2' 3(97!37AK) ?8?\*(74##
- n:&F?) (a&3(?)!?!G!=?A2F7) 34!HA?F F7: A(&8!P!A243?F4!!&?) \*!3K7!:&8!A?::(=?:4#
- MF' &A3!?!G!\*&?; &8!<&:F() \*!H?) !M b!() !/2:?' 7!P!?) !3K7!-:A3(A!:?237!#

-)?3K7!:! &:&F 737!:!&84?A?) 4(=7:7!=()!:=:&G3() \*!3K7!A?) 4?8(=37!=4A7) &:(?4\_!<K(AK!&GG7A34!; ?3K!3K7!42' ' 8T!&)=! =7F&)=!=(F7) 4(?) 4! ?G!42AK! 4A7) &:(?4\_!(4! :78&37!=3?\_! ?8(AT! &)=! 87\*(48&3(?)! () 3(3&3(974! ?G!3K7! /` !3?<&:=! 3K7! =7978?' F7) 3!?!G!3K7! /DO. ()!37: F4!?!G!K&:=!&)=!4!G3!() G:&43:2A32:7#OK747!() 3(3&3(974! F&() 8T!() A82=7!3K7! :?9(4(?)4! ?G!60, ^\_!<K(AK!<(88!&GG7A3!() 37:?' 7:& (8(3T! &)=!&84?13K7!K&:F?) (a&3(?)!?!G!=?A2F7) 34!P! :?A7=2:74!&?) \*!3K7! 42' ' 8T!AK&() 4!3K7!42' ' ?3! ; T! /` !' ?8(AT! :7\*&:=() \*!3K7!=7978?' F7) 3!?!G!3K7! +M&)=!&84?13K7! /` !' ?8(AT! ?!)!3K7!= (4&=9&) 3&\*7=!:7\*(?) 4#

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RN ; &". \$%, - ( . \$%%\$+, D" #(Y(, 8: 9,&\$+, - . #G-%+ ' "(+%. #: -%+(#C#+" 8(

OK7!A?F; ()&3(?)4!?!G!9&:(&3(?)4! ?G!3K7!F&()!2) A7:3&()3(74! ?G!3K7!4A7) &:(?4! ?G!G?2:!+?4(3(?)! ' & 7:4!4787A37!=G?:: =:&G3() \*!3K7!A?) 4?8(=37!=4A7) &:(?4! &:7! :747) 37!=()!3K7!G?88?<() \*!3&; 87#OK7!4787A3(?)!<&4! F&=7! ; &47=!=?)!& :7&8(43(A!& ' :?&AK!?!G!3K7! ?44(; 87!G232:7!A?F; ()&3(?)4! ?G!3K747! &:&F 737:4#

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0&; 87!R! Critical uncertainties

W-#, +, - . (	W\$: "%			
WWT(				
WWK(				
WWR(				

	:743:(A3(?)4!:7F&()!P! A?F' 87U!A243?F4! ' :?A7=2:74#		
	n(*K! %7=(2F! ,?<!!	! ✓! ✓! !	
	/~!+M42' ' ?:30 *!+?%(AT! @3:?) *!	! ✓! ✓! !	
WW[(	+M&=?' 3(?)!	n(*K! ,?<!	✓! ✓!

OK7!=73&(87!=!)&8T4(4!?:G!3K7!3<?4734!?:G!A?F; ()&3(?)4!?:G!2)A7:3&()3(74!:7\*&:=() \*!3K7!43:2A32:7!?:G!3K7!A?)4?8(=&37=!  
4A7)&:(?4\_!)&F78T! 3K7!=7F&)=! G?:7A&43() \*! 3K7! 42' ' 8T! ()G:&43:2A32:7!=7978?' F7)3! &=! 3K7! 37AK)?)?8?\*T!  
=7978?' F7)3!(4!':747)37=!(?)3K7!G?8?<() \*!3&; 874M

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2F5&gt;X2(^&gt;! A&gt;7AOX; (

0&amp;; 87!\$J

Scenario demand variations

W\$%\$8"+%"#(	2"8\$. =(_-%"&\$#+,. E(^\$%,+\$+,-. (T! 32F5(T6!	2"8\$. =(_-%"&\$#+,. E(^\$%,+\$+,-. (K! 32F5(K6!	; - *%"&"(
F&-. -8,&(E%-B+' (J(Z2W(!	n(*K!!	%?=7:&37!	++"!
W-: *9\$+,-. (Z%-B+' (	n(*K!	%?=7:&37!	++"!
: ' ,G+(-( %"E,-. \$9,`\$+,-. (-G( :=-*&+,-. !	,?< H%?=7:&37!=7A:7&47!?:G! ()37:)&3(?)&&G8?<4!=27!3?8?<! :7*(?)&&(4&3(?)!?:G!':?2A3(?)!G?:! K(*KE37AKZ43:&37*(A!':?2A34!#!	n(*K! H%&c?!=7A:7&47!?:G!K(*KE 37AKZ43:&37*(A!':?2A34!?)!4' 7A(G(A! A?::(=?4!=27!3?1:7*(?)&&(a&3(?)!P! M)A:7&47!?:G!/~!F&A:?:7*(?)&& G8?<4!#!	++"!
O+' "%(F&-. -8,&(: \$%\$8"+%"#(!	>&(8!42; 4(=(74!4AK7F74!G?:!&8! A?F' &)(74!3:&)4' ?:3() *!*&?=?=4! 3?Z6:?:F!()!QK() &!	>&(8!42; 4(=(74!4AK7F74!()!QK() &! :7F&() *!4&F7!&4!3?=?T#!	++C!
W-9,+,&\$9( W\$%\$8"+%"#(!	• O&:(GG!:7*(F74!&4' 7!:3?=?T#!! • >743:(A3(?)4!3?1:&(8!3:&)4' ?:3!?:G! =&)*7:?:24!*&?=?4!G:?:F!QK() & 8(G37=#! • D7?1?8(3(A&8!:78&3(?)!; 73<77)!/`! &)=!QK() &!(4!43&; 87#!	• 67A:7&47!?:G!3&:(GG4#! • . 7<!7)3:&3!P!7F7:7)A7!?:G! *?97:)F7)3!?<)7!=!7)37:1:(474! (F' &A3() *!& ' 8(7!=!3&:(GG4#! • >743:(A3(?)4!3?1:&(8!3:&)4' ?:3!?:G! =&)*7:?:24!*&?=?4!G:?:F!QK() & :7F&()!&4!3?=?T#!	++C!

O+' "%!	<ul style="list-style-type: none"> <li>• , ?&lt;!=7978?' F7) 3!?!G! =(4&amp;=9&amp;) 3&amp;*7!=:7*(?) 4#!</li> <li>• OK7!4K(G3) *!?G!7A?) ?F(A! ?) 3!?!G! *:9(3T!3?&lt;&amp;:=4!/&amp;437:)!/2:?' 7#!</li> </ul>	<ul style="list-style-type: none"> <li>• OK7!(F' ?:3E7U' ?:3!; &amp;&amp;) A7! ; 7A?F74!F?:7!7X2&amp;8!?)!3K7!:&amp;(8E ?:237!3?/!&amp;437:)!/2:?' 7#!</li> <li>• @3:?) *!=7978?' F7) 3!?!G! =(4&amp;=9&amp;) 3&amp;*7!=:7*(?) 4#!</li> </ul>	++\$! P++"!
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; aWW01(^&gt;! A&gt;7AOX; (

0&amp;; 87!\$\$. Scenario supply variations!

W\$%\$8"+%"#!	<ul style="list-style-type: none"> <li>• ; *: : 9C(A. G%\$#%* &amp;+ *%"( = "D"9-: 8". +( ^%\$, +, - . (T( 3AX_! &gt;(T6!</li> </ul>	<ul style="list-style-type: none"> <li>• ; *: : 9C(A. G%\$#%* &amp;+ *%"( = "D"9-: 8". +( ^%\$, +, - . (K( 3AX_! &gt;(K6!</li> </ul>	; - *%"#!
A8: \$&+G%-8( &8\$+"(& \$. E"(	n(*K!!	, ?<!!	++\$!
5-=\$%( A. G%\$#%* &+ *%"( = "D"9-: 8". +(	<ul style="list-style-type: none"> <li>• M) &amp;)=!b &amp;37:&lt;&amp;T!0:&amp;) 4' ?:3!H!b 0! 2):78(&amp;; 87!P!A' &amp;A(3T!7=2A3(?!)!)&amp;88!M)0!47:9(A74!0K7!-:A3(A!?:237! ; 7A?F74!&amp;!:78(&amp;; 87!&amp;837:) &amp;3(97!G??:1 3K7!@27a!Q&amp;)&amp;#!</li> </ul>	<ul style="list-style-type: none"> <li>• %() ?:!A&amp;' &amp;A(3T!7=2A3(?!)!)M)0! ?!:!) ?!:7=2A3(?!)#. &amp;9(*&amp;; (3T! ' 7:(?=4!?G!3K7!-:A3(A!?:237!7F&amp;()! :78&amp;3(978T!4F&amp;88#!</li> </ul>	++\$!
! \$,9B\$C( , G%\$#%* &+ *%"( = "D"9-: 8". +(	<ul style="list-style-type: none"> <li>• 3@OXXF@7F2(Fa! &gt;; A&gt;(#". \$. %, -6(</li> <li>• OK7!/^ E-4(&amp;A?) ) 7A3(?!)!97!:8&amp;)=!() A: 7&amp;474!4(*) (G(A&amp;) 38T!3K7! :&amp;(8!A?::(=?4!?' 7:&amp;3(?!)#</li> <li>• @(*) (G(A&amp;) 3!() 9743F7) 34!G: ?F! OK() &amp;!() 3?18?*(43(A4!() G:&amp;43:2A32:7! &amp;)=!&amp;44734#!</li> <li>• M) A: 7&amp;47!?G!&amp;88!?' 7:&amp;3(?!)&amp;!</li> <li>• &amp;:&amp;F737:4!() !A?::(=?4! A?) ) 7A3() *!/2:?' 7!)?3?13K7! ; :?&amp;=E*&amp;2*7!) 73&lt;?:V!3?&lt;&amp;:=4! &gt;244(&amp;#!</li> <li>• M) A: 7&amp;47=!() 37:?' 7:&amp;; (3T! 3K:?:2*K!() G:&amp;43:2A32:7! () 9743F7) 34#!</li> </ul>	<ul style="list-style-type: none"> <li>• 3Z! FFX(Fa! OWF(#". \$. %, -6(</li> <li>• @(*) (G(A&amp;) 3!() 9743F7) 34!() !:&amp;(8! 3?&lt;&amp;:=42AA77=() *3K7!3&amp;: *734!?G! 3K7!D:77) !67&amp;#!!</li> <li>• @K(G3)&gt;&amp;(8! ?(AT!42AA744G28!&amp;)=! &amp;88!:&amp;(8!0/. EO!A?::(=?4!&amp;:7! (F' 87F7) 37!=!&lt;(3K!() A: 7&amp;47=! ?' 7:&amp;3(?!)&amp;8!AK&amp;:&amp;A37:(43(A4!P! A' &amp;A(3T##!!</li> <li>• M) A: 7&amp;47=!() 37:?' 7:&amp;; (3T! 3K:?:2*K!() G:&amp;43:2A32:7! () 9743F7) 34#!</li> </ul>	++\$!P! ++C!
5\$%+,8"( = "D"9-: 8". +(	<ul style="list-style-type: none"> <li>• 67A:7&amp;47!=F?==&amp;8!4' 8(3!G??:1 F&amp;:(3(F7!3:&amp;) 4' ?:3#!+?:34!() ! . ?:3K7!:)!/2:?' 7!K&amp;97!8?43!3K7!:) ' &amp;:3!?G!3K7!():A?)) 7A3(9(3T!() G&amp;9?2:?!G!@?23K7!:) !' ?:34!() !/2:?' 7#!</li> </ul>	<ul style="list-style-type: none"> <li>• , ?&lt;!() A: 7&amp;47Z67A:7&amp;47!?G! . ?:3K7!:)!&amp;=!@?23K7!:)!' ?:34! F&amp;:(3(F7!A?)) 7A3(?!)4!&amp;=!3:&amp;G(A! • D:77)!' ?:34!() G:&amp;43:2A32:7! =7978?' F7) 3#!</li> <li>• %&amp;:(3(F7E:&amp;(8!() 37:F?==&amp;8(3T!!</li> </ul>	++\$!
! - \$=(7%\$. #: -%+( A. G%\$#%* &+ *%"( = "D"9-: 8". +(	<ul style="list-style-type: none"> <li>• &gt;?&amp;=!() G:&amp;43:2A32:7!A?)) 7A3() *! ' ?:34!&amp;=!6:T!37:F() &amp;8! =7978?' F7) 3#!!</li> </ul>	<ul style="list-style-type: none"> <li>• +?8(AT!&amp;*&amp;() 43!7F(44(?!)4!87&amp;=4!3?!) :7=2A3(?!)!G!:&amp;=!=7978?' F7) 3!</li> </ul>	++\$!

	• 67978?' F7)3!?!G!@T)A:?'F?==&8(3T! ()!2:?' 7#!	&)=!7=2A7=!F?==&8!4' 8(3!G?::! :?'&=##!	
O+' "%(F&-. -8,&(	: \$%%8" + "%#(!	0/. !0!*?97: )&)A7!?)! A?88& ; ?:&3(?)!&)=!; &88)A7!=! =7978?' F7)3##!	!

7F@] X00OZ1(^&gt;! A&gt;7AOX; (

0&; 87!\$"  
Scenario Technology variations!

W\$%\$8" + "%#!	7"+"& . -9-EC("D"9-: 8". +( ^\$%, \$+, - . (( 37F@] (T6!	7"+"& . -9-EC("D"9-: 8". +( ^\$%, \$+, - . (K(( 37F@] (K6(!	(
A. + "%-: "%\$1, 9,+C(!	, ?<!&=?' 3(?)!?G!60, ^!H67=7:&37!= ' 8&3G?: F4I#!	n(*K!&=?' 3(?)!?G!60, ^!H67=7:&37!= ! 8&3G?: F4I#!	!
WA(,. G%\$#+%*&+*%"( = "D"9-: 8". +(!	3_O! FAZX(_O00OcF! (#&". \$%, -6( • OK7! /` !G&(84!3?1473!(34!<)! 43&)=&:=4!G?::!+M! • ^?:(*)!37AK) ?8?*T!A?F' &)(74! ' :?9(=7!() 6:&43:2A32:7!G?::!+M&)=! G?:(*)!8?*(43(A4!A?F' &)(74!)?88! ?23!+M) 73<?:V4!?97!/:?7# • OK7!CJi !?G!A:&*?!(4!3:&) 4' ?:37!=?97!:3K7!+M) 73<?:V!() A82=() *! (F' ??:3!G8?<4!&)=!4?F7!=?F743(A! ! A:&*?F?974#!	3@0A5>7F@] >5WAOX(#&". \$%, -6( • /2:?' 7&)!Q?FF(44(?)!43:?) *8T! 42' ' ?:34!+M' ?8(AT#! • /` !4734!*8?; &8!43&)=&:=4!G?::!+M! • /2:?' 7&)!8?*(43(A4!A?F' &)(74! A?88& ; ?:&37!?)!() 37*:37!=3:&4' ?:3!) 73<?:V4!&)=! /2:?' 7&)!=?F743(A!A:&*?F?974! 9(&+M! • 197:&88!SJi !?G!A:&*?!(4! 3:&) 4' ?:37!=?97!:3K7!+M) 73<?:V#!	++0!
WA(,. \$19,. E( #%"D,&"#(Y( +%"& . -9-E, "#( \$D\$, 9\$1, 9,+C(!	• +M@7:9(A74!&9&(88; 87!P!247=!=()! A?F7!&=9&) A7!=!A&474##!	• +M7)&; 8() *!47:9(A74!&)=! 37AK) ?8?*(74!H-M!M?0_! ; ?AVAK&() ##!H&.*78T!&=?' 37!=; T! ()=243:T##! • L24() 744!Q?88& ; ?:&3(?)!&=9&) A7!=&)=!?' 7:&3(?)!?G!M) 378(*7) 3!n2; 4! &)=!Q?::(=?4##!	++0!
] \$%8-., \$+, - . (-G( =-&*8". +#(Y( :%-&*=*%"#(	• @() *87!6?A2F7)34!&)=! ' :?A7=2:74!K&:F?) (a&3(?)! <(3K!) /` !H F?=7:&37!60, ^! &=?' 3(?)!E!7^0M#!	• Q243?F4!&)=!L24() 744!6?A2F7)3! K&:F?) (4&3(?)!&84?!=?234(=7!/:` !HK(*K!60, ^!&=?' 3(?)!E!7^0M#!	!

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> @- . # -9, = \$ + " = ( ; & " . \$ %, - ( T (3! \$ # " = ( - . ( + " (@OXXF@7F2(Fa! > ; A > ( Y( O! FAZX(\_O00OcF! (#&". \$%, - #6 ; , + \* \$ +, - . (

M!3K(4!4A7) &amp;: ( ?\_!&amp;!K(\*K!7A?) ?F(A!\* : ?&lt;3K!(4!&amp;AK(797!=G?88?&lt;7!=; T!&amp;4(\*)(G(A&amp;)3! ?' 28&amp;3(?)!\*&amp;=?&lt;3K#!n?&lt;797:\_!3K(4! \*: ?&lt;3K!(4! &amp;: (7!= &lt;(3K! &lt;?:8=&lt;(=7!G&amp;(82:7!()!3K7! :7=2A3(?)! ?G!Q12!7F(44(?)4!:74283() \*!()!&amp;)!() A:7&amp;47! ?G! \*8?; &amp;8!

<&: F() \*!&) =! 7:(=?=4! ?G! K(\*K!=: ?2\*K3#! -3!3K7!4&F 7!3(F 7!\_3K747!K(\*K!879784! ?G! \*: ?<3K!=?!) ?3!&8? <!3K7!3:7) =! ?G! :7\*(?) &&(a&3(?)!3?!) ; 7A? F 7!=?F() &) 3!&) =! \*8?; &&(a&3(?)!A?) 3() 274\_!V77' () \*!3K7! F&t?:(3T! ?G! ' :?2A3(?)!() !-4(&HQK() &I&) =!3K24!3K7!() 37:) &3(?) &&G:7(\*K3!G8? <4! 7F&() !K(\*K#!OK7!\*7? !8(3(A&8! 78&3(?) 4! ; 73<77) !3K7!/\_!&) =!QK() &! :7F&() !43& ; 87!&8? <() \* \_G: ?F!F?:7!() 9743F 7) 34!G: ?F!QK() &!3!8?\*(43(A4!() G:&43:2A32:7!&) =!&44734!() !/2:?' 7#

7%\$. #9\$+,-. (+-B\$%="#(+ " (%\$#. #: -%#(C#+" 8(

>7\*&:=() \*! 3K7! (F' &A34! ?) 3K7! 3:& 4' ?:3&3(?) ! ) 73<?:V\_! =: ?2\*K3! ) 7\*&3(978T! &GG7A34! 3K7! A& ' &A(3T! ?G! () 8&) =! <!37: <&T4! ; T!8? <7:() \*! <!37: !879784! ?G! : (97:4!G? !8?) \*! 7:(=?=4!&) =!3K7:7; T! F&V() \*!() 8&) =! <!37: <&T!3:&) 4' ?:3! 2) :7(& ; 87#IM! I?!) 3:&43\_!3K7! F 783() \*!G!(A7!&8? <4!3K7! -: A3(A! :237!3? !K&9714(\*) (G(A&) 38T!8&: \*7:1) &9(\*& ; 8(3T! 7:(=?=4! F&V() \*!3K(4! :237! F?:7!&33:&A3(97#n? <797:\_!3K7!7U' 7A37!=() A:7&47!() !3:&GG(A!3?!. ?:3K7:) !' ?:34! ; 7A&247! ?G!3K7! ' ?37) 3(&8! =7978? F 7) 3! ?G!3K7! -: A3(A! :237!(4! :743:&) 7!= ; T!3K7!(F' &A34! ?G! =: ?2\*K3!A&24() \*! ' :? ; 87F 4! () !3K7! (: A?) ) 7A3(9(3T! 3K: ?2\*K!M O!0! OK747! :742834! () !: ?&=3:& 4' ?:34! V77' () \*!3K7!(\_! ?87! () !3K7!4T437F! ; 23!&4! ' &:3! ?G! 4T) AK: ?F? =&8! 4?823(?) 4! 3?\*73K7!: <(3K! :&8! OK7! 8&337!: () A:7&47=!(34! 4K&:7! A?) 4(=7:& ; 8T# ^2:3K7: F?:7! 3K7! A?) ) 7A3(9(3T! (44274! ?G!. ?:3K7:) !' ?:34! 47) =!3:&GG(A!3? !3K7!A?) \*7437!=() ?:3K!: ?237!&G&A3! <K(AK!G2:3K7!:A&2474!3K7! =7978? F 7) 3! ?G!4T) AK: ?F? =&8! 4?823(?) 4!G?: !3K7!K() 37:&8) =!3:& 4' ?:3&3(?) !G!: ?F!3K7!%7=(37:&8) !' ?:34#

OK7! ; 783!&) =! :?&= !&F ; (3(?) 4! ?G! QK() &42' ?:37!= ; T!3K7!43& ; 87! :78&3(?) 4! <(3K!3K7!/\_!&) =!3K7!&G?:7F7) 3(?) 7!= QK() 747!() 9743F 7) 34!() !8?\*(43(A4!() G:&43:2A32:7!&) =!&44734!43(?) \*8T!7) K&) A7!3K7!247! ?G! :&(8!G?:!() 37:A?) 3() 7) 3&8! 3:& 4' ?:3&3(?) 4!&) =!&84?!) =2A74!3K7!4K(G3! ?G!7A?) ?FT3? <&: =4!&437: ) !/2:?' 7#n? <797:\_!3K747!() 9743F 7) 34!8:7! G?A247!=() ?! 3K7! (F' :?97F 7) 3! ?G! 4' 7A(G(A! A?::(=?:4! H:78&37!= F&() 8T! 3?!) (37:?' 7:& ; 8(3T! (44274! &) =! A& ' &A(3T! 4K? :3&\*74!&) =!3K24!=() ?3!A?) 3:(; 237!4(\*) (G(A&) 38T!3? !3K7!=7978? F 7) 3! ?G! = (4&=9&) 3&\*7!=!7\*(?) 4!74' 7A(&8T!() !/437: ) !/2:?' 7#!

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>7\*&:=() \*!3K7!37AK) ?8?\*(A&8!=(F 7) 4(?) !?G!3K(4!4A7) &:(?\_!3K7!=7978? F 7) 3! ?G!3K7!+KT4(A&8!() 37:) 73!G(&84!3? !G?8? <!3K7!43:?) \*! \*:<3K! ?G!3K7!7A?) ?FT!&) =!3!42' ?:3!3K7! (A:7&47=!(37:A?) 3() 7) 3&8! &) =! =?F743(A!G8? <4!OK7!/\_! =?74! ) ?3!42' ?:3!43:?) \*8T!3K7!+M(F' 87F 7) 3&3(?) !87&90! \*! :?F!G? :!G? :7(\*) !37AK) ?8?\*T!A?F' &) (74!3? !43& ) =:&=4!G?: !3K7!+M <K(87!G?:7(\*) !8?\*(43(A4!A?F' &) (74!743& ; 8(4K!+M) 73<?:V4!3? !3K7!/\_! #^2:3K7: F?:7! 3K7! ' ?8(AT!() (3&3(974! ?G!3K7!/\_! ?G!3K7!6(\*3&8!0:&) 4' ?:3!P! , ?\*(43(A4!1^? :2F!H60, ^!!=?!) ?3!K&9713K7!7U' 7A37!=!&37! ?G! &=? 3(?) !&) =! ?! 3!A?) 3:(; 237!4(\*) (G(A&) 38T!3? !3K7! <(=7!(F' 87F 7) 3&3(?) !?G!3K7!+M! %? :7!4' 7A(G(A&8T! 3K7! G7=7:&37!=! 8&3G? F4K&971&8? <&: =? 3(?) !&) =!3K24!&:7!) ?3!42' ?:3() \*!() 37:?' 7:& ; 8(3T! <K(87!3K7!787A3:?) (A!^? 7(\*K3! 0:&) 4' ?:3! M) G?: F&3(?) ! H7E^OM! K&4! &! F?=7:&37! &=? 3(?) ! &AK(79() \*! 4() \*87! =?A2F 7) 3! &) =! ' :?A7=2:74! K&: F?)(a&3(?) !?) 8T! <(3K! ?G!3K7!/\_#

-4!&:74283\_!3K7!+M47:9(A74!&:7!) ?3! <(=78T!&9&88; 87!&) =!&:7!247=!(?) 8T!() !A7:3&() !&=9&) A7!=A&474Z) 73<?:V4!3K24! V77' () \*!3K7!\_7:A7) 3&\*7! ?G! A:& \*?3!3:& 4' ?:37!=!3K: ?2\*K!3K7!+M ) 73<?:V! :78&3(978T!8? <! . {CJ!\_!() A82=() \*! F&() 8T! (F' ?:3! G8? <4! &) =! &! 4F&88! ' 7:A7) 3&\*7! ?G! 3K7! =?F743(A! A:& \*? ! F?974# !OK(4! K&4! &) 7\*&3(97! (F' &A3! ?!) 3K7! 7) 9(:?) F 7) 3! &4!3K7!+M&4!3K7! ?37) 3(&8!3?!(A:7&47!7G(G(7) AT!&) =!7=2A7!4(\*) (G(A&) 38T!3K7!7) 9(:?) F 7) 3&8!(F' &A3! ?G!3:& 4' ?:3&3(?) #!

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674'(37!3K7!?:\*=A?)7A3(9(3T!?)G!?)?:3K7!):!?:34!3K7!(F'87F7)3&3(?)!?:G!7F(44(?)!':(A!)!;T!3K7!/:2:?7&!)Q?FF(44(?)!?:!/^!F7F;7!:A?2)3:(74!&G67A34!4K('!():!8!)74!<K(AK!())3(&8T!=97!3!3:&)4K('F7)3!G?:F!.?:3K7!):!/:2:?7!3?!.3K7!%7=(37!:&)7&!)!=!3K7!3?!.A?2)3:(74!234(=7!3K7!/:!OK(4!:742834!()!3K7!=7A:7&47!?)G!3K7!F&:(3(F7!A?)7A3(?)4!&)=!3K7!3:&G(A!3?!.?3K!.?:3K7!):!&@?23K7!):!?:34!&3:7)=!G2:3K7!7)K&)A7!=;T!3K7!7\*(?)&8(a&3(?)!?:G!?:2A3(?)!<K(AK!7=2A74!()37!)&3(?)&8!F&:(3(F7!G8?<4!-4!74'?)47!3?!.3K7!7<!A?)=(3(?)4!/:2:?7&!)!?:34!F?97!3?<:&=4!3K7!\*:77)!)G:&43:2A32:7!=7978?F7)3!&)=!()9743!()!3K7!F&:(3(F7E:&8!()37:F?=&8(3T#

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||!?:7!3?!.G2:3K7!7)K&)A7!:&8!G8?<4!/:!<?:V4!3?<:&=4!3K7!=7A:7&47!?:G!3&:G64#!n?<797!3K7!743:(A3(?)4!3?!.&8!3:&)4'?:3!?:G!:&=)7:24!\*&?!=4!A?)3()27!3?!.7U(43!3K7!4&F7!&4!3?&=T!<K(87!&84?!.OK()747!42;4(=74!3?!.3K7!:&8!3:&)4'?:3!?:G!A?)3&()7:4!:7F&():!3?!.F&():!3&()!3K7!()7X2(3T!():!3K7!A?F'73(3?!)!;73<77)!:!P!OK()747!A?F'&)(74#

^()&8T!3K7!F?:7!43:(\*)7!3!F&:V73E;&47!=F7&42:74!?)!A&::?)!7F(44(?)4!F&V7!:&=3!:&)4'?:3!8744!A?F'73(3(97!()!37:F4!?:G!A?43!A?F'&:7=I3?!.&8!&)=!;7=2A74!4(\*)G(A&)38T!3K7!():!F?=&8!4'8(3#

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-4!&:74283!S!J!1?G!3?3&8!A&:?:H(F'?:37!=&)=!&F743(A!4!3!:&4'?:37!=;V\_87&=()!3?!.4(\*)G(A&)3!;7)7G(34!():!37:F4!?:G!3K7!7)9(:?)F7)3&8!F'&A3!?:G!3!:&4'?:3!&)=!3K7!77)()!3?!.G!3K7!42'?:8T!AK&():4#

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- -97:&\*7!4'77=4!?:G!3!:&4'?:3!F?=74#
- D7)7:&8(a7=3!:&)4'?:3!A?43!?:G!3!:&)4'?:3!F?=74!():A82=()!\*&8!3T'74!?:G!A?434!H8&:2!A&:(3&8!G278!A?434!3&:(G64!73A#\_!3!:&)4'?:3!3(F7!73A#
- OK7!I-33:&A3(97)744m!A?43!?:G!)?=74#

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Table 13: Scenario parameters

W\$%\$8"+%"(	A8: 9,&\$+, - . #(Y%"9"D\$. +(XF>@(: \$%%8"+%"#(	W\$%\$8"+%"( @-. # -9,=\$+"; &". \$%, -(T!(	W\$%\$8"+%"( @-. # -9,=\$+"; &". \$%, -(K!(
A. G%\$#+%* & *%"(	<ul style="list-style-type: none"> <li>, ? &lt; 7: !&amp; 97: &amp; * 7!4' 77 = 4!3? !M b! H; 7A&amp;247! ?G! : 7 = 2A7 = !A&amp; ' &amp; A(3T! #</li> <li>, ? &lt; 7: !&amp; 97: &amp; * 7!4' 77 = 4!3? !: ? &amp; = ! ) 73 &lt; ? : V! H; 7A&amp;247! ?G! : ? &amp; = ! A? ) * 743(?) !#</li> <li>OK7! &amp; 97: &amp; * 7!4' 77 = !?G! : &amp; (8! ) A: 7&amp;474! H; 7A&amp;247! ?G! ( 9743F7 ) 34!3? ! ) G: &amp; 43: 2A32: 7! &amp; ) = ! ) A: 7&amp;47 = ! ( 37: ? ' 7: &amp; ; ( 8(3T! #</li> <li>OK7! &amp; 97: &amp; * 7!4' 77 = !?G! : &amp; (8! ) A: 7&amp;474! H; 7A&amp;247! ?G! ( 9743F7 ) 34!3? ! ) G: &amp; 43: 2A32: 7! &amp; ) = ! ) A: 7&amp;47 = ! ( 37: ? ' 7: &amp; ; ( 8(3T! #</li> </ul>	<ul style="list-style-type: none"> <li>OK7! &amp; 97: &amp; * 7!4' 77 = !?G! : &amp; (8! ) A: 7&amp;474! H; 7A&amp;247! ?G! ( 9743F7 ) 34!3? ! ) G: &amp; 43: 2A32: 7! &amp; ) = ! ) A: 7&amp;47 = ! ( 37: ? ' 7: &amp; ; ( 8(3T! #</li> <li>OK7! &amp; 97: &amp; * 7!4' 77 = !?G! : &amp; (8! ) A: 7&amp;474! H; 7A&amp;247! ?G! ( 9743F7 ) 34!3? ! ) G: &amp; 43: 2A32: 7! &amp; ) = ! ) A: 7&amp;47 = ! ( 37: ? ' 7: &amp; ; ( 8(3T! #</li> </ul>	
?"\$E"(7\$%,GG#(	@3: 2A32: & 8! ) A: 7&47! G&A3? : ! H; 7A&247! ?G! : 7 = 2A7 = !A& ' & A(3T! #	. ?!43: 2A32: & 8! G&A3? : ! & ' 8(7 = !: 7F & ( ) 4! 7X2&#!	
! - \$ = (+\$%,GG#(	@3: 2A32: & 8! ) A: 7&47! G&A3? : !; 7A&247! ?G! ) A: 7&47! ?G! = 7F & ) = !G? : !: ? & = ! 3: & ) 4' ? : 3&3(?) !H = 27!3? !8?43! A& ' & A(3T! ?G! M b! #	@3: 2A32: & 8! G&A3? : !   \$! ' 7: !3#VF !H; 7A&247! ?G! A& : ; ? ) !' : ( A ) * !H!	
! \$,%(+\$%,GG#(	@3: 2A32: & 8! ) A: 7&47! G&A3? : !; 7A&247! ?G! ) A: 7&47! ?G! = 7F & ) = !G? : !: ? & = ! 3: & ) 4' ? : 3&3(?) !H = 27!3? !8?43! A& ' & A(3T! ?G! M b! #	@3: 2A32: & 8! G&A3? : ! { \$! ' 7: !3#VF !H( ) !? : = 7: ! 3? !F & V7! : & (8! F? : 7! A? F' 73(97! #	
5 --=\$%(# : 9, +(	<ul style="list-style-type: none"> <li>67A: 7&amp;47! ?G! * 7) 7: &amp; ( a7 = !3: &amp; ) 4' ? : 3! A? 43! ?G! : &amp; (8! H( ) A: 7&amp;47 = !4K&amp; : 7! #</li> <li>M) A: 7&amp;47! ?G! * 7) 7: &amp; ( 47 = !3: &amp; ) 4' ? : 3! A? 43! ?G! : &amp; (8! H( ) G( A&amp; ) 38T! = 7A: 7&amp;47 = !4K&amp; : 7! #</li> <li>@F &amp; 8! ) A: 7&amp;47! ?G! * 7) 7: &amp; ( 47 = !3: &amp; ) 4' ? : 3! A? 43! ?G! : &amp; (8! H( ) A: 7&amp;47! ?G! 4K&amp; : 7! #</li> </ul>	<ul style="list-style-type: none"> <li>@( * ) ( G( A&amp; ) 3! ) A: 7&amp;47! ?G! * 7) 7: &amp; ( 47 = !3: &amp; ) 4' ? : 3! A? 43! ?G! : &amp; (8! H( ) G( A&amp; ) 3! = 7A: 7&amp;47! ?G! 4K&amp; : 7! #</li> <li>@( * ) ( G( A&amp; ) 3! = 7A: 7&amp;47! ?G! * 7) 7: &amp; ( 47 = !3: &amp; ) 4' ? : 3! A? 43! ?G! : &amp; (8! H( ) A: 7&amp;47! ?G! 4K&amp; : 7! #</li> </ul>	
@-. +, . +\$% (=,D, = "( %\$+, -(	<ul style="list-style-type: none"> <li>M) A: 7&amp;47! ?G! &amp; 33: &amp; A3(97) 744! A? 43! ?G! . ? : 3K7: ) !47 &amp; ' ? : 34! ; 7A&amp;247! ?G! M b! A? ) ) 7A3(93T! : ? : 87F4! H: 7 = 2A3(?) Z4F &amp; 8! ) A: 7&amp;47! () 3K7! 3K: ? 2* K' 23! ?G! : ? : 3K7: ) !47 &amp; ' ? : 34! #</li> <li>@F &amp; 8! = 7A: 7&amp;47! ?G! &amp; 33: &amp; A3(97) 744! A? 43! ?G! : ? : 23K7: ) !47 &amp; ' ? : 34! H( D8? ; &amp; (4&amp;3(?) !?G! ' : ? : 2A3(?) !: 7F &amp; ( ) 4' ? : 7 = ?F( ) &amp; ) 3! #</li> <li>67A: 7&amp;47! ?G! &amp; 33: &amp; A3(97) 744! A? 43! ?G! / 2: &amp; 4( &amp; ) !8! ) = !; : ( = * 7! H( ) A: 7&amp;47 = ! ( 37: A? ) 3( ) 7) 3&amp;8! : &amp; (8! 3: &amp; ) 4' ? : 3&amp;3(?) !#</li> </ul>	<ul style="list-style-type: none"> <li>67A: 7&amp;47! ?G! &amp; 33: &amp; A3(97) 744! A? 43! ?G! ) ? = 74! ?G! 3K7! / 2: &amp; 4( &amp; ) !8! ) = !; : ( = * 7! H( ) 27!3? !: 7* ( ? ) &amp; (4&amp;3(?) !?G! ' : ? : 2A3(?) !#</li> </ul>	

7%\$. #: -%+( FGG,&," . &C(	• >7=2A3(?)!?G!3:&)4' ?:3!3(F 7!G?:!&8! F?=74!3?!A7:3&()!A?::(=?4!<(3K!+M (F' 87F7)3&3(?)!?:767::() *!3?12' !3?1 CJ i !?G!G:7(*K3!G8?<4#!	• >7=2A3(?)!?G!3:&)4' ?:3!3(F 7!G?:!&8! F?=74!3?!A?::(=?4!7G7::() *!3?1SJi ! ?G!G:7(*K3!G8?<4!H=27!3?!7U37)=7=+M (F' 87F7)3&3(?)!#!
7%\$. #: -%+(@-#+(	• >7=2A3(?)!?G!*7)7:&8(47=!3:&)4' ?:3! A?434!G?:!&8!F?=74!()!3K7!A?::(=?4! <(3K!+M(F' 87F7)3&3(?)!H:7G7::() *!3?1 2' !3?1CJ i !?G!G?<4!=27!3?1K7! :7=2A3(?)!()!3K7!247!?G!&44734!P! 3:&)4' ?:3!3(F 7#!	• >7=2A3(?)!?G!*7)7:&8(47=!3:&)4' ?:3! A?434!G?:!&8!F?=74!()!3K7!A?::(=?4! <(3K!+M(F' 87F7)3&3(?)!H:7G7::() *!3?1 SJi !?G!G?<4!=27!3?1K7!:7=2A3(?)!()! 3K7!247!?G!&44734!P!3:&)4' ?:3!3(F 7#!

!

## C

OK7!7U' 7A37!=?23A?F 7!?G!3K7!+, - /0!&) &8T3(A4!(4!3?1&88<!43&V7K?8=7:4!<(3K()!3K7!/D0. !) 73<?:V4!3?1?' 3(F(47! '88))() \*!&)=!:7E' 88))() \*!; &47!=!?)!':7E=7G()7!=!\*?&84!&)=!A?)43:&()34!7#\*!\_,?<EQ&:;?)!?:2374\_!G&43743!:?2374\_! 8?<743!A?43!:?2374\_!73A!-4!3:&)4' ?:3!A?F' &)(74!<(88!A:7&4() \*8T!K&97!3?1&AA?2)3!G?:!3K7(:!A&:;?)!7F(44?)4\_!&  
3:&=7E?GG! ; 73<77)!78(& (8(3T\_!A?43\_!&)=!A&:;?)!G??3' :()3!<(88!K&97!3?1 ; 7!&AK(797!=()!3K7! \*7?E7A?)?F(A!&)=!A?) )7A3(9(3T!F?=704##!

-!4() \*87! '7:G?:F&)A7!()=(A&3?:!H\+M!4!() &=7X2&37!G?:!3K7!' 2: ' ?47#%283(' 87! \+M!4:&7!) 77=7=\_!&4!) ?!4() \*87! \+M  
A&)!=?l243(A7!3?13K7!A?F' 87U(3T!?G!3K7!42' ' 8T!AK&()!&)=!3K7!= (43()A3!:?874!&)=! ' &:34!()9?897=##!

1) 7!?G!3K7!()=(A&3?:4!K(\*K8(\*K37!=()!3K7!' ?4(3?)! ' &7:4!(4!3K7!@A(3@-%,=-%@-.. . "+&D,+C(A. ="H6!OK7!=7G() (3?)!  
?G!O?::(=?!O?) 7A3(9(3T!M)=7U!(4W &!3:&)4' ?:3!)?=7]4!87978!G!()37\*&3(?)!()!3K7! \*8?; &8!3:&)4' ?:3!) 73<?:V\_!&4!  
F&)(G7437!=!; T!(34! ' ?4(3?)!()! ' ?:3!A&' &A(3T\_!7GG(A7)AT!&)=!7&47!?G!':?A74474\_!47:9(A7!G:7X27)AT\_!47:9(A7!X2&8(3T!  
&)=!=(\*3&8!A?)) 7A3(9(3T#!O?)) 7A3(9(3T!)!2:!=76()3(?)!4!&:78&3(97!F 7&42:7\_!()!3K7!47)47!3K&3!<7!=?)?3!247!A?434!  
&)=!3:&)4(3!3(F 7#!OK7!()=7U!K&4! ; 77)!=74(\*)7!=!3?1K78' ! ' ?:3!&23K?:3(74!f! ; 3K!47' &?3!&4!<78!&4!()8&)=! ' ?3!  
&23K?:3(74!f!3?1(=7)3(GT!&)=!(F' :?97!3K7(:! ' ?4(3?)!()!3K7!) 73<?:V\_!&)=!3K7:7; T!(F' :?97!3K7!) 73<?:V\_!!

M)!&==3(?)!3?13K7!QQM!G?:!3K7!&)&8T4(4!?G!3K7!7A?)?F(A!&)=!7)9(:?)F 7)3&8!(F' &A3!()!7&AK!4A7)&:(?!=7G()7!=!3K:77!  
&==3(?)&8A&37\*?:(74!?G!\+M!4:&7!=76()7!=!3K&3!&88<!F 7&42:() \*!&)=!A?F' &:() \*!:742834!G: ?F!3K7!4A7)&:(?4!()!37: F 4!  
?G!3:&)4' ?:3!A?434\_!78(& (8(3T\_!&)=!7F(44?)4#OK(4!A&)! ; 7! ; 3&()7!=<(3K!F?=784!79&82&3() \*!3(:! ; T!3:(!3?1&!K(\*KE  
87978!:7' ?:3() \*!?G!3K7!7F(44?)4!:7=2A3(?)!?97!:!&T7&:#!

0&: \*73!()=(A&3?:4!4K?28!=; 7!X2&)3(G(& ; 87!&)=!&8(\*)7!=<(3K!7A?)?F(A!&)=!7)9(:?)F 7)3&8!(F' :?97F7)34#!OK7!247!  
?G!3K747!()=(A&3?:4!4K?28!=; 7!4(F' 87! ; 23!247G28G?:!&)&8T4(4!G?:!&88! &:3(74!&)&8T4() \*!42' ' 8T!AK&()!()!3?3&8!&)=!G?: F!  
&)&8T4() \*!4' 7A(G(A! ' &:34!K78' () \*!()!A?F' &:() \*!&)=! ; 7)AKF&:V() \*#!OK7!()=(A&3?:4!)77!=!3?1 ; 7!A&8A2&37!=!G?:!  
=(GG7:7)3!A?) \*743()!879784!&)=!A?)4(=7:() \*!= (GG7:7)3!?:(\*()4E=743()&3(?)!8?&=4#!

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OK7!G?88?<() \*!3&; 87!4K?<4!3K7!8(43!?G!\+M!\*?:?2' 7=!( ) 3? !F & ( ) !A&37\*?: (74M

Table 14: Consolidated KPI's

Category	Indicator	Units	Description
	+?:3!A&' &A(3T! "/GG(A(7)AT!&)=!7&47!?G! @7:9(A7!G:7X27)AT! @7:9(A7!X2&8(3T! 6(*(3&8!A?)) 7A3(9(3T! x2&8(3T!?!G:&43:2A32:7!	07:F()&&!:7&!<77V! %?974! 7:! }!47:9(A74! 7:! }!=(:7A3!A?)) 7A3(?) 4!3?!	+?:3! A&' &A(3T! ()! 37:F4! ?G! 0/`! &)=! 9?82F7! A&' &A(3T! (4! & ' 8(A& 87! G?!) ; ?3K! 47&' ?34! &)=! ()&)=!K2; 4#! /GG(A(7)AT! =7' 7)=4! ?)! A243?F4! &)=! ; ?:=7:! A87&:&)A7! X2&8(3T! 3K7!A?F' 737)A7! ?G! 8?*(43(A4! 47:9(A74!H4V(884!V)<K?<1&)=!:78(& ; (8(3T# OK7!K(*K7:!3K7!G:7X27)AT! ' 7:! G87U( ; (8(3T! (4! *(974! 4K(' 7:4! G?!) ' 8&)) () *! 3K7! 3:&) 4' ?:3! ?G! 3K7(:!*?=?=4#! OK7!F?:7!=(:7A3!A?)) 7A3(?) 4!3?!) :() A(' && 7) 3:T! ):=74!&)=!) ?=74_3K7! ; 7337:#! /U' 8&() 4! 3K7! 438*7! ?G! =(*(3&8!=7978?' F7)3!?) !& OE4A&87!*:(:_!<K(AK!7U' 8&() 4!=(*(3&8!& ; (8(3T#! \$I - ; (8(3T!3?!)3:&AV!&)=!3:&A7#!! "I O:7&37!&)=!; ??V! :?237!?) 8() 7#! CI ^() =!4K(' ' () *!() G? :F&3(?) ?!) 8() 7#! OI %7&42:7!A&: ; ?)!G??3' :() 3#! -AA744( ; (8(3T!!
7%\$. #: -%+(&-#+(	- ; 4?8237!A?43! >78&3(97!A?43! ^(88! :&37!H247=!A&' &A(3T! ! "9,\$1 ,9,+C(	zZ3?!) zZ3?)EVF! i ! n:4!	n&9() *!K(*KEX2&8(3T!()G:&43:2A32:7!(F' :?974!3K7! 87978! ?G! 4&G73T! &?) *!3K7! :?237! &)=!8?<7:4!3K7! :(4V! ?G! A?) *743(?) #!%67&42:7!=; T!&AA744( ; (8(3T! ?G! F283(' 87! 3:&) 4' ?:3! F?=74# ; T! :?&=_! :&8_! <&37:<&T4_! (' 78() 7#!\$!A:7=(3!G? :!7&AK!F?=:&8(3T# 0?3&8! 3:&) 4' ?:3! A?43! G? :F! ?:(*() !H8?&=() *!! 3?!
			G() &8!=743() &3(?) !H2) 8?&=() *!! = (9(=7=! ; T! 3K7! 3?3&8!= (43&) A7! ?G! 3K7! c?2:) 7T# 6737:F() 74!3K7! ?AA2' (7=!3:&) 4' ?:3! A&' &A(3T! ()! :78&3(?) !3?!) (34!3?3&8!A&' &A(3T! () !9?82F7!HFCI!?:! <7(*K3!H0?) !#!!! 0(F7! 3&V7!) 3?!) 3:&978! 3K7! =(43&) A7! G? :F! 3K7! 8?&=() *! ?() 3!3?!) 3K7! 2) 8?&=() *! ?() 3#!

	1) E3(F7!=78(97:(74!	i !	>78&3(?)4K(' ! ; 73<77)! &A32&8! &) =! 7U' 7A37=! 3:&) 4' ?:3!3(F7#
	L?3387) 7AV4!	D:&=7=!4A&87!	/9&82&3(?)! ?G! 3K7! 43&324! ?G! =(GG7:7) 3! 3T' 74! ?G! ; ?3387) 7AV4#
F8,##,-. (	Q1 "!"7F(44(?)4!	*Z3?)~VF!	0?3&8!Q1 "!"7F(44(?)4!=27!3?13:&)4' ?:3&3(?)#
	. 1U!7F(44(?)4!	*Z\$JJJ-3?)~VF!	0?3&8!. 1U!7F(44(?)4!=27!3?13:&)4' ?:3&3(?)#

!

OK7!4A?' 7!?G!3K747!A&amp;37\*?: (74!(4!; :(7G8T!7U' 8&amp;() 7=!() !3K7!G?88?&lt;() \*!' &amp;:&amp;\*:&amp;' K4#!

!

#### 4.6.1 Corridor Connectivity Index

OK7!F&()! 2:' ?47! ?G!3K(4!() =(A&3?:!(4!3?! F7&42:7!3K7!87978! ?G!A?) ) 7A3(9(3T! ?G!3K7!A2::7) 3!0/. EO! ) 73<?:V! <(3K! 7F7: \*() \*3:&=7IA?::(=?:4!3K(4! AK&' 37:!' :747) 34!&F73K?= ?8?\*T!3? !F7&42:7IA?::(=?:IA?) ) 7A3(9(3T# @797:&8!F73K?= 4! &8:7&=T!7U(43!3?743(F&37!3K7! A?)) 7A3(9(3T! ?G!8?\*(43(A4!8?A&3(?)4! &) =! 7U' :744!3K(4! <(3K! &) !() =7U#! - ) !7U&F' 87!(4! 3K7! b?8=!+?3!M)=7U! <K(AK! A?F' &:74! AK&:&A37:(43(A4! ' ?4(3?)\_! G&A(8(3(74! &) =! 47:9(A74! ?G! 3K?24&) =! ?G! ' ?:34! &:?2)=! 3K7! <?8=#! - ) ?3K7!: 7U&F' 87!(4!3K7!, () 7!:@K(' ' ) \*!Q?) ) 7A3(9(3T!M)=7U! H@QM! <K(AK! F7&42:74!3K7! () 37\*:&3(?)! ?G!A?2) 3:(74! <(3K!) \*!8?; &8! 8() 7!:4K(' ' ) \*!) 73<?:V4!H^ . QO-6! "J\$R&I# n?<797!: 3K747! () =(A74! &:7! G?A24() \*!?) !3K7!G?78&)=! ?3!4(=7! <K7:7&4!3K(4! ' & 7!:G?A2474!?) !3K7!A?)) 7A3(9(3T! ?G!A?::(=?:4ZK() 37:8&) =! <(3K! H7F7: \*() \*! 3:&=7! :?2374#! - ) !7U37) 4(97!=7G() (3?) ! ?G!3K(4!() =(A&3?:! &) =!(34!= (F7) 4(?) 4!A&) !; 7!G?2)=! () ! +?4(3?)!+&' 7!:!\$#!

!

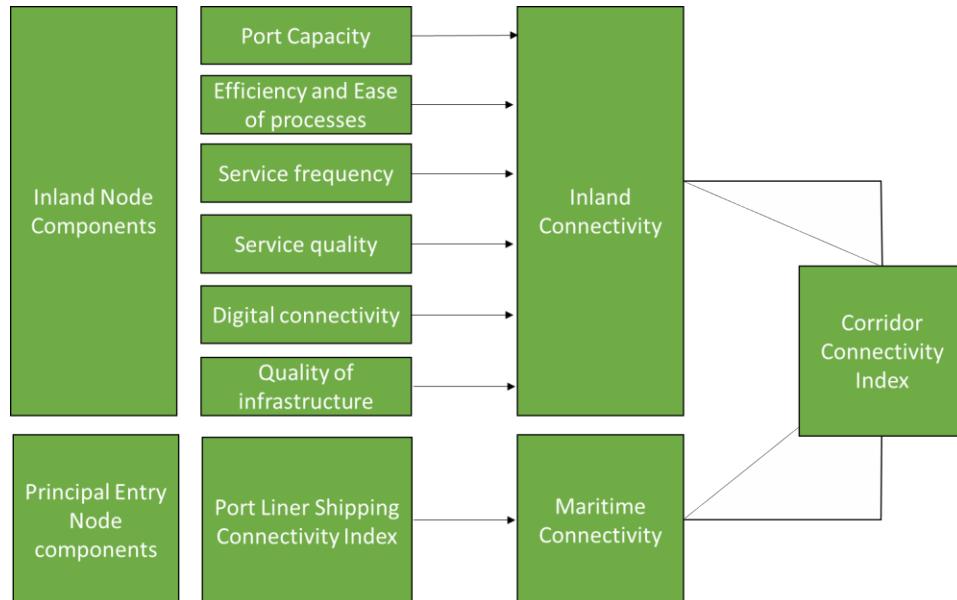


Figure 17: Main dimensions of the CCI indicator

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#### 4.6.2 Transport costs

OK747!\\+M!&:7!:78&37=13?13K7!7A?)?F(A!A?434!?G!3:&)4'?:3!?'7:&3(?)4!&)=!G&A(0(3&37!3K7!&)&8T4(4!?G!3K7!8?\*(43(A&8!(F'&A3!?G!3K7!3:&)4'?:3!G8?<!&3!7&AK!43&\*7!?G!3K7!42'8T!AK&()#\\+M!&:7!7F'8?T7=!(0!37:F4!7U':7447=!(0!zZ3?)EVF!:78&3(97!3?13K7!3?3&8!9?82F7!?G!\*&=413:&)4'?:37=1G?:F!3K7!?:(\*()13?13K7!=743()&3(?)#!-88?<4!A?F'&:(4?)!?G!3K7!=GG7:7)3!&837:)&3(974!?G!3:&)4'?:3!F?=74!(0!&!&:3(A2&&:IA?::(=?!:!<(3K!?3K7!:IA?::(=?:4W!

- ^:7(\*K3!A?43!G?&IA?)3&()7:\_!0?)#!OK(4!(4!A:(3(A&8!3?12)=7:43&)=!3K7!97:&8!G:7(\*K3!4'7)=#!6737:F()7=\_!T!=9(=0)\*!3K7!3?3&8!A?434!G?&:G:7(\*K3!4K(''()!\*;T!3K7!)2F;7:\_!G!A?)3&()7:\_!0?)!?:!VF!4K(''7=1G?&I!\*(97!)3(F7W!
  - -;4?8237!A?43!M!Z!3?)#!
  - >78&3(97!A?43!M!Z!3?)!-VF#!
- ^(8!:&37W=737:F()74!3K7!?AA2'(7=\_!3:&)4'?:3!A'&A(3T!()!:78&3(?)!3?!(34!3?3&8!A'&A(3T!()!9?82F7!HFCl!?:!<7(\*K3!H0?)I#!
  - -A32&8!A'&A(3T!238(a7=1Z!0?3&8!A'&A(3T#!
!

#### 4.6.3 Reliability

>78(&:(8(3T!7X2:(74!&\*??:!2)=7:43&)=()!\*!G!3K7!G(97!=F7)4(?)4!?G!A?)7A3(9(3T!W()G:&43:2A32:7\_!3:&=7\_!?'8(3(A&8!G()&)A(&8!&)=!A2832:&8!M!4!(F'?:3&)3!3?I&==:744!(44274\_!:(4V4\_!&)=!;?3387)7AV4\_!<K(AK!)77=13?I;7!F(3(\*&37!=G?::!78(&87!3:&)4'?:3?!)13K7!A?::(=?:#!

>78(&:(8(3T!(4!&)!(F'?:3&)3!G2)A3(?)!?G!3:&)4'?:3!4T437F4\_!(4!&)!7447)3(&&A?F'?)7)3!?'G!3:&GG(A!7GG(A!7)AT\_!<K(AK!)7U':74474!3K7!7&47!?G!F?:(8(3T!&)=!3K24!4K?28=1&84?I;7!F7&42:7=#!>78(&:(8(3T!F7&42:74!4K?28=1:7687A3!3K7!7&47!?:!=(GG(A283T!?G!\*&=413?!)7:6?F!3K7!():3!('4#!@()A7!:78(&:(8(3T!(4!A?)A7:)7!=<(3K!3:&978!3(F7!9:&:(8(3T\_!4'77=\_!4T437F!24\*&7!&)=!4T437F!A'&A(3T\_!F&!)T!:78(&:(8(3T!F7&42:74!<(8!A?F7!G?:F!3K7!'7:4'7A3(97!?G!3K7!42'8(7:4!?G!3K7!F?=74!&)=!3K7!()G:&43:2A32:7#!

OK7!:78(&:(8(3T!\\+M!=7&4!<(3K!3K7!7&47!?G!F?:(8(3T!&)=!<(3K!A?)\*743(?)!?AA2::7)A7!&)=!2:&3(?)!?)13K7!3:&)4'?:3!\_)73<?:V!Q?)\*743(?)!F&T!;7!=76()7!=&4!&!)!()A:7&47!()3:&978!3(F7!H?::!7=2A3(?)!?G!4'77=I!&:97!&I3K:74K?8#!@?\_!A?)\*743(?)E:78&37!=&33:(;2374!&)=!3:&GG(A!7GG(A!7)AT!&:7!3T'(A&8T!743(F&37!=&47!=?)!3K7!()G?:F&3(?)!?)!3:&978!3(F7!G?::!?:(\*()E=743()&3(?)!&:(4!4'77=4!=78&T4!73A#!OK7!4&F7!F7&42:7!F&T!;7!A&A28&37!=G?&I47'&:&37!3(F74!?G!3K7!=&T!&)=!&(43()A3!879784!?G!A?)\*743(?)!H:78&3()!3?I:78(&:(8(3T#!

!b(3K!)!3K(4!A&37\*?:T!&:7!\*:?2'7!=()=(A&3?:4!42AK!&4!4'77!=?G!3:&)4'?:3!\_!78(&:(8(3T\_!<K(AK!)7U':74474!3K7!'7:A7!)3\*&7!G!?)E3(F7!=78(97:(74\_!?:!3K7!G:7X27)AT!&G!47:9(A7\_!?:!3K7!G:7X27)AT!&G!47:9(A7#!

>78(&:(8(3T!F7&42:7F7)34W!!

- Q?)\*743(?)!87978W3?179&82&37!4(32&3(?)4!3K&3!\*7)7:&37!;?3387)7AV4!&)=!3K7:7G?:7!(F'&:(!3:&GG(A!G8?<\_!&(&3()!3(F74!&)=!78&T4#!OK(4!\\+M()A82=74W!
  - .2F;7:\_!G!&:7&4!&?)\*!3K7!A?::(=?:!3K&3!\*7)7:&37!X27274#!
  - -97:&\*7!:737)3()!H:&(&3()!3(F7!7!:;?3387)7AV#!
- 1)E3(F7!=78(97:(74W:797&8!3K7!&(\*(&3T!?G!3:&)4'?:3!&4!&!7:A7)3\*&7W!
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#### 4.6.4 Emission

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/9(:?)F7)3&!(F' &A34!()A82=7!7F(44(?))4!6: ?F!97K(A874!&) =! ?3K7!:7F(44(?))4!6: ?F!&)T!?' 7:&3(?))4!&) =! <&437! ' :?2A7=#! /)9(:?)F7)3&!( )=(A&3?:4! F7&42:7! 7F(44(?))4! ?G! K&:FG28! \*&474!42AK! &4! 01"! ?! . 1U! &) =! AK7AV! A?F' &(&)A7!<(3K!A?)3()7)3&!:!\*8?; &8!7F(44(?))4!7=2A3(?))3&: \*734##!

M! \*7)7:&8!3K7!G?A24! ?G!3K7!7)9(:?)F7)3&!(F' &A34! ?G!@Q%!H@2' ' 8T!QK&()!%&)&\*7F7)3!K&4!; 77)!?)!3:&)4' ?:3! AK&()4!\_<K(AK!&:7!V7T!G2)A3(?))4!()!8?\*(43(A4!0K7:7G?:7!F&)T! ?G!3K7!:7879&)3!F7&42:74!3?79&82&37!3K7!7)7: \*T! 7GG(A7)AT! ?G!42' ' 8T!AK&()4!&:7! 78&37=13?13:&)4' ?:3!AK&()4##!

OK7! \+M4787A37!=()3K7!7)9(:?)F7)3&8!4243&()&: (8(3T! \*:?2' ! (4!Q1"!7X2(9&87)3! \*:77)K?247!\*&474!&4!(3!()A82=74!)?3! ?)8T!A&: ?)!=(?U(=7\_!; 23!&8! \*:77)K?247!\*&474!3K&3! ' :?2A7!42AK!7GG7A3#!OK(4!()=(A&3?:!(4!=:(;7A38T!:7&37=13?13K7! A&: ?)!G??3' :( )3!\_<K(AK!()!3K(4!A&47\_!(4!&)!743(F&37! ?G!3K7!3?3&!(F' &A3!3K&3!&)!&A3(9(3T!K&4!?)!A8(F&37!AK&)\*7#! Q&: ?)!=(?U(=7! 7X2(9&87)3! (4! &2)(97:4&8! F7&42:7! 247=13?!)=(A&37! 3K7! \*8?; &8! <&: F() \*! ' ?37)3(&8! ?G! 7&AK! \*:77)K?247! \*4#! MB! (4! 247=13?!)&44744! 3K7! (F' &A34! ?G! 3K7! 7F(44(?))H?!: &9?(&)A7! ?G! 7F(44(?))H? ?:G! =(GG7:7)3! \*:77)K?247!\*&474#!

/F(44(?))!F7&42:74!H7)9(:?)F7)3&!(F' &A3!W!

- /F(44(?))4! H' 7!:0?0)4! VF!W!&X2&)3(3T! ?G! K&:FG28! \*&474! :787&47=1()3?13K7!7)9(:?)F7)3! H'Q1"! . 1U##!# 0:&)4' ?:3! 7F(44(?))4! &:7! A&&A28&37=1; &47=1?!)&)7F(44(?))!:&37! 7U' :7447=1() \*Z3?)EVF#!OK(4! \+M <(8! 3K7:7G?:7!)77=13?1; 7!()67::7!=1; &47=1?!)G8?<4!87)\*3K4!&)=13:&)4' ?:3!F?=7!&AA?:=( ) \*13?13K7!=(43&)A7! 3:&97887=1?13?13K7!&F?2)3!&)=13T' 7! ?G!G278!247=1?13?13K7!3T' 7! ?G!3:&)4' ?:3?1?G278!247=W!
- /F(44(?))4!Q1"E7!•13?3&8!Q1"E7!7F(44(?))4!v\*W!Z!H0?3&8! \*??=4!v3?)W!U!6(43&)A7!WF!W#!!
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rn? <797:\_!3!4K?28=1; 7!)?37=13K&3!3K7!() (3(&8!8(43! ?G! \+M! :747)37=1; 78?<!&4!3K747!7F7: \*7=1G: ?F!3K7!&) &8T4(4! ?G! 3K7!+?4(3?!)!+&:7:4!(4!)?3!7UK&243(97!&3!3K(4!43&\*7! ?G!3K7!1 :?c7A3#MB!<(8!; 7!:7&447447=1-2:() \*13K7!1 :?c7A3!7U7A23(?!)! &)=!<(8!; 7!G2:3K7!7) : (AK7=13?1&84?!)A82=7!()=(A&3?:4!3K&3!<(8!7F7: \*7!G: ?F!3K7!?23A?F7! ?G!3K7!F?=78!247=1G?!: 3K7!4A7) &: (7!4!4(F28&3?!)!3K7!&44744F7)3! ?G!3K7!9&:(?24!4A7) &: (?4!) &::3(974!=7978?7!=&) =!3K7!1 :?9(4?!)4! ?G! 3K7!1 :?1 ?4&8!=?A2F7)3##!

OK747!<(8!()A82=7!()=(A&3?:4!7&37=13?13K7!F?) (3?:( ) \*1&)=!\*?97: )&)A7! ?G! /D0. \_!3K7!A?) ) 7A3(9(3T! ?G!7)3(:7!:7\*(?)4! &)=!3K7!= (GG7:7)3!&4' 7A34! ?G! 78(&: (8(3T!&) =!7! 7:&3(?))&8!7GG(A7)AT#!!

>7\*&:=( ) \*13K7!3T' 7! ?G!()=(A&3?:4!3K&3!<(8!; 7!247=13K7!A?F; ()&3(?!) ?G! ; ?3K!?; c7A3(97!&) =!42; c7A3(97!3T' 74!(4! 7U' 7A37=13?147:97!; 7337!13K7!1 2: ' ?474! ?G!3K7!1 :?c7A3#^2:3K7!:()G? :F&3(?!)&) =!73&(84!&: ?23!3K7! \+M! <(8!; 7! ' :?9(=7!=&84?13?16\$##J#!

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## Annex 1: Position Papers

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