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Climate Change and Rail Transport

Improving energy efficiency in railway transport

Note by the secretariat

I. Background

1. The Working Party will recall that held at the seventy-sixth session of the Working Party on Rail Transport (SC.2) a workshop was held focusing on climate change continuing the work undertaken by SC.2 in this area. In line with this work and considering the focus that the Inland Transport Committee is placing on climate change mitigation with the development of a new strategy, this document looks at ways in which energy efficiency can be improved in the railways to further increase the environmentally friendly credentials of the sector.

II. Introduction

2. Railway transport is one of the most sustainable means to move passengers and goods. The quantity of energy and the levels of greenhouse gasses (GHGs) emitted are smaller than the other means of transport. Therefore, the shift from other modes of transport to the railway is an important goal inserted in the programs of many countries to reach the objectives defined in The Paris Agreement and the United Nations Sustainable Development Goals (SDGs).

3. The already high sustainability level of the railway sector has limited the urgency to improve its performance and, compared to the other means of transport, the effort to develop innovative technologies and increase efficiency has been lower in recent years. This lack of research and investment made possible just minor improvements, especially when compared to road transport where modern technologies made it possible to significantly reduce energy consumption and GHGs emissions.

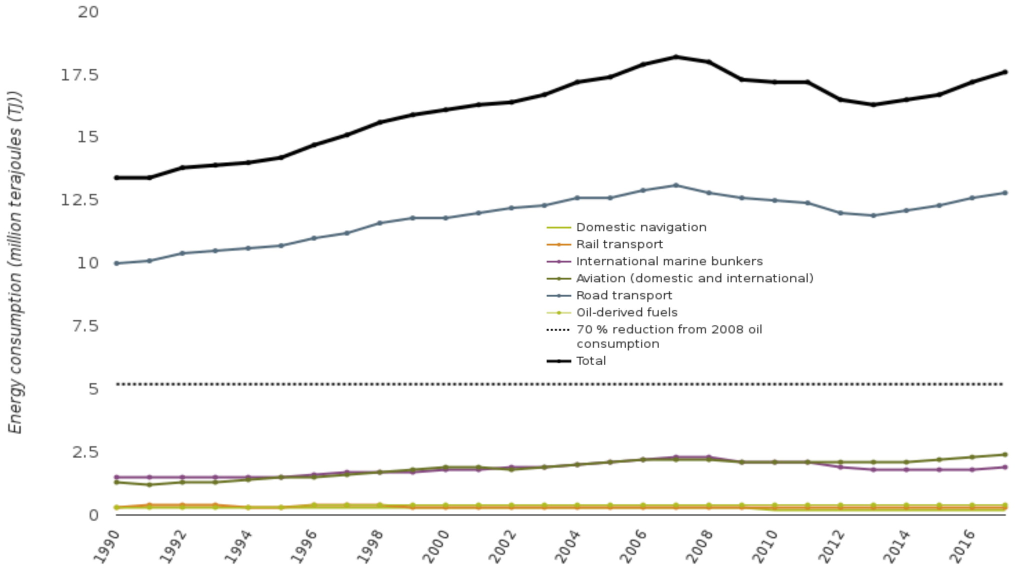
4. There are still significant improvements that could be achieved in the railway sector and some of them could be developed at low cost and relatively quickly. The implementation of new technologies would initially require effort on the side of the railway operators; however, the investments would be repaid in a short timeframe thanks to the money savings arising from energy consumption.

5. This document provides an overview of the current level of energy usage and GHG emissions in the railway sector, compared with the other means of transport. It also provides an analysis of the best practices in further increasing railway sustainability, particularly through a reduction in energy consumption. These best practice examples are divided into two categories: those requiring capital investments, and the others that require little or no expenditure. The document concludes by proposing alternative ways forward for the Working Party in relation to this subject matter.

II. Energy consumed in the transport sector

6. As previously stated, railway transport is one of the most sustainable means of transport, in the following paragraph the current levels of energy consumption and GHGs will be analysed.

Figure 1
Energy consumption in transport sector (1990,2017)

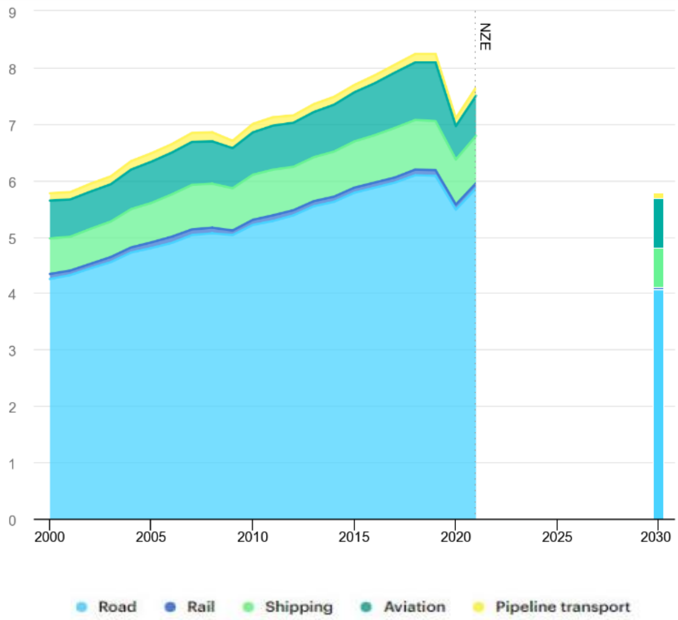


Source: European Environment Agency, 2019, "Final energy consumption by transport mode", data provided by Statistical Office of the European Union (Eurostat). https://www.eea.europa.eu/data-and-maps/daviz/final-energy-consumption-by-transport-6#tab-chart_3.

7. The figure 1 above shows the energy consumption of the different transport modes, both for freight and passenger, in the European Union (EU) in the period between 1990 and 2017. The graph is available on the European Environment Agency's website, and it has been elaborated using data provided by Eurostat. Railway transport, shown in orange, accounts for just a small fraction of the total consumption of energy in the analysed countries. This is as a result of the low market share of rail transport but also the greater energy efficiency of the rail sector. In 2017 the rail sector in the EU accounted for 6.8 per cent of the total traffic, consuming 0.3 million Terajoules (TJ) of energy, equivalent to less than 2 per cent of the total energy consumption of the transport sector.[1]

[1] https://op.europa.eu/en/publication-detail/-/publication/f0f3e1b7-ee2b-11e9-a32c-01aa75ed71a1/language-en/format-PDF/source-287498905.

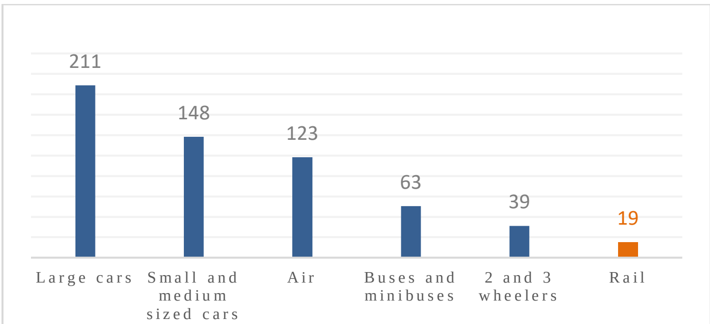
Figure 1
Global CO_2 emissions from transport by sub-sector in the Net Zero Scenario, 2000-2030



Source: IEA, Paris https://www.iea.org/data-and-statistics/charts/global-co2-emissions-from-transport-by-sub-sector-in-the-net-zero-scenario-2000-2030, IEA. License: CC BY 4.0.

8. A similar situation can be seen at the global level, as reported by the International Energy Agency (IEA) where in 2021 the total energy consumption in the transport sector was equal to 113.4 million Terajoules (TJ), while rail transport accounted for 2.27 million TJ (2per cent).[2] This patterns is repeated in relation to Greenhouse Gas (GHG) emissions where, as shown in figure 2 prepared by the International Energy Agency (IEA), in 2019, 0.1 giga tonnes (GT) of CO_2 were emitted by railway transport out of a total of 8.24 GT for the transport sector as a whole.[3] Going into further detail, freight rail transport emits on average one-fourteenth of the CO_2 produced by road transport,[4] while passenger rail services emit, on average, less than one-tenth of that of a large car every km.[5]

Figure 3
Average CO_2 emissions per passenger-km (grams)



Source: IEA https://www.iea.org/data-and-statistics/charts/well-to-wheel-wake-wing-ghg-intensity-of-motorised-passenger-transport-modes-2.

2 https://www.iea.org/reports/rail
3 https://www.iea.org/reports/transport Note that the sole direct emissions are considered, therefore, as an example, the emissions from the electricity produced to run the trains are not accounted.
4 https://climate.mit.edu/explainers/freight-transportation#:~:text=Breaking%20down%20freight%20emissions&text=Most%20ships%20burn%20fossil%20fuels,of%20freight%20the%20same%20distance.
5 https://www.iea.org/data-and-statistics/charts/well-to-wheel-wake-wing-ghg-intensity-of-motorised-passenger-transport-modes-2.

9. This is shown more clearly in a comparison of different modes. Table 1 below shows an example, for a passenger journey between Geneva and Paris, on a workday, comparing the energy consumption and CO_2 emissions for different transport modes.

Table 1
Geneve-Paris passenger energy consumption and CO_2 emissions

Passenger	*Rail*	*Car*	*Airplane*
Energy consumption (L of gasoline equivalent)	16.9	25.7	40.2
CO_2 emissions (KG)	4	57.8	95.8

Source: eco passenger.

10. The table above has been elaborated through the data provided by "eco passenger".[6] As can be seen, the train's energy consumption expressed in litres of gasoline equivalent, including energy requested to create the electricity needed by rail, is less than the other two ways of transport.

11. Table 2 below provides the same comparison but for the freight sector using data from EcoTransIT World[7] showing the significant advantage of the rail sector.

Table 2
Geneve-Paris freight energy consumption and CO_2 emissions

Passenger	*Rail*	*Truck*	*Airplane*
Energy consumption (Megajoules)	264	645	13,732
CO_2 emissions (KG)	1.3	40.5	931.2

Source: EcoTransIT World.

12. Taking this analysis further, a 10 per cent energy saving in the freight transport example, considering that one train could easily transport over one thousand tonnes of freight, would lead to a saving of 26 Gigajoules. This amount is equal to the yearly energy consumption of seven people in Switzerland.

13. When looking at the CO_2 emission results in tables 1 and 2 the difference is even more staggering: travelling by train allows people to emit less than a fourteenth of the value when driving a car and less than a twenty-fifth of the value when taking an airplane. For freight transport, the difference is even greater with rail transport emitting just a tiny fraction of CO_2 of what would be produced using the other two modes of transport.

III. Energy consumed in ECE countries by rail transport

14. As stated by UIC "Energy efficiency offers huge potential for cost savings - a per cent improvement in energy efficiency will save several million euro per year for most railways - and is also the most direct way to reduce CO_2 emissions and secure strong environmental performance…".[8] This section provides an estimate of the total amount of energy which is used in the ECE countries by rail transport based on data available in the UNECE statistical database for total passenger-km and tonne-km, using 2019 data and covering forty-one

[6] http://ecopassenger.org/bin/query.exe/en?ld=uic-eco&L=vs_uic&protocol=https:&OK#focus.
[7] ttps://www.ecotransit.world/en/emissioncalculator/.
[8] https://uic.org/sustainability/energy-efficiency-and-co2-emissions/.

countries shared data about passenger traffic[9,10] and thirty-seven for freight transport.[11] A 50-50 split between electrified and diesel has been used in the estimation. This calculation includes only the energy consumption needed for running trains.

15. In 2019, a total of 509,623 million of passenger-km and 1,414,019 million of tonne-km were travelled.

16. According to the methodology developed by EcoTransIT World,[12] an average freight electric train consumes, to transport a tonne of goods, 15.7 Wh per Km, while a diesel train 42.4 Wh per Km. Therefore, total consumption of freight electric trains is about 11.1 million MWh while about 30 million MWh are consumed annually by diesel trains. Note that diesel trains consume on average 2.7 times the energy of electric trains.

17. On the passenger side, using the "Eco passenger" methodology,[13] the average energy consumption of a passenger per km is equal to 88.2 Wh for electric trains and 25.2 g of diesel for non-electric trains. Multiplying these values by the total passenger km provides total consumption of 22.5 million MWh and 6,421 million kg of diesel. As the consumption in Wh is not available for passenger diesel trains, the same ratio as above for freight has been used – diesel being 2.7 higher than electric – also for the passenger. With this assumption the total energy consumption for the passenger rail sector is about 60 million MWh.

18. The total consumption of energy consumed by railways in considered ECE countries is equal to about 124 million MWh, approximately 0,45 million TJ. Considering that the EU only total for rail energy consumption is 0,3 million TJ, the ECE wide estimation seems acceptable.

19. As a comparison, consider that the average electricity consumption of a home in the United States of America is about 10 MWh per year,[14] the total energy used to run railway operations could provide energy to 12,4 million homes for an entire year. This comparison helps to understand why saving energy in the rail sector is still important: an achievable level of savings equal to 10 per cent would free up electricity to more than 1 million homes.

IV. Energy saving investments

20. As previously stated, significant improvements are still possible in rail transport adopting measures to save energy and, therefore, reduce CO_2 emissions. These strategies can be divided into two categories: the ones that require large investment but have the potential for creating the largest savings in the future, and other, more operations related actions that require little or no initial expenditure but could still help to avoid energy wastage and related CO_2 emissions. This section identifies these two approaches.

Replacing and maintaining old rail vehicles

21. While it is clear that modern locomotives and other rolling stock are more energy efficient than older models, replacing the vehicles, which would be an expensive investment, is not always necessary: scheduling frequent maintenance can still have a large impact on reducing energy consumption. As a simple example, replacing and maintaining wheelsets

[9] Albania, Austria, Azerbaijan, Belarus, Bulgaria, Canada, Croatia, Czechia, Denmark, Estonia, Finland, France, Greece, Hungary, Ireland, Israel, Italy, Kazakhstan, Latvia, Lithuania, Luxembourg, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Republic of Moldova, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye, Ukraine, United Kingdom, United States, Uzbekistan.

[10] Only the energy consumed by transport, excluding the ones from rail stations, is included.

[11] Albania, Austria, Azerbaijan, Belarus, Bosnia Herzegovina, Bulgaria, Canada, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Kazakhstan, Latvia, Lithuania, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Republic of Moldova, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom.

[12] https://www.ecotransit.org/wp-content/uploads/20230612_Methodology_Report_Update_2023.pdf.

[13] https://ecopassenger.hafas.de/hafas-res/download/Ecopassenger_Methodology_Data.pdf, page 18.

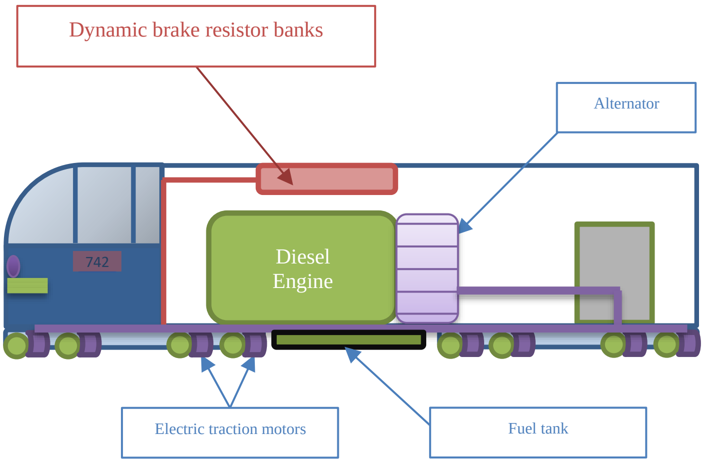
[14] https://www.energybot.com/blog/average-energy-consumption.html#:~:text=The%20EIA%20aggregates%20data%20for,at%2014%2C302%20kWh%20per%20home.

correctly can reduce contact friction with the rails, reducing the power necessary to move the train.

Diesel replacement

22. Electric trains, as demonstrated in the previous paragraphs, are more efficient than diesel ones both in passenger and freight transport. In fact, as shown by the Environmental and Energy Study Institute (EESI),[15] diesel locomotives are able to transform just 30-35 per cent of the energy combusted into energy used to move the train, while electric trains can use up to 95 per cent of the electric energy collected by the pantograph. This is due to the manner in which diesel locomotives work: the power generated by the diesel engine is not directly used to drive the wheels, instead, the power is used to run an alternator which generates electric energy which is delivered to electric traction motors to transfer energy to the wheels (see figure 4 below). This process leads to significant wastage in generating traction power. Electric trains are also less expensive in terms of both running and maintenance costs. Diesel locomotives using hydraulic traction, without transforming fuel in electric power, exist, but they are rarely used because they are even less efficient than diesel-electric ones.

Figure 4
Diesel-electric traction components



Source: Secretariat elaboration.

23. While electric rolling stock is more efficient, electrification costs are often very significant making them not economically viable on less used lines. This has also been confirmed by the European Commission through its alternative fuels observatory: *"On low-density lines there is today no proven cost-efficient solution to replace diesel-powered trains."*[16]

24. The degree of electrification across the ECE region varies significantly with EU member States having, on average, more than 50 per cent of the lines currently electrified, while those outside the EU having much lower levels.

25. As an alternative, and complement to electric traction, dual or multi system locomotives have been introduced that allow for both electric and diesel running sometimes with the assistance of a supplementary electric battery. This technology allows energy savings when the train is running on electrified lines and/or when the electric battery is in use. For the moment, fully battery operated rolling stock are not common for mainline services, due to the long charging times and the high costs associated with their construction and maintenance, and the technology is used primarily in some shunting locomotives. Research and prototypes have been developed aimed at converting existing diesel rolling stock to hybrid alternative fuels but the cost of the conversion is very high and requires

[15] https://www.eesi.org/articles/view/electrification-of-u.s.-railways-pie-in-the-sky-or-realistic-goal.

[16] https://alternative-fuels-observatory.ec.europa.eu/transport-mode/rail#:~:text=Rail%20transport%20is%20currently%20by,is%20running%20on%20these%20lines.

significant reregistration and certification making it not a viable solution for the moment and only an option at replacement.

26. Other fuels, such as biodiesel, have been already used to replace diesel in order to emit fewer pollutants, however, currently the market is still limited. Hydrogen has been tested successfully as an alternative but this also still in its infancy. Further research into hydrogen engines would allow a wider usage.

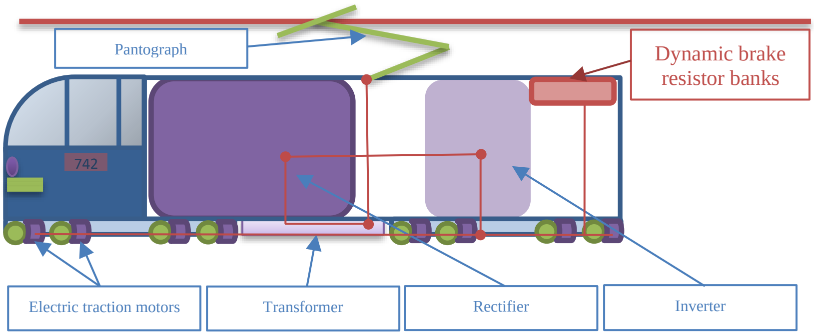
Higher overhead lines' voltage

27. For electrified lines, supplying electricity at a higher voltage would lead to a decrease in losses to the electricity transmission network. In addition, the electrical equipment of a 25 kV locomotives is on average lighter than for 3 kV one, leading to further energy. This solution would be effective both for the already electrified lines and the new ones, but the prohibitive costs to adapt current locomotives to the higher voltage means that this solution should be considered only when electrifying new lines.

Regenerative braking systems

28. Rolling stock can use two different systems to brake: mechanical and dynamic. The first one is based on activating brakes that directly slow the train using mechanical force while dynamic braking involves reversing the electric traction motors which normally move the wheels: the traction motors are then used as electric generators creating resistance against the train's actual movement and slowing it. Traditionally, the electricity generated has been transformed into heat transferring it to resistor banks (see figures 4 and 5). In recent years, train manufacturers have provided systems to return this energy produced by electric trains directly to the electric network through the pantograph or to store it in a battery on the train.

Figure 5
Electric locomotive with dynamic break resistor



Source: Secretariat elaboration.

29. The current system without batteries makes savings possible only if another train or other appliances connected to the same electric network use the energy produced at the same time, the exceeding energy is used to power the resistor banks. Some tests have been conducted installing batteries or supercapacitors on the side of tracks,[17] but energy loss increases the longer it needs to travel therefore its optimal application is on urban lines. On electric rolling stock, regenerative braking without batteries has already proven itself highly effective in saving energy: different studies have been performed and all of them highlighted that the savings depend on the type of locomotive, speed, environment temperature and various other factors, but a saving of at least 10 per cent of energy consumption is possible.

30. As mentioned before, the energy can be also used to charge a battery on a train, but to date, the energy storage instruments are not efficient enough to store significant amounts of electricity. The advantage of using batteries is the possibility to save energy also for diesel locomotives. Moreover, the batteries can be used by trains to manoeuvre in rail terminals when not electrified.

[17] https://www.fsnews.it/it/focus-on/sostenibilita/2021/4/22/fs-energia-frenata-treni-progetto-rfi-stazione-forli.html.

Anti-idling systems and auxiliary engines

31. It is common in the railway sector to leave the locomotives idling instead of switching off them as switching on a locomotive is a long procedure, moreover, locomotive engines use water as the coolant, which could make it not work if the temperature is below 5 C°. Other mechanical systems, such as the braking system, require the engine to be switched on in order to work properly. This leads to substantial energy wastage. whether through diesel fuel or electricity and therefore different technologies have been developed in recent years to counter this. These actions can have a strong impact on reducing energy usage at very low or no costs.

32. Automatic Engine Start-Stop (AESS) Control Technology is one of the simplest technologies available: the technology switches off the engines according to a series of parameters but it will still maintain the water at the right temperature and the other instruments ready to work. This technology can reduce idling times by up to 40per cent, but shutdowns are not possible when the outside temperature is under 5 C°.[18]

33. The provision of an Auxiliary Power Unit (APU) is more efficient compared to the AESS: an additional small engine is added to a locomotive, and it works instead of the main one when the train is not running. This smaller, frequently electric, power unit is efficient enough to maintain the mechanical systems operating and allows for the main engine to be turned off leading to a consistent reduction in energy consumption. More energy savings can be achieved if the APU is powered by a battery. APUs can be also associated with an AESS to act in parallel.[19]

34. Using an external electrical system, known as Shore Power Plug-in Technology, could benefit energy consumption during traditional idling time without installing any auxiliary engine. In fact, with this technology, the main engine is directly connected to an external power source when parked, which, thanks to additional systems, could make it possible to switch off the main engine.

35. All of these systems can also contribute to ensuring economic savings both reducing the energy consumed and making the locomotive engines last longer.

Freight terminals and shunting

36. Rail freight terminals are frequently not electrified. This can be due to the high costs to electrify and maintaining multiple lines, but mostly as a result of operational restrictions. Therefore, shunting vehicles or old locomotives with diesel engines are used to move rolling stock to their final destinations with low energy efficiency.

37. Investing to renovate the shunting fleet with vehicles equipped with batteries or anti-idling systems, as mentioned before, would be very efficient solution for these types of vehicles.

Driving assistance technologies

38. Train manufacturers and operators have developed instruments and technologies to monitor and improve train driving of trains to save energy. These technologies include systems that suggest to drivers the best practices to increase or decrease the speed and coasting according to the different paths. Others directly control the acceleration and dynamic braking systems. As an example, the adaptive control (ADL) developed and used by SBB "…makes driving recommendations to the locomotive crew, helping to avoid unscheduled stopping at red signals"[20] reducing total energy consumed.

39. SBB introduced also a "punctuality display" which shows the estimated time of passing through different checkpoints to save energy-correcting speed. This instrument allows trains to arrive on time avoiding delays that could influence the lines scheduling

[18] https://otc-cta.gc.ca/eng/publication/noise-and-vibration-idling-locomotives.

[19] https://sgp.fas.org/crs/misc/IF10978.pdf.

[20] https://company.sbb.ch/en/sbb-as-business-partner/services-rus/energy/sustainable-energy/energy-efficiency.html.

forcing other trains to consume more energy. SBB has estimated that, thanks to the resulting energy saving, the investment would be repaid within 6 months.[21]

Lighting, climate conditioning systems and auxiliary appliances in passenger trains and railway stations

40. Rolling stock driving, air conditioning and lighting account for up to 90 per cent of the electricity consumed by railways.[22]

41. Systems intended to provide comfort to passengers can account for about 20 per cent of energy consumption for passenger trains. However, the long life of coaches could affect the quality of the appliances installed. In fact, the technologies installed on the coaches could be old and with a low energy efficiency compared to the more recent ones. Investing in renovating lighting and other appliances would allow for significant savings with even better performance leading to more comfort for passengers. This applies both to facilities on the trains and in railway stations. Modern technologies could also limit energy consumption to only when required by demand: installing automated instruments which adapt the appliances' use to specific needs, accompanied by timers and sensors can avoid waste of energy. For example, air conditioning systems can be set to a lower power setting in the evening and the escalators can work just when a passenger is approaching. As an example, precise timetables are set by SBB in order to warm passenger trains only when needed.[23]

Using renewable energy

42. This installation of solar panels on railway infrastructure such as station, depot and freight terminal roofs can produce further energy efficiency gains for the railways as well as power some of the hybrid systems mentioned in previous paragraphs.

V. Energy saving strategies and behaviours

Routes planning, speed setting and coasting

43. During a train's journey, most energy is consumed to increase speed, whether when departing after a stop, to overcome a gradient or during normal running. This should be considered during driving and when planning the usage of tracks by trains.

44. Some strategies are useful to save energy such as accelerating more in the first phases of travel to coast during the remaining sections; accelerating only in the initial stages of ascents to take advantage of inertia during descents; favouring coasting instead of braking. All these behaviours can be summarized as "proactive driving."

45. A planning system which seeks to prevent stops during a journey and a driving style in which the increases in speed are as smooth as possible and takes advantage of the characteristics of the natural morphology to save energy could be crucial. As an example, the German company Deutsch Bahn declares that its driver training programmes aimed at ensuring an efficient use of energy, lead to up to a 13 per cent reduction in the consumption of energy.[24]

46. A lower average speed, and/or maximum speed have been also indicated by various operators as a way to reduce energy consumption. Governments could consider introducing regulations to diminish the maximum speed, but this could be difficult to implement for highly crowded routes. In fact, these would lengthen the travel time causing a decrease in the number of trains running and also affecting the level of service offered.

Loading of passengers and freight and number of journeys

47. Locomotives, particularly the ones for freight transport, are powerful machines able to carry significant load. Once that engine has been started and the train is running, adding

[21] https://news.sbb.ch/it/media/articolo/123593/treni-piu-puntuali-e-risparmio-di-energia-grazie-a-un-nuovo-indicatore-per-il-personale-di-locomotiva.

[22] https://www.ns.nl/en/about-ns/sustainability/climate-neutral/energy-saving-measures.html.

[23] Energy efficiency SBB.

[24] https://nachhaltigkeit.deutschebahn.com/en/measures/train-drivers.

one tonne of freight or one passenger coach does not impact heavily on energy consumption. Improved train-frequency planning would allow for a smaller number of journeys but more efficiently loaded. Therefore, studies on how to schedule and arrange train journeys could be performed to assure energy savings without affecting the level of service offered. A smaller number of coaches and stops could be also considered for passenger trains according to the demand. These behaviours could lead to a major reduction in the energy used per passenger or per tonne of freight. In fact, a too stringent initiative in maximizing efficiency would make it inconvenient for passengers and clients to use the train instead of other means of transport.

48. The presence of a restaurant-coach or similar serviced coaches, even if convenient for the rail operators, are not efficient from an energy consumption point of view. Instead, using double-deck coaches is a very efficient way of providing services during peak hours and/or on crowded routes.

49. Particularly for freight trains, increasing the maximum length and/or weight allowed on the lines by the infrastructure manager would contribute greatly to energy reduction. All the modifications of provisions concerning the maximum length and/or weight should be carefully evaluated considering the necessary safety parameters.

50. Taking the example identified previously for a journey between Geneva and Paris, if train load factors were higher than the current average, CO_2 emissions per passenger would decrease from 4 to 1,4 Kilograms and the energy consumption would reduce to 5,9 litres of gasoline equivalents.

Aerodynamics and weight

51. Due to the low average speed, the aerodynamic shape of the train is not significant for in reducing energy consumption for freight trains, however, it is important for high-speed passenger trains. The aerodynamics of rail vehicles is something over which the national governments and rail operators have low control, but they could still take care of it when loading containers. These should also be considered when deciding how to distribute the weight throughout the entire train. Some proposals to improve the aerodynamics of pantographs, which account for 8 per cent aerodynamic drag, and freight cars have been put forward along with some covering the air resistance of bogies.[25] Furthermore, covering open-top freight wagons can substantially reduce air friction, however, the resulting energy savings are minor and outweighed by the costs of covering them all.

Distributed power (multi locomotives trains)

52. For freight trains requiring multiple locomotives to carry the load, not positioning all the locomotives at the front, but distributing across the train's length could allow for a reduction of the horsepower required and of the energy needed. Therefore, studies on the best dispositions should be performed.

Empty running

53. Attempts at reducing empty running primarily for freight trains but also for passenger trains will also have a positive effect on reducing energy wastage. To tackle this some operators have adopted some creative solutions. As an example, the "infinity train", in Australia, uses the energy created by regenerative braking when running loaded downhill to come back to the original station.

Operation of auxiliary systems

54. A number of steps can be taken to save energy in other areas. For example, reducing the power needed by a cooling system by setting the temperature one °C higher/lower could lead to a significant reduction in energy consumption. Similar savings are possible for the heating and lighting system. In terms of lighting, maximising natural light can have an impact, as such appropriate cleaning of windows and translucent surfaces is important. Closing certain parts of a station in off-peak periods can also lead to energy savings as well as reducing the working time of decorative lighting in rail stations could also save energy.

[25] Technologies (railway-energy.org).

Maintenance and renewal work on railway lines

55. Maintenance and renewal work on railway lines should be planned in order to not divert trains to longer routes, this would allow both energy savings and a guarantee of the continuous quality of service. This would be easier when planning them during the night and would also allow to better distribute the energy consumption during the whole day, thus not overloading power lines.

Workforce training and client information

56. Rail sector employees, particularly train drivers, should be involved in energy saving projects: their efforts to save energy is crucial, and they could provide suggestions based on their experience and their own efforts to drive in a low energy manner. Training modules should also be offered to the employees to help them to understand which areas are affecting current energy consumption and how to improve their practices.

VI. Next steps

57. This document has highlighted a number of steps that can be taken by railway operators and infrastructure managers based on best practice examples from the sector. It has not been possible, at this stage, to prepare an estimation of potential total energy savings across the region from the implementation of these initiatives. As such, this document should be seen as a steppingstone to a more detailed analysis on energy saving initiatives for the rail sector.

58. Based on this background document, and preliminary analysis, the Working Party may wish to consider a more detailed questionnaire to send to member States and their railways to understand what initiatives they are taking in reducing energy use of their networks and operators. A more detailed analysis could then be carried out based on the responses that are received to the questionnaire.

59. The Working Party may wish to consider requesting that the secretariat seek the collaboration of partner international organisations in the preparation of this analysis with the aim of working towards some key recommendations on reducing energy consumption across the sector. As a first step in this process, delegates may wish to consult the energy saving checklist included in the annex to this document.

Annex

Energy saving checklist

The checklist below provides a summary list of the possible investments and practices that national railways may wish to follow. This list is intended to be used as a guide in developing new energy-efficient strategies and investments.

1. Fleet, rail network and rail station renovation:

(a) Replacing and maintaining old rail vehicles;

(b) Replacing diesel locomotives with electric ones, when possible, or dual/multi ones;

(c) Using locomotives equipped with recovery braking systems;

(d) Using locomotives equipped with anti-idling systems;

(e) Using new shunting vehicles or energy-saving dual locomotives in freight terminals;

(f) Installing driving-assistance technologies;

(g) Renovating passenger-comfort appliances, such as lighting and air conditioning;

(h) Installing sensors, timers, and energy-saving technologies;

(i) Installing appliances that are using renewable energy;

(j) Electrifying lines and installing high-voltage overhead lines.

2. Energy saving behaviours:

(a) Planning routes with few stops;

(b) Lowering the average and maximum speed and coasting;

(c) Loading the trains more to plan fewer travels;

(d) Considering aerodynamics and weight;

(e) Using the optimal power distribution for trains with more than one locomotive;

(f) Reducing the working time in the offices;

(g) Optimizing the usage of auxiliary appliances in railway stations and in trains;

(h) Training the workforce to consume less energy;

(i) Providing information and suggestions to clients and passengers to consume less energy.