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POTENTIALS OF MODAL SHIFT FOR GHG EMISSION REDUCTION ON THE CORRIDOR IV II. THE RESULTS AND DISCUSSION

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Abstract: *The paper presents analyses of possibilities for reduction of the greenhouse gas (GHG) emission on Corridor IV by use of intermodal alternatives to present freight transport routes. The analyses is based on results of the EU funded project "Greening Intermodal Freight Transport in South-East Europe", which was motivated by the fact that the dominant polluter in the SEE is road freight transport. The main idea for the GHG emission reduction on the Corridor IV was shift of part of freight transport from roads to present railway and maritime transport alternatives. However, such shift threats to increase time waste and productivity of the freight transport, requiring a careful cost-benefit analysis before implementation.*

In this second part of the analysis are presented the results obtained on basis of the methodology and the proposed alternatives presented in the first part. The results show that the key factor of GHG reduction on Corridor IV is preparation of an efficient railway network before any other steps are performed.

INTRODUCTION

The first part of the two-part paper presented motivation, methodology and the object of the study.

The basic motive for the study is reduction of the greenhouse gases (GHG) emission. In the first part are defined terms “greenhouse effect” and “greenhouse gases”, and the negative trends of heating of the Earth’s atmosphere are described. It was also explained that transport belongs to important sources of GHG emission and that the transport sector is the only major sector in the European Union (EU) where greenhouse gas emissions are still rising. Further, it was stressed that that the road transport is dominant transport GHG emitter due to relatively inefficient energy consumption in comparison with rail and ship transport. These facts motivated activities of the EU funded project “Greening Intermodal Freight Transport in South-East Europe” (GIFT), which tried to find, to study and to promote the already existing rail and ship alternatives for freight transport that would partially reduce the GHG emission in the South East Europe (SEE).

The methodology that is used to study transport alternatives comprised estimation of absolute and relative reduction of specific GHG emission (equivalent CO_2 emission per kilometer and per transported ton of goods), as well at the net-present-value (NPV) of the reduction. The basis for the methodology consists of the data on specific GHG emission in the

countries of the region and the estimated variation of market share of the proposed alternatives in the period 2015-2030.

The set of proposed alternatives considers use of road, rail and sea freight transport for transport along the routes Athens-Sopron and Athens-Ploiesti, and it is considered representative since it covers the whole area of the Corridor IV, including all possible transport modes that exist in the area.

In the second part of the paper will be described the expected effects of introduction and promotion of the proposed alternatives.

RESULTS

Athens – Sopron route

Scheme "+Rail"

The "+Rail" transport scheme comprises concurrent use of road and rail transport modes using the "Rd" and "Ra" alternatives.

The projected amounts of reduction of GHG emission, in different scenarios for the period 2020-2030, as well as their respective monetized NPV, are presented in the Figure 1. The figures show that it is expected that the mere establishment of intermodal terminals (the "low-shift" scenario), as technical basis for modal shift, is expected to have only minor effects (between 6.7% and 11.7%) on reduction of the GHG emission of intermodal transport. Even more, NPV of the reduction of GHG emission is expected to reach maximum, close to 1.00 EUR/t, around 2026, and later is expected decrease.

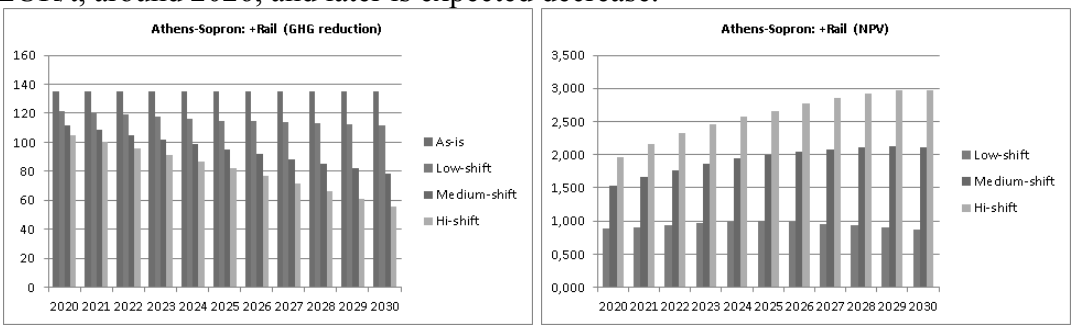

Figure 1: Projections of GHG reduction ($kgCO_2e/t$) and NPV (EUR/t) by "+Rail" scheme on the "Athens-Sopron" route

On the other hand, the effects of introduction of incentives and other measures of transport policies (the "medium-shift" scenario) are expected to lead to a considerably higher reduction of the GHG emission (up to 28.4%), with permanent increase of the NPV up to 2.11 EUR/t. It should be noticed that the maximum of the NPV is expected to be reached in 2026 as in the "low-shift" scenario, but the value would be kept until the end of the decade. The effects of the introduction of efficient intermodal services (the "high-shift" scenario) would not show such a dramatic decrease of the GHG gas emission reduction in comparison to "medium-shift" scenario (up to 40.1%), but it would, nevertheless, cause equal increase of the NPV, which would be around 2.98 EUR/t by the end of the decade. Furthermore, the increase of the NPV in the "high-shift" scenario is expected to be permanent through the whole decade.

Scheme "+Ship"

The "+Ship" transport scheme comprises concurrent use of road and maritime transport modes using the "Rd" and "ShRd" alternatives. The "ShRd" alternative uses truck for freight transport between Koper and Sopron, in total length of around 450 km. For that reason, the "ShRd" alternative has 25% higher GHG emission than "Ra" alternative. Consequently, although the emission of maritime transport is generally smaller than the emission of the railway transport, the reduction of the GHG emission in all scenarios of the

"+Ship" scheme is significantly smaller than in the "+Rail" scheme, as it may be seen in the Figure 2.

The projected maximal amounts of reduction of GHG emission are 8.2%, for the "low-shift" scenario, 13.2%, for the "medium-shift" scenario, and 20.5% the "high-shift" scenario. The respective maximal values of the NPV are expected to be 0.61 EUR/t, 0.98 EUR/t and 1.52 EUR/t, roughly twice smaller than with the "+Rail" transport scheme. However, the "+Ship" scheme is expected to have permanent increase of NPV during the considered decade, which presents its advantage over the application of the "+Rail" transport scheme.

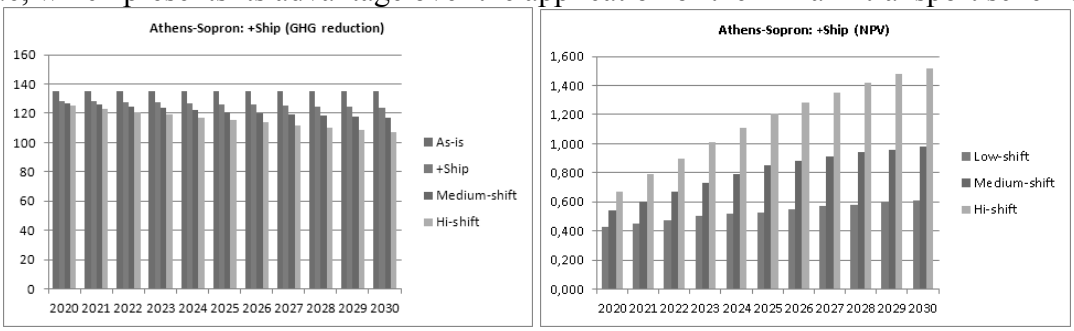

Figure 2: Projections of GHG reduction ($kgCO_2e/t$) and NPV (EUR/t) by "+Ship" scheme on the "Athens-Sopron" route

Scheme "+Rail+Ship"

The "+Rail+Ship" transport scheme comprises concurrent use of road, rail and maritime transport modes, using the "Rd" "Ra" and "ShRa" alternatives. The "ShRa" alternative uses train for freight transport between Koper and Sopron, and it is the alternative with, by far margin, the smallest emission of GHG gases. Consequently, the GHG emission in all scenarios of the "+Rail+Ship" scheme is significantly smaller than in other schemes, as it may be seen in the Figure 3.

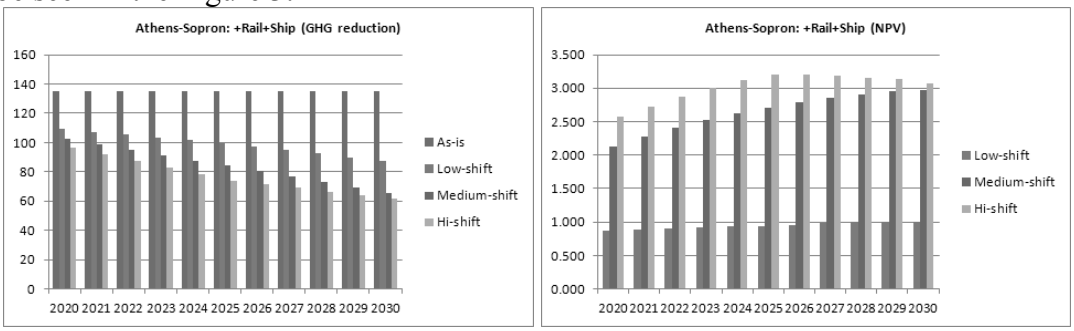

Figure 3: Projections of GHG reduction ($kgCO_2e/t$) and NPV (EUR/t) by "+Rail+Ship" scheme on the "Athens-Sopron" route

The projected maximal amounts of reduction of GHG emission are 27.3%, for the "low-shift" scenario, 40.1%, for the "medium-shift" scenario, and 41.4% the "high-shift" scenario. The respective maximal values of the NPV are expected to be 2.03 EUR/t, 2.98 EUR/t and 3.21 EUR/t. The striking feature of the transport scheme is that the effects of the "medium-shift" scenario (transport policies) are very close to "high-shift" scenario (introduction of intermodal transport services). While the difference is notable in the beginning of the considered period, the NPV in the "high-shift" scenario is expected to decrease after 2025, and, due to the permanent increase of NPV in the "medium-shift" scenario, the two NPVs tend to converge.

Route Athens-Ploiesti

Scheme "+Rail"

The "+Rail" transport scheme comprises concurrent use of road and rail transport modes using the "Rd" and "Ra" alternatives, therefore, again the same structure as for the

"Athens–Sopron" route. Consequently, the obtained results of the calculations are very similar to what is seen with the Athens–Sopron route, and they are presented in the Figure 4.

The first important feature is that the mere establishment of intermodal terminals (the "low-shift" scenario), as technical basis for modal shift, is expected to have only minor effects (between 2.9% and 8.8%) on reduction of the GHG emission of intermodal transport. The difference in comparison to the "Athens-Sopron" route is that the NPV of the reduction of GHG emission does not reach maximum in the period 2020-2030, but increases through the whole decade.

The second important feature is that the effects of transport policies (the "medium-shift" scenario) and introduction of intermodal services (the "high-shift" scenario) are expected to lead to much higher reduction of the GHG emission (up to 29.2% and 40.9%, respectively), with permanent increase of the NPV (up to values of 1.44 EUR/t and 2.01 EUR/t, respectively). As it was the case with the "Athens-Sopron" route, the differences between various scenarios of the "+Rail" transport scheme are substantial, which means that the modal shift from road to railway transport mode is very sensitive to the supporting policies.

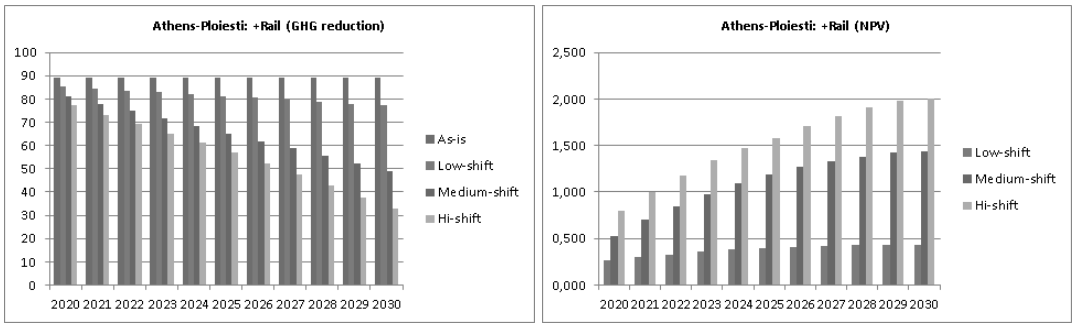

Figure 4: Projections of GHG reduction ($kgCO_2e/t$) and NPV (EUR/t) by "+Rail" scheme on the "Athens-Ploiesti" route

Scheme "+Ship"

As it was the case on the "Athens-Sopron" route, the "+Ship" transport scheme comprises concurrent use of road and maritime transport modes using the "Rd" and "ShRd" alternatives. On the "Athens-Ploiesti" route, however, the "ShRd" alternative uses truck for freight transport between Alexandroupoli and Ploiesti, which is, with its length close to 800 km, almost twice longer than the transport link Koper-Sopron. For that reason, the "ShRd" alternative has almost twice higher GHG emission than the corresponding "Ra" alternative, which means that the positive effects of the reduction of emission by maritime transport are cancelled by the truck transport, as it may be seen in the Figure 5 (The reader should notice the difference in scaling between the Figure 4 and the Figure 5).

The expected reduction of the GHG emission in the "low-shift" scenario is below 1%, and even in the "hi-shift" scenario, the maximal expected reduction of the GHG emission, in the 2030, is expected to be only 8.9%. In comparison with other innovative transport schemes, the "+Ship" transport scheme on the "Athens-Ploiesti" route is inferior due to extensive use of road transport, and its application would need strong justification.

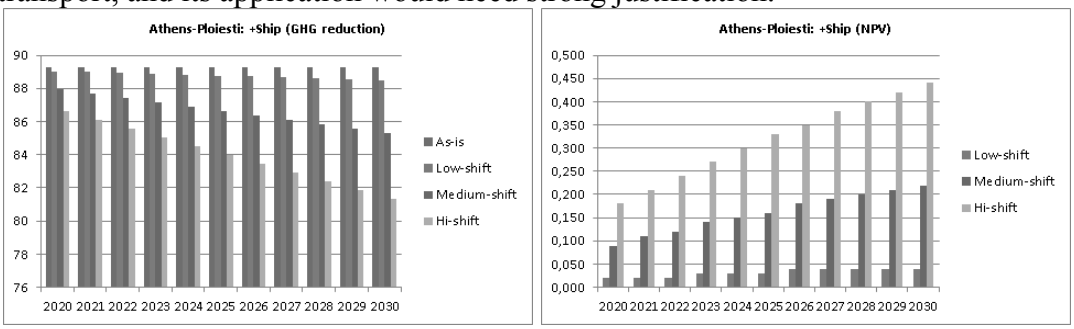

Figure 5: Projections of GHG reduction ($kgCO_2e/t$) and NPV (EUR/t) by "+Ship" scheme on the "Athens-Ploiesti" route.

Scheme "+Rail+Ship"

The "+Rail+Ship" transport scheme comprises concurrent use of road, rail and maritime transport modes, using the "Rd" "Ra" and "ShRa" alternatives, as it has been the case with the "Athens-Sopron" route. The "ShRa" alternative uses train for freight transport between Alexandroupoli and Ploiesti, and it represents the alternative with the smallest emission of GHG gases. Consequently, the GHG emission in all scenarios of the "+Rail+Ship" scheme is significantly smaller than in other schemes, as it may be seen in the Figure 6.

The projected maximal amounts of reduction of GHG emission are 25.7% for the "low-shift" scenario, 31.5% for the "medium-shift" scenario, and 32.6% the "high-shift" scenario. The respective maximal values of the NPV are expected to be 1.55 EUR/t, 2.04 EUR/t and 2.57 EUR/t. The "+Rail+Ship" scenario of the "Athens-Ploiesti" route shows two important features: first, due to the deflation, the NPV of the transport scheme permanently decreases in all scenarios so that the maxima of the GHG emission reduction and its NPV do not coincide; second, as it was the case with "+Rail+Ship" transport scheme of the "Athens-Sopron" route, the effects of the "medium-shift" scenario (transport policies) and the effects of the "high-shift" scenario (introduction of intermodal transport services) converge with time.

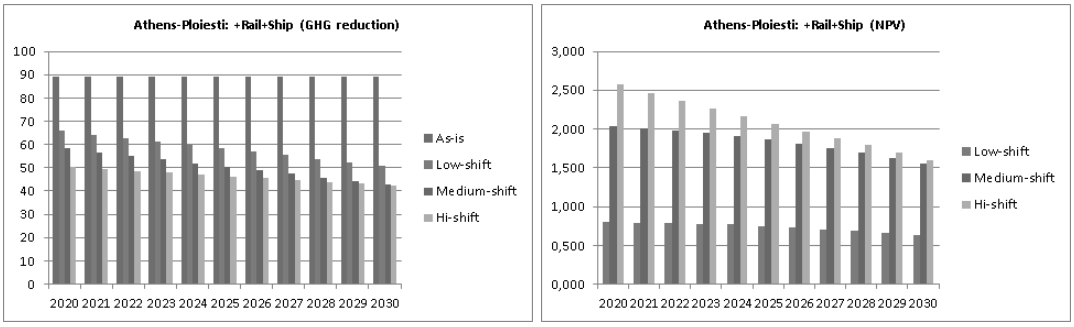

Figure 6: Projections of GHG reduction ($kgCO_2e/t$) and NPV (EUR/t) by "+Rail+Ship" scheme on the "Athens-Ploiesti" route

DISCUSSION

A summary of the results of SEA calculations is presented in the Table 1, which, in a condensed way, illustrates the expected trends of the GHG emission reduction and the respective NPV in the period 2020-2030. The last column of the table indicates by background color the trend of the NPV in a certain scenario. The black background indicates that the trend is decreasing (maximum is in the beginning of the period), the white background indicates that the trend is increasing (maximum is in the end of the period), and the grey background indicates that the trend has maximum during the period, in 2025 or 2026, depending on the specific scenario.

The three types of dependence of the NPV in the analyzed scenarios are caused by the opposite trends of three factors. The first factor is the modal shift, which is in all case expected to lead to decrease of the GHG emission, and thus to increase of the NPV, during the considered period. The second factor is deflation, which leads to decrease of NPV of all measures taken during the considered period. The third factor is the projected change of the marginal abatement costs during the period 2020-2030, presented in [3], which shows much higher increase of the traded emission costs (15 times increase) in comparison with non-traded emission costs (15% of increase). In this study, it means that the NPV of freight transport by electric trains decreases with time much faster than the NPV of freight transport by other transport modes. Therefore, if the modal shift is oriented towards electric trains, then

the NPV will decrease with time, and if the shift is oriented towards diesel trains of ships, then the NPV will decrease only if the expected modal shift is less than 15% between 2020 and 2030.

CONCLUSION

The most important aspect of the presented analysis is that the trend of increase of GHG reduction emission is common for all of the studied scenarios. It means that all of the proposed actions will certainly lead to the decrease of the GHG emission. However, since the monetary value and the benefits vary a lot between the proposed transport schemes and scenarios, a certain conclusions may be derived.

The first important conclusion arises from comparison of the expected results of the proposed schemes: this study suggests that the transport schemes oriented only towards the modal shift from road to ship transport (i.e. "+Ship" transport schemes) are not efficient. While the inclusion of ship transport reduces GHG emission, the effects of the modal shift toward ship transport are expected to be significantly decreased if the transport scheme does not include railway transport. Since ports are generally not the final destinations of the transported goods, and since many of the important centers of the SEE region are not close to ports, transport by ship is in such cases followed by the additional road transport for hundreds of kilometers, which cancels the benefits of the GHG emission reduction by ship transport. Due to the geographical structure of the SEE region (seaports on the borders of the region and lack of the diversified IWW network), the railway transport mode is the key to efficient GHG reduction of the intermodal transport in the SEE region.

The second important conclusion arises from the comparison of the various studied scenarios: the level of the requested action strongly depends on the present state. The development of the intermodal infrastructure, without implementation of additional policies, is expected to have results only if it opens completely new links for intermodal transport. On the other hand, technical improvements of the present facilities are not expected to have tangible effects if they are not accompanied by policies that will affect the prices and duration of the intermodal transport. The policies that are oriented towards prices of intermodal transport (higher taxes for road transport, incentives for intermodal transport) are expected to have effect for transport schemes that do not have ship transport as a present alternative. However, if the present freight transport already uses ship transport, then the policies oriented towards prices are not expected to be efficient, and the policies that would reduce duration of transport by efficient intermodal services are expected to be the answer.

Table 1: Initial, final and maximal values of GHG emission reduction and NPV of the studied transport schemes in period 2020-2030

Route	Scheme	Scenario	GHG reduction (%)		NPV (EUR/t)		
			2020	2030	2020	2030	Max
Athens-Sopron	"+Rail"	Low-shift	6.7%	11.7%	0.88	0.87	1.00
		Medium-shift	11.7%	28.4%	1.53	2.11	2.11
		Hi-shift	15.0%	40.1%	1.97	2.98	2.98
	"+Ship"	Low-shift	4.7%	8.2%	0.43	0.61	0.61
		Medium-shift	5.9%	13.2%	0.54	0.98	0.98
		Hi-shift	7.3%	20.5%	0.67	1.52	1.52
	"+Rail +Ship"	Low-shift	14.1%	27.3%	1.71	2.03	2.03
		Medium-shift	17.8%	40.1%	2.13	2.98	2.98
		Hi-shift	21.2%	23.7%	2.57	3.07	3.21
Athens-Ploiesti	"+Rail"	Low-shift	2.9%	8.8%	0.27	0.43	0.43
		Medium-shift	5.9%	29.2%	0.53	1.44	1.44

		Hi-shift	8.8%	40.9%	0.8	2.01	2.01
	"+Ship"	Low-shift	0.3%	0.9%	0.02	0.04	0.04
		Medium-shift	1.5%	4.5%	0.09	0.22	0.22
		Hi-shift	3.0%	8.9%	0.18	0.44	0.44
	"+Rail +Ship"	Low-shift	16.3%	25.7%	1.55	1.27	1.55
		Medium-shift	21.0%	31.5%	2.04	1.55	2.04
		Hi-shift	26.8%	32.6%	2.57	1.6	2.57

ACKNOWLEDGEMENT

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ПОТЕНЦИАЛИ ПРИ СМЯНАТА НА ВИДОВЕТЕ ТРАНСПОРТ ПО КОРИДОР IV ЗА НАМАЛЯВАНЕ НА ГАЗОВИТЕ ЕМИСИИ II. РЕЗУЛТАТИ И ДИСКУСИИ

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Ключови думи: *Опазване на околната среда, намаляване на газовите емисии, трафик замърсяване*

Резюме: *Статията представя анализ на възможностите за намаляване на газовите емиси (GHG) по Коридор IV, чрез използване на интермодални алтернативи на товарни транспортни маршрути. Анализът се базира на резултатите от финансиран от ЕС проект "Зелен интермодален товарен транспорт в Югоизточна Европа", което е мотивирано от факта, че доминиращият замърсителят в Югоизточна Европа е автомобилния товарен транспорт. Основната идея за намаляване на емисиите на парникови газове по Коридор IV е изместване на част от товарния транспорт от автомобилния към железопътни и морски транспортни алтернативи. Въпреки това, подобни алтернативи за смяна, водят до увеличаване загубите на време и производителността на товарния транспорт, което изисква внимателен анализ на разходите и ползите, преди изпълнението.*

В тази втора част на анализа са представени резултатите, получени въз основа на методологията и предложените алтернативи, представени в първата част. Резултатите показват, че ключовият фактор за намаляване на газовите емиси по Коридор IV е подготовката на ефективна железопътна мрежа, преди да се извършват каквито и да било други действия.