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ECORailS –
Energy efficiency and environmental criteria in the awarding of regional rail transport vehicles and services

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Annex VIII: Approaches for the evaluation of economic potential and implementation time of technologies and operational measures

1. Introduction

1.1 Scope and approach

In most European countries, regional rail services are today coordinated by regional or national Public Transport Administrations (PTAs) which usually organise train services by Public Service Contracts (PSC). These contracts define the extent and the quality of services as well as the price the PTA has to pay to the contracted Train Operating Company (TOC).

The quality of services (including e.g. energy consumption) depends to a great extent on the quality of the rolling stock which is used. If the TOC procures the rolling stock, it must fulfil the qualitative requirements of the PTA. Some PTAs procure rolling stock themselves and provide it to the contracted TOC; thus the PTA can influence the quality of the fleet directly.

Wherever European PTAs are committed to environmental goals, have sufficient and reliable funds, and respect some basic principles of passenger-friendly service concepts, regional railway passenger services have become a great success in terms of increasing numbers of passengers and enhanced service quality.

PTAs have three basic options for awarding train services:

- Competitive tendering
- In-house provision by a TOC which is owned by the regional administration or government itself
- Direct awarding to another operator, usually the national or "incumbent" railway company

In case that the PTA buys the rolling stock, competitive tendering must be used for this procurement as usually public funds are involved. For awarding the respective *services*, however, all three options given above can be chosen.

Although a lot of PTAs already have their experiences with quality criteria, EE/ENV criteria have their own challenges and political background. This is the reason why the ECORailS consortium took the effort to elaborate the present Guidelines. We hope that these Guidelines are easy to handle and become a great step for the common objective of reducing the energy consumption of passenger mobility in Europe.

For the objectives of ECORailS all three main types of awarding (competitive tendering, in-house provision by own TOC or direct awarding to third party TOC) are equally relevant. All these types of award procedures have their specific advantages and disadvantages both in general and in terms of EE/ENV criteria. These advantages/disadvantages will be discussed in chapter 5.4 by way of environmental considerations. The Guidelines will make active use of the existing standards and specifications as the UIC Leaflet 345 “Environmental specifications for new rolling stock” and the Technical Recommendation “Specification and verification of energy consumption for railway rolling stock” of UIC and UNIFE.

1.2 Why to use environmental standards in rail transport

The railway is one of the most environment-friendly means of passenger transport. This is due to inherent advantages of rail services and technologies. Modal shift towards rail transport can be an appropriate measure for reducing energy consumption, CO_2 emissions, pollutants and noise. However, the competing modes, especially private cars and buses, have improved their environmental performance substantially in recent years while the railways have not yet realised all their energy-efficiency and environmental potentials. Further improvement is crucial for the railways in order to contribute to a more sustainable future.

The key environmental areas for the railways are energy consumption and CO_2-emissions, noise, and pollutants. Energy consumption and CO_2-emissions are related to each other.

This area is the strategic key area for the sustainability of transport in general. The inherent advantages of rail transport are most prominent in terms of energy efficiency and the ECORailS project therefore focuses on this issue. The emission of pollutants, a specific problem of diesel operations, is an issue especially in agglomerations where high concentrations of particulate matters (PM) and Nitrogen oxides (NO_x) affect the health of the population. Pollutants have therefore been regulated by EU immission law and are thus also an issue for TOCs and PTAs. Noise emissions are the “Achilles’ heel” of rail transport. Opposition against new railway lines or extended operations is usually due to the expected noise emissions. Thus more silent railways will accelerate modal shift.

There are three main reasons why public administrations should provide for environmentally-friendly rail transport:

(1) One of their most important aims is to enhance the living conditions of the population; this also includes preventing high risk global warming and climate change as well as preventing incidences of health risks due to toxic emissions (pollutants) and noise.

(2) The second reason is the necessity to reduce risks to public finances. The energy consumption of passenger trains is a relevant part of their operational costs. The specific demand for energy is steadily increasing while the availability of resources is limited. Consequently energy prices will increase and may have a severe impact on public finances. Additionally noise and pollutant emissions caused by train operations may lead to budget risks due to costly retrofitting of fleets or contract amendments between PTA and TOC.

(3) The environmental benefit demonstrated by the railways over other modes of transport is a vital precondition in ensuring social and political support for this mode of transport. Showing the commitment of the rail sector, including PTAs, to environmental goals contributes to a good situation for the railways in general.

These outcomes clearly show that the application of environmental and energy efficiency criteria will reduce political and financial risks, although it may in some cases result initially in higher investment costs or even slightly increased operational costs. The ECORailS consortium which includes a number of PTAs is convinced that financial, but also technological and legal obstacles can be overcome by clearly analysing the technical potential, carefully defining the requirements and incentives and embedding all tenders in a more long-term oriented and coordinated environmental strategy. The analysis of the state of the art shows that solutions are available for the railways which will allow the reduction of energy consumption and negative environmental impacts with affordable efforts.

1.3 Target audience

The target group of this project are first of all Public Transport Administrations (PTAs) which play a key role today when it comes to improving the quality and environmental performance of passenger rail transport. ECORailS will provide expertise and Guidelines for them in order to successfully include environmental criteria in their awarding procedures. Decision makers within European regional PTAs will be supported by these Guidelines on every step on the way to include environmental criteria into their awarding procedures and service contracts.

The Guidelines are written to comply with European awarding legislation in order to maximise their impact on overall awarding practices. This document will show how to create awarding text modules compliant with European law, usable by PTAs for regional awarding in all EU member states. An annexed catalogue containing information on cutting-edge technology along with details on particularly promising technologies and operational measures will also be available.

The Guidelines benefit from both the own ECORailS research activities and the results of previous and currently ongoing technological projects like EVENT, PROSPER and Railenergy in order to enable and encourage the European PTAs to profit from already available results. ECORailS cooperates with all involved interest groups: PTAs, train operating companies and manufacturers.

1.4 Structure of the Guidelines – how to use them

The present document is the second draft of the ECORailS Guidelines. It will be the base for test applications in four European regions – Copenhagen/Øresund, Berlin/Brandenburg, Brescia/Lombardy and Timisoara. The results of these tests, as well as any other feedback from users and relevant stakeholders, will be considered or incorporated in the final version of the Guidelines to be published in the first half of 2011.

A typical award project covers the whole process from identifying the services to be awarded or vehicles to be procured to the monitoring of the actual performance during the operation. Methods to include EE/ENV criteria in this process will be described. The document is structured in the following way: The different awarding phases, their main purposes and the basic ways to include EE/ENV criteria are described in chapter 4. The issues in terms of EE/ENV criteria which are relevant for the strategy and the preparation phase are shown in chapter 3, while necessary details for the compilation, assessment and monitoring of the tender or contract including the legal background are discussed in chapter 4. More detail and background information will be provided in annexes and on the internet.

1.5 Credits and disclaimer

Allianz pro Schiene which is responsible for the editorial process of the Guidelines wishes to thank all partners of the ECORailS consortium for their strong commitment to the objectives of the project, their intensive and effective work as well as their valuable contributions. The ECORailS consortium wishes to thank all stakeholders who have already been involved in meetings or discussions for their commitment and valuable input. We also like to thank the European Commission and the Executive Agency for Competitiveness & Innovation (eaci) for their support which is an encouraging sign for the ecological and economical relevance of regional passenger train services.

Please bear in mind this is a preliminary version and neither Allianz pro Schiene nor any other partner of the ECORailS consortium accept any liability for problems which may occur by using this version in real awarding projects or other circumstances.

2 European law relevant for awarding and tendering

In general, European legislation encourages explicitly the application of environmental criteria. According to European law, awarding authorities are free to decide *what* to award and which quality criteria (including EE/ENV criteria) can be applied. PTAs must however respect certain rules *how* to award, which are defined in European legislation (in particular: Regulation (EC) No. 1370/2007, also: fundamental freedoms of the European Treaty).

European legislation allows ambitious ecological standards to be set and enforced by awarding procedures as long as the following four main principles are observed:

- Non-discrimination;
- Proportionality;
- Transparency;
- Equal treatment.

These principles which result from the fundamental freedoms of the European Treaty[1], observe the process of awarding itself, not the subject f the awarding process. Of importance is that any criteria, requirements, bonus/malus which are used for the evaluation of tenders, must be defined in awarding documents as well as in the public service contracts. This includes the method for calculation of compensation or penalty levels and how to monitor the compliance to the criteria.

When awarding railway services, the PTAs enjoy great flexibility (although not unlimited) when it comes to the type of awarding procedure, the duration of contracts, the selection of the TOC, and the definition of criteria. National legislation on awarding and tendering may however limit the PTA's flexibility to some extent. In spite of that, in the countries participating in the ECORailS project there are no prohibitions regarding the use of a certain procedure of awarding for regional railway services, although there are some specific national rules for the application of direct awarding and in-house provision.

When the PTA is going to procure vehicles, the stricter EU regulations for public procurement must be respected. The latter regulations must also be considered in case of awarding services when environmental criteria for rolling stock are explicitly defined.

The EU regulation no. 1370/2007[2] regulates the allowable financing and the awarding of public services in the sector of passenger land transport (railway, tramway, bus and underground), and intends to raise the efficiency and attractiveness of public regional passenger transport. The regulation, which came into force in December 2009, offers a far greater scope for PTAs considering the design of the awarding procedure compared to the stricter European procurement directives. For example, the regulation (in Art. 5 par. 3) specifies merely that: *"The procedure adopted for competitive tendering shall be open to all operators, shall be fair and shall observe the principles of transparency and non-discrimination."* As a special exception for rail services, the regulation also allows the use of direct awarding or in-house provision of the services by the PTA (art. 5 par. 6). The regulation allows explicitly the inclusion of environmental criteria into the contract (art. 4 par. 6):

> *"Where competent authorities, in accordance with national law, require public service operators to comply with certain quality standards, these standards shall be included in the tender documents and in the public service contracts."*

[1] Treaty of Lisbon, in force since 1st Dec. 2009
[2] "Regulation of the European Parliament and of the Council on public passenger transport services by rail and by road" (Regulation (EC) No. 1370/2007)

The regulation 1370/2007 allows for contract lengths up to 15 years if the contract is awarded through competitive tendering and 10 years if direct awarding is being used. The contract length can be extended up to 50 % if, for example, exceptional investments have been made in the rolling stock linked predominantly to the passenger transport services covered by the contract. If justified by the amortisation of rolling stock investments in relation with exceptional infrastructure and if the public service contract is awarded in a fair competitive tendering procedure, a public service contract may even have a longer duration. If direct awarding is applied, contract durations of more than 15 years are not possible in any case.

The European procurement directives (2004/17/EC and 2004/18/EC) are mainly relevant when the PTA wants to procure rolling stock for railway services itself, or when a PTA makes specifications about the rolling stock to be procured by the successfully bidding TOC. The directives basically allow freedom of manoeuvre for the contracting authority to specify the subject of the award, e.g. considering energy efficiency or pollution. However, the requirements have to be non-discriminatory. For example, the specification of a particular pollution filter (in the sense of a specific producer) would not be allowed. On the other side, the specification of a maximum level of pollution or a cleaning method would be permitted, even if these limits were stricter than required by European or national regulations of emission limits. The establishment of specific environmental evaluation criteria for the appraisal of the offers is possible, but environmental standards:

- should be associated with the subject of the contract;
- do not admit unlimited scope of action for the public authority;
- have to be mentioned explicitly in the contract notice and the tender documents;
- have to be consistent with the basic principles of EU-legislation.

The European Court of Justice (ECJ) has already emphasized the permissibility of environmental assessment criteria in awarding, as long as they are non-discriminatory and they are associated with the subject of the contract.

In summary it can be stated that

- ambitious ecological standards can be set and enforced by awarding procedures;
- transparent assessment criteria allow for an assessment of the environmental quality offered in a legally compliant way;
- grant programmes and fair competition are compatible if grants are made available to all participants of a competitive awarding procedure in a non-discriminatory way.

See also Annex I!

3 Strategic considerations for the successful application of EE/ENV criteria

Main associated actions at PTAs:	Actions at PTA concerning energy efficiency and further environmental criteria
Strategic considerations, definition of long-term objectives	• Definition of long-term objectives and perspectives • Definition of a fleet strategy • Dialogue with target groups and key actors (Train Operating Companies, Infrastructure Managers, manufacturers, research organizations, other PTAs, associations, etc.) • (Public) Announcement of targets and desired innovations

There are different options to develop and publish strategic considerations. In some regions strategic considerations and targets are covered by a transport development plan. A transport development plan is an instrument where among others environmental targets (such as 20% energy efficiency improvements or share of renewable energies for a long-term time frame as 2020/2030) can be included. Other options to organise a stakeholder dialogue and political agreements with government or political bodies are conceivable.

3.1 Main issues to be considered

There are at least seven main issues to be considered which are relevant for the environmental effects:

- Overall transport policy including targets for modal shift and environmental targets for the transport sector of the area

Rationale (in terms of EE/ENV criteria): Relevant for fleet strategy, infrastructure investments and identification of main environmental problems to be addressed.

For details see chapter 5.1!

- Quality of infrastructure (slow orders, level crossings)

Rationale: By investments in the infrastructure quality the energy consumption can be reduced significantly while the travelling speed can be increased. This has positive implications for the fleet strategy and should be considered when the potentials for enhanced EE are analysed. Avoiding braking and acceleration has also positive effects on noise emissions.

For details see chapter 5.3!

- Electrification

Rationale: Electrification has in general a positive impact on all kinds of environmental effects (EE, CO2, pollutants, noise). Furthermore, it has strong effects on the fleet strategy.

For details see chapter 5.3!

- Institutional changes concerning energy supply

Rationale:
(1) Charging of electric traction energy: In some countries the electric traction energy (in the catenary) is not paid by the TOC, or not charged according to the real energy consumption and prices. The PTA should go for charging systems which give direct and clear incentives for the TOC to save energy. The institutional framework of the energy supply system has implications for the weighting of EE criteria within award procedures.

(2) Use of renewable energy: The use of renewable energy may be encouraged by direct procurement by the infrastructure manager, by new options for the transmission of renewable energy through the railway grid or by overtaking the supply infrastructure by e.g. the PTA.

For details see chapters 5.5 and 5.6!

- Integrated strategy for noise protection (silent vehicles instead of e.g. noise protection walls)

Rationale: Investments in noise protection walls, protecting windows etc. and similar measures can in some cases be reduced when silent trains are procured. The additional costs for silent vehicles or their retrofit are often lower than the comprehensive construction of noise protection walls, especially when the infrastructure is almost only used by regional passenger trains. Due to specific financing conditions (typically investments for protection walls financed by the national budget and silent rolling stock financed by regional PTAs) new arrangements with the infrastructure manager (IM) and other TOC might be necessary in order to make rail noise abatement more economical for the society. Such arrangements could be part of noise action planning.

For details see chapters 5.9 and 6.14!

- Fleet strategy

Rationale: Even if a PTA does not own the rolling stock for its services and wants to widely use competitive tendering, it should analyse whether and how long old, modernised or new trains should be used. New rolling stock has usually the greatest potentials for EE/ENV improvements. On the other side, it might not be economic to scrap vehicles which have not yet reached their technical end of life. Besides exceptional cases it is not advisable to replace rolling stock only for environmental reasons. Potentials and risks of later replacement or of modernisation should be analysed. Modernisation usually can have relevant, although limited positive effects in terms of EE and emissions, but may cause individual solutions, relatively high costs and problems with authorisation. The fleet strategy in terms of new/old/modernised rolling stock may have strong implications for the potential of environment-related improvements and for the definition and weighting of criteria.

For details see chapter 3.2 and 5.3!

- Mid- or long-term innovation strategy for rolling stock

Rationale: If the PTA wants to achieve substantial improvements in terms of EE/ENV quality compared to existing or currently available rolling stock, the TOC and the manufacturer need time for development, authorisation, testing and calculating. The PTA should well in advance announce what environmental standards it is going to require or to encourage. A coordinated approach with other PTAs is advisable although not indispensable. In order to gain the confidence of the manufacturers that their efforts will be rewarded, the PTA should follow the announced strategy consistently.

Announcements should be given between 0.5 and 2 years before the Invitation to Tender (ITT).

For details see chapter 3.2!

The definition and review of strategy and strategic targets is a permanent challenge. A dialogue with TOCs, manufacturers, scientists as well as strategic political decisions within the government is necessary. The forecasts of energy prices and supply, as well as the consequences of noise action planning, air quality planning, and other immission law and targets should be considered.

3.2 Timeframe of awarding and EE/ENV criteria

In the sixth chapter of these Guidelines, criteria will be proposed which can immediately be used by PTAs for improving the environmental and energetic performances of the passenger services under their responsibility. If advanced solutions are desired which are not yet available on the market, the PTA has to keep in mind that a long period of time may be required for developing, testing, manufacturing and homologation of new designs of railway vehicles, which would take up to 4 years, depending on the number of vehicles and previous efforts of the manufacturer and the TOC. This time period would start with the signing of the Contract. Even evolutionary improvements need sufficient time for the incorporation in the vehicle design, testing and authorisation. In order to achieve more advanced results and to trigger a continuous innovation process the EE/ENV criteria may be embedded in a more long-term orientation. One or more of the following instruments could be used:

Clear environmental strategy: A clear environmental strategy of the PTA or public announcements about EE/ENV criteria to be included in the next tender(s) give orientation for TOCs and manufacturers which innovations and achievements will be honoured in future awarding projects. This can work as an incentive for their research and development activities if the announcements are reliable in the eyes of the manufacturers.

Coordinated action with other PTAs: As the size of series is a crucial aspect for manufacturers who want to develop vehicles with new technologies at reasonable prices, coordinated action of more than one PTA may help to trigger the innovation process.

Incentives instead of requirements: If it is not sure that a certain performance value or emission limit can be achieved at reasonable costs, incentives should be applied instead of strict requirements.

"Postponed" requirements: In case of long contract durations for services the PTA may, after an analysis of the state of the art and technologies under development, require certain performance values or technology for a later date, e.g. five years after start of operation. The TOC would have to modernise or replace its fleet if it is not able to fulfil the requirements at the beginning of its operations under the contract in question. A "postponed requirement" is thus only appropriate if it is clear that the technologies will be able at a certain time in the short- or mid-term future. Furthermore the refurbishment of the existing fleet, using the new technologies must be reasonable or the replacement of the existing fleet must be economical within the considered timeframe if modernisation does not seem to be appropriate.

Incentives for later modernisation: If the development or even the nature of desired new technologies, their applicability to modernisation of existing vehicles, costs and reliability are not certain, rather incentives for future modernisation should be chosen instead of "postponed" requirements. Such incentives could also encourage the replacement of the existing fleet by new rolling stock with advanced standards.

Modernisation paths: If the existing fleet is to be replaced by the TOC within the first years of the contract, a timeframe for the delivery of new vehicles could be foreseen. For these

future deliveries more advanced EE/ENV standards might be required or encouraged than available at the date of tendering.

Flexibility for testing: Although most PTAs will, with good reasons, leave the responsibility for testing new vehicles and technologies to the manufacturers and the TOCs, PSCs should allow for certain flexibility for testing in real operations.

4 Including EE/ENV criteria into the awarding process

4.1 Reference model of awarding

There are different "cultures" of awarding in the participating countries. For example the time the bidders have to respond to an invitation to tender (ITT) varies between three months and 1.5 years. Although these different procedures may have their own unique benefits, it is possible to successfully include environmental criteria within all approaches and time frames applied, provided that the ITT (or direct contract) is elaborated based on a sufficient analysis of options and potentials. In spite of some differences among the countries, a common legal framework – established by the EU directives – has to be applied in all member states. These Guidelines therefore follow a reference model of approach agreed by the PTAs which participate in the ECORailS project.

All award projects, being for services or for the procurement of rolling stock, can be structured into seven phases, according to the chart and the descriptions below. The following sub-chapters provide an overview for the use of EE/ENV criteria in the different awarding phases by way of diagrams and short descriptions. This model can easily be used by each procurement authority in Europe.

Although these Guidelines should encourage all PTAs to start directly with the inclusion of EE/ENV criteria into their actual awarding projects, it is advisable to consider strategic issues in order to achieve a successful mid- and long-term environment-related innovation process. This is indicated by the "roof" of the following chart.

The first phase ("A. Preparation") is necessary in order to define the awarding project, basic decisions e.g. about the type of awarding procedure, targets in terms of transport, social and environmental policy. A draft selection of EE/ENV criteria and setting of priorities would be part of this phase.

The second phase ("B. Elaboration") comprises the detailed elaboration of tender or contract documents, including the detailed definition of awarding criteria. The latter includes e.g. the selection of criteria, selection and definition of indicators, decision on requirements, preferred solutions and incentive schemes as well as the ways of weighting and monitoring.

In the third phase ("C. Response to tender") mainly the bidders have to work on the offers while the PTA should be ready to answer the bidders' questions, give clarifications and additional information.

The fourth phase ("D. Evaluation and awarding") is dedicated to the evaluation of the bids by the PTA which is the base for the award decision. The decision shall be published and be justified according to the award regulations of the respective Member State and government.

The fifth phase ("E. Negotiations") might be useful in order to clarify details of the contract or to verify of elements of the offers. This step can especially be helpful if the bidders have the option to provide qualitative concepts e.g. for environmental improvements. In such cases the situation might occur that verification and monitoring procedures for these additional issues must be agreed upon. In case of competitive tendering such negotiations must not affect the main subjects of the tender. In some countries national law prohibits such a negotiation phase. In this case all details which might be relevant for the Public Service Contract (PSC) must be already defined in the elaboration phase (B).

The sixth phase (F. Preparation of contract period") covers the remaining time before the actual start of operation. The offered performance of the selected operator must be verified and instruments and systems for monitoring purposes during the contract period must be defined and installed.

The seventh phase ("G. Follow up during the contract period") covers the time of the operation itself. The main purpose in terms of quality criteria like environmental performance

or energy efficiency is to monitor the real performance and to apply the bonus/penalty schemes which have been agreed upon before.

<table>
<tr><td colspan="2"><u>Main phases at PTA in a typical award project:</u></td><td colspan="2"><u>Main associated actions at PTA:</u></td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Competitive Awarding</td><td>Direct Awarding / In-house provision</td><td>Competitive Awarding</td><td>Direct Awarding / In-house provision</td></tr>
<tr><td colspan="2">A. Preparation</td><td colspan="2">A. Definition of the award project: decision on award procedure; identification of needs, options and targets</td></tr>
<tr><td colspan="2">B. Elaboration</td><td colspan="2">B. Elaboration of ITT / (direct) contract text plus planning of phases D-G; publication of tender documents</td></tr>
<tr><td>C. Response to tender</td><td rowspan="3">C. + D. + E. Negotiation</td><td>C. Mainly bidding operators to work; PTA to answer bidders' questions</td><td rowspan="3">C. + D. + E. Agreement on the contractual clauses and on the economical and technical details of the contract</td></tr>
<tr><td>D. Evaluation and awarding</td><td>D. Evaluation, decision and justification; communication of the result</td></tr>
<tr><td>E. Negotiation</td><td>E. Further negotiations and specifications; preparation of the contract</td></tr>
<tr><td colspan="2">F. Preparation of contract period</td><td colspan="2">F. Verification of performance with selected operator; preparing of monitoring</td></tr>
<tr><td colspan="2">G. Follow up during the contract period</td><td colspan="2">G. Monitoring and bonus/penalty awards on annual basis</td></tr>
</table>

It is obvious that in phase B ("Elaboration") the necessities of phases D to G must be considered in advance and targets need to be defined. Only criteria should be selected which can clearly and legally sound be defined, evaluated and monitored. This is especially valid in case of competitive awarding. In case of direct awarding and in-house provision phases C to E can be merged as the formalized tendering process is replaced by direct contact and negotiations between the PTA and the train operating company (TOC) or the supplier of rolling stock (manufacturer).

4.2 Main actions of the PTA during the phases of awarding

In the following table it is shown which major actions should be considered by the PTA in terms of energy efficiency and further environmental criteria during the seven phases of an

awarding project. In all of these phases energy-efficiency and further environmental criteria should be considered as an integral part of the process.

Main phases of awarding projects

	Main awarding phases:	**Main associated actions at PTAs:**	**Actions at PTA concerning energy efficiency and further environmental criteria**
A	Preparation	Definition of the award project; decision on award procedure; Identification of needs, options and targets	• Analysis of the actual situation (environmental performance, "baseline") • Identification of main environmental problems • Identification of mandatory and non-mandatory target levels for energy consumption, noise and pollutants • Market analysis (technological potentials, economic and legal restraints, potential bidders) • Draft definition of targets in terms of energy efficiency, noise and pollutants • Draft prioritisation and weighting • Decisions concerning new, refurbished or existing rolling stock
B	Elaboration	Elaboration of ITT / (direct) contract text plus planning of phases D-G; publication of tender documents	• Analysis whether and how the criteria can be evaluated, validated and monitored • Clear definition of EE/ENV criteria (requirements, target values, performance specifications, penalties, incentives...) • Selection of relevant technologies/requirements • Requirements regarding LCC&CBA; elaboration of a form to permit the easy comparison of offers • Definition of priorities and weighting against other criteria • Definition of how to monitor the compliance • Draw up of contract including the conditions for monitoring, verification and fulfilment of the EE/ENV criteria
C	Response to tender / quote request	Mainly bidding operators to work; PTA to answer bidders' questions	• Responses to bidders' questions for clarifications; forwarding the information to the other bidders. • Receipt of offers

D	Evaluation and awarding	Evaluation, decision and justification; communication of the result	• Evaluation of offers in terms of EE/ENV criteria • Assessment whether the selected offer is realistic and reliable in terms of environmental performance
E	Negotiations	Further negotiations and specifications; preparation of the contract	• Definition of more detailed specifications if necessary • Definition of verification and monitoring procedures if necessary • Detailed definition of incentive or bonus / penalty regimes according to the performance offered by the bidder
F	Preparation of contract period	Verification of performance with selected operator; preparing of monitoring	• Verification of environmental performance (especially of vehicles) as far as it is possible and appropriate before starting the operation • Test runs for the verification of energy consumption
G	Follow up during the contract period	Monitoring and bonus / penalty awards on annual basis	• Monitoring of real-life energy consumption / environmental performance (application of bonus/penalty if necessary) • Verification and monitoring of operational measures • Verification measures as in phase F if further procurement or refurbishment is foreseen during the contract period • Verification and monitoring if environmental performance is affected by maintenance or vehicle quality • Identification and overcoming of obstacles for better environmental performance (in co-operation with the bidder when appropriate)

4.3 EE/ENV issues during the awarding process (overview)

In this chapter the process of an environment-aware awarding procedure will be described in form of a checklist, including the main questions and topics, with rationale and references for the respective keywords.

4.3.1 Phase A - Preparation

Main awarding phase:		Main associated actions at PTAs:	Actions at PTA concerning energy efficiency and further environmental criteria
A	Preparation	Definition of the award project; decision on award procedure; Identification of needs, options and targets	• Analysis of the actual situation (environmental performance, "baseline") • Identification of main environmental problems • Identification of mandatory and non-mandatory target levels for energy consumption, noise and pollutants • Market analysis (technological potentials, economic and legal restraints, potential bidders) • Draft definition of targets in terms of energy efficiency, noise and pollutants • Draft prioritisation and weighting • Decisions concerning new, refurbished or existing rolling stock

Phase A is the definition phase of a specific award project. Lines or networks to be awarded will be defined. Service concept, quality standards and the duration of the contract must be preliminary decided. As far as environmental criteria and energy efficiency are concerned some basic analyses should be made and some draft decisions should be taken. For the following steps or issues EE/ENV criteria should be considered:

- Identification of lines or networks; definition of lots:

  Rationale: Main aspects for the definition of lines, networks and lots should be the needs of passengers, existing contracts, existing rolling stock and the need for renewal, infrastructure situation, and the existence and ability of interested TOC. Nevertheless, environmental aspects should be considered, e.g.:

  (1) Energy efficiency: Do the defined lots allow for sufficiently homogeneous occupancies (without too much operational efforts by way e.g. of strengthening or shortening of trains);

  (2) Noise: If the invention of silent rolling stock is possible only partially or step-by-step – are the lots defined in a way that the new fleet can be concentrated on the lines which have the most serious noise problems;

  (3) Pollutants: analogously to noise.

  In any case a certain level of flexibility should be allowed for modification of services during the contract duration.

- Timetable and service concepts

  Rationale: Also the timetable and service concepts should mainly respect the passengers' needs e.g. in terms of travel time and good direct or corresponding connections. However, spare time in the timetable should provide better options for punctuality and energy-efficient driving, and thus furthermore promote the use of public transport.

  For details see chapter 5.3!

- Decision about the type of the awarding procedure (competitive tender, direct award to own TOC or direct award to third-party TOC)

  Rationale: EE/ENV criteria can be included in all types of awarding procedures named above. The decision about the approach mainly depends on political decisions, market situation and specific circumstances and not on environmental criteria. It should be considered, however, that direct awarding or in-house provision, under certain circumstances, may allow for more flexibility in negotiations, contract and testing if quite ambitious innovations are desired.

  For details see chapter 5.4!

- Identification of main environmental problems

  Rationale: Although the focus should be on energy efficiency and CO_2 emissions, noise and pollutants (in case of diesel operation) should not be neglected. If the region faces serious noise or air quality problems along the lines in question, the respective criteria should get a relatively high relevance in the awarding process.

  For details see chapters 5.2, 5.8 and 5.9!

- Analysis of energy prices, charging and supply system

  Rationale: If the traction energy is not charged according to real consumption, it should be checked whether this regime can be changed for the contract which is being prepared. Additionally: are there options for the procurement of "green" energy?

  For details see chapter 5.5!

- Analysis of the actual situation in terms of energy consumption and CO_2 emissions

  Rationale: The analysis of the actual situation in terms of energy consumption is essential for the estimations of savings which can be achieved by operational measures or new rolling stock. If no sufficient data are available, a measurement campaign should be considered. Alternatively, estimations based on the current train configurations and traction technologies could be helpful.

  For details see chapters 5.6 and 5.7!

- Draft definition of targets in terms of energy efficiency

  Rationale: Based on the as-is analysis and additional analysis of available technologies and feasible operational measures, a first estimation of the saving potential during the next contract period can be made. Thus a target can be defined and used as a "good solution" or reference in tender or contract documents.

  For details see chapter 5.7!

- Analysis of the actual situation in terms of noise; draft definition of targets in terms of noise

  Rationale: It should be checked whether measured emission values of the existing rolling stock are available. If not, information of the norms which are fulfilled (e.g. TSI noise or national regulations) can be helpful. Be aware that values given in dB (A) cannot easily be compared if definitions and measurement conditions are not harmonised. The analyse can show whether existing noise problems can be solved by modernisation or procurement of new rolling stock or whether more ambitious noise limits than required by TSI Noise should be aimed at in the present awarding.

  For details see chapters 5.9 and 6.14!

- Analysis of the actual situation in terms of pollutants; draft definition of targets in terms of pollutants

  Rationale: The emission standards of existing diesel engines or DMU should be available. Depending on the air quality in the respective area it should be decided whether pollutant emissions should be addressed in the awarding project and which standard (e.g. Stage IIIb, Stage IIIa, or UIC II) should be required as minimum or rewarded. New engines for existing tractive units may be an option.

  For details see chapters 5.8 and 6.13!

- Vehicle concept and comfort for passengers

  Rationale: Conceptual decisions about the vehicles and the comfort standards should be reviewed with respect to environmental effects. It is a prominent question whether the train configurations can easily be adapted to the actual demand. Articulated MUs, double-deck trains and MUs in general have advantages compared to conventional MUs, single-deck trains or loco-hauled trains, but these advantages may be outweighed by specific conditions, sub-optimal design or the higher flexibility of loco-hauled trains. It might be an option to let the bidding TOC decide about the vehicle concept and to assess the offered rolling stock with respect to its actual environmental and energetic performance. However, comfort standards should be defined sufficiently clear so that the reduction of energy consumption will not have relevant negative effects on the comfort for passengers.
  For details see chapter 5.3 and 6.9!

- Locations for parked trains and maintenance facilities

  Rationale: Noise and pollutants at stabling or maintenance facilities may cause disturbance to the neighbourhood. Timetable concept, infrastructure situation and the bidders' maintenance concepts should be reviewed with respect to this problem.

- Draft prioritisation and weighting

  Rationale: Based on the analyses mentioned above a first approach to prioritisation and weighting of environmental targets compared to each other and compared to other quality and economical criteria should be agreed upon. This may be modified after more detailed analyses in phase B.

- Concept for a weighting scheme

  Rationale: Independently from environmental aspects a concept for weighting quality criteria against price and other elements is needed if the PTA aims at competitive

tendering. The weighting scheme should allow for appropriate inclusion of environmental aspects.

For details see chapters 4.3.2, 5.10 and 6.16!

- Decisions concerning new, refurbished or existing rolling stock

  Rationale: The fleet strategy (see phase S) should be concretised with respect to the current awarding project and the relevance of EE/ENV considerations. It should be decided whether e.g. new or refurbished material will be required or encouraged or whether it will be up to the bidders to decide which generation of rolling stock to offer.

  For details see chapter 5.3!

- Availability of loan programmes or specific public funds

  Rationale: In some Member States special loan programmes are offered for environment-friendly or highly innovative investments. These may be used by PTAs or the TOCs in certain situations. Using such loan programmes in combination with competitive tendering is feasible if loans are offered to all potential bidders. Also EU funds may be available in specific cases.

Phase A comprises merely definitions and concept decisions while phase B is dedicated to the elaboration of the actual tender or contract texts. In phase B further analyses and decisions in detail will be needed. The results of phase A should be reviewed before finalising phase B.

4.3.2 Phase B - Elaboration

Main awarding phase:		Main associated actions at PTAs:	Actions at PTA concerning energy efficiency and further environmental criteria
B	Elaboration	Elaboration of ITT / (direct) contract text plus planning of phases D-G; publication of tender documents	• Analysis whether and how the criteria can be evaluated, validated and monitored • Clear definition of EE/ENV criteria (requirements, target values, performance specifications, penalties, incentives...) • Selection of relevant technologies/requirements • Requirements regarding LCC&CBA; elaboration of a form to permit the easy comparison of offers • Definition of priorities and weighting against other criteria • Definition of how to monitor the compliance • Draw up of contract including the conditions for monitoring, verification and fulfilment of the EE/ENV criteria

Phase B ("Elaboration") is the crucial one. The tender and contract documents are being elaborated and a sound assessment, selection, definition and weighting of all criteria is needed. The main steps within this phase are:

1. Drafting text for minimum requirements
2. Drafting text for advanced ecological criteria (preferred options, penalties, incentives)
3. Drafting text for how to evaluate the tenders (yes/no, weighting scheme)
4. Drafting text for preparation before the contract period (i.e. testing of rolling stock, technologies, eco-driving, driver training etc.)
5. Drafting text for the monitoring activities (including penalty and incentive schemes) during the contract period
6. Review and validation of text modules for all above items

In the next paragraphs an overview over the relevant EE/ENV criteria and ways for their inclusion is given. In the sixth chapter of this document details (including examples for text modules) are given on how the criteria can exactly be defined, evaluated, weighted and monitored.

Ways to include EE/ENV criteria

In terms of energy efficiency the most comprehensive criterion is the energy consumption per seat km or per train km. Although these offer the best assessment basis for energy efficiency

improvements, it may be advisable to use additionally other indicators, encourage certain technologies or operational measures. In case of technologies the preferred approach is to specify the technology functionally (e.g. efficiency of energy storage or necessary functions of parked train control systems) and not specific solutions or products. The latter could even cause major legal problems while the functional approach is viable in almost all cases.

In case of competitive tenders the criteria for the assessment have to be described in the awarding documents. Usually the price per year (extrapolated from the length of the service contract) or per train km is the most important parameter. It is, however, not realistic to *require* technological or energy efficiency standards in awarding procedures, which are not yet certain to be available on the market at reasonable prices and reliability. This could lead to the withdrawal of a tender and thus to considerable political, economical or legal problems. Therefore, the PTA has to differentiate between the minimum standards and advanced ecological standards. Experience shows that the requirement of ecological standards, which exceed the current regulations is generally accepted by the bidders. Also the better assessment of those bids with ambitious environmental standards in the bid evaluation is commonly accepted, if the tender documents give a clear and calculable picture on the assessment criteria and reflect, to a reasonable extent, availability, reliability and costs of the respective technologies.

In the technical sense there are mainly four ways of using criteria:

(1) Requirements

(2) Preferred options which can be encouraged by weighting

(3) Penalties if a defined quality is not realised during the contract duration

(4) Incentives for good performance or improvements during the contract duration

Requirements are criteria that the TOC or manufacturer need to fulfil as minimum standards in order to be qualified for the contract. The evaluation of a requirement is easier compared to the evaluation of incentives and weighting since the TOC either fulfils the criterion or not.

Tender responses with advanced ecological standards, compared to the mandatory requirements, may receive a higher scoring due to bonus points at the assessment ("preferred options"). These advanced ecological standards have to be monitored as well. The preferred options and the weighting system must be announced in advance.

Incentives and/or penalties are rather commonly used today in service contracts and usually include criteria like punctuality, growth in number of passengers etc. The argument for including incentives or penalties is to promote (or prevent) a certain behaviour. This could be a way to reduce energy consumption or to reduce the emissions from diesel vehicles.

The four ways of using EE/ENV criteria mentioned above should be considered for each single criterion. At the end of the elaboration phase the configuration of requirements, weighting, penalty and incentive schemes should be reviewed and finalised.

Part of the awarding documents is the request that the bidder has to prove the compliance of the offered vehicles with the required or agreed environmental standards (if the rolling stock is not provided by the PTA). This can be done e.g. by documented evidence of the vehicles to be used, by confirmation of the manufacturer that the vehicle technology is effective and limit values will be adhered to.

(For more details see chapter 6.4!)

Monitoring energy consumption

Monitoring the energy consumption is an important pre-requisite for strategic decisions of the PTA and for clear definitions of requirements, weighting and incentive schemes. Increasing energy prices are a risk for public finances. Thus the share of energy costs in Public Service Contracts (PSC) is relevant information for assessing these risks and to ensure sufficient

budgets for Public Transport in the future. Information about the real energy consumption on a particular line or network provides the baseline for identifying potentials and future improvements. Such a monitoring system is, of course, necessary, if an incentive scheme in terms of energetic performance is applied, but even if such an incentive scheme has not been achieved, a monitoring system should be applied in order to get better baseline information for the next contract period or the next award project. The monitoring system should include the relevant information which is also necessary for the definition of service profiles, like speed profile, gradients, ambient conditions etc. More information is given below in conjunction with the direct performance indicators.

Direct performance indicators

Direct performance indicators describe the overall result of all efforts to reduce the energy consumption of specific train services. Using direct performance indicators means that energy efficiency criteria are included in the awarding procedure without referring to a single technology or operational measures, although requirements, preferred options, penalties or incentives in terms of equipment and/or operational measures might be used additionally. A direct performance indicator shows the energy consumption of a traction unit in relation to a unit which refers to transport or operational performance. The unit of the enumerator is “kWh” (kilowatt hours) while the denominator is given as

- *passenger km*
- *seat km*
- *train km*
- *gross tonne km*

In most cases we recommend to use “kWh per seat km” or “kWh per train km”. The indicator “kWh per gross tonne km” can be appropriate when locomotives are procured or analysed independently from the train consists they are supposed to haul.

Using a direct indicator is more legally secure than referring to single technologies since thus there will be less risk for discrimination. The direct indicator can be used for the definition of requirements, “preferred options” (in this case: a desired level of energy consumption), penalty or incentive schemes.

In spite of their elegance, the use of direct performance indicators for the energy consumption implies some efforts by the PTA and some restraints have to be respected such as definitions regarding train configuration and interior design, side-conditions for simulation and verification; description of the network, technology and methods for monitoring, boundaries between traction energy, comfort functions and stand-by.

For more details see chapter 6.5!

Indirect performance indicators

The most relevant indirect indicator is “weight per seat”. The mass of a vehicle is especially decisive in regional passenger transport with its frequent stops and a high share of energy consumption for acceleration. The parameter "weight per seat" can be used for the procurement or description of passenger carriages for loco-hauled trains, especially when it is intended to procure or operate them independently from the locomotives.

For more details see chapter 6.6!

Financial and economical benefits

Energy costs are usually one of the financial burdens of a TOC. In spite of that there are some reasons why a PTA should additionally request energy savings when contracting out passenger rail services.

- There are some cases where energy costs are borne directly, at least partially, by the PTA and not by the TOC. In other cases energy is either not charged according to the real consumption (e.g. fixed percentage of the track access fee) or not according to market prices. In these cases the PTAs (or the society in general) would have to pay for the energy consumption directly or indirectly without appropriate incentives for the TOCs to reduce their consumption.
- Cost calculations of bidding TOCs focus on the first period (contract of usually 7-15 years) of operation. Increased investment costs for more energy-efficient technologies are only accepted by the TOC if they can be balanced by savings in this first period of operation. In the second and third contract period energy efficiency and energy costs will be worse than the state-of-the-practice of that time. This will be a financial burden for the collective of PTAs, especially if increasing energy prices are to be expected.
- Actual energy prices do not sufficiently reflect the urgency of climate protection nor future shortages of energy supply. Therefore additional investments and expenses for innovations today will prevent public transport from future cost risks. PTAs may accelerate innovations in terms of energy efficiency. This is reasonable with respect to the needs of transport, climate policy and preventing risks from public finances.

Reductions of the energy consumption are usually achieved by higher initial investment costs for new vehicle designs, special technologies or features of the rolling stock. Because of the reasons given above it is reasonable for a PTA to encourage such investments by offering a higher remuneration for the services or by financing such investments directly, e.g. in case of direct contracts or procurement of vehicles by the PTA itself. However, a PTA needs information which reductions or improvements can be achieved by additional payments. Also additional costs, e.g. for maintenance, have to be calculated. Main instruments for assessing the cost-/benefit ratio in terms of energy efficiency are:

- Life cycle cost analysis (LCC) for the whole vehicle or fleet
- Life cycle cost analysis for a special technology (feature, aggregate)
- Life cycle analysis of energy consumption.

In these Guidelines only rough assumptions for specific technologies can be given as providing more detailed information would rely basically on announcements of the manufacturer or assumptions on the future use. The benchmark will be what a manufacturer offers for fixing in a contract. Nevertheless, some basic information is available and some expectations are reasonable and are presented in the description of specific technologies in chapter 4.

For more details see chapter 6.8!

Relevance of single technologies and operational measures

Despite the relevance of direct performance indicators it might be reasonable to require or encourage specific technologies or operational measures in order to boost the innovation process or to cover areas which are not covered by the direct indicator(s) to be used. In these Guidelines a selection of such technologies and operational measures is presented, referring to the state of the art in 2010, which might be considered by PTAs to be required or encouraged as "preferred option" or by incentives. Furthermore, the analyses of these solutions can show which potentials exist, including considerations about costs, reliability and implementation time.

"Technologies" refer to the equipment of vehicles and the infrastructure, mainly the energy supply infrastructure for electric traction. These technologies typically require considerable investment costs while saving operation costs during the lifetime of the equipment or of the vehicles. In contrast, "operational measures" can usually be applied also to existing vehicles and infrastructure. Although in some cases investments are necessary (like energy meters or driver training), these initial costs are relatively low and there is no need to condemn existing vehicles. The most promising operational measure is energy-efficient driving. It has therefore a prominent role in the following descriptions.

Technologies (equipment of vehicles and infrastructure)

In this test version of the Guidelines four such technologies are highlighted:

1. Braking energy recovering by super capacitors on board equipment: Recovering energy when braking is already a standard feature of electric locomotives and EMUs. In spite of that, the recovered energy can often not be used efficiently because of timetable and infrastructure configuration. On board storage of energy is therefore an additional option. A further advantage is that vehicles with this technology may cover some distance without external energy supply. This technology is also an option (in the mid-term perspective) for diesel locomotives and DMUs to use recovered energy for traction. There are some competing technological options, but the analyses indicate that super capacitors are a promising technology, offered by several manufacturers.
2. Braking energy recovering by super capacitors in fixed installations: On some networks the operational situation does not allow the reception and immediate re-use of energy. For this reason, storage technologies, such as super-capacitors, could be considered and collocated in fixed installations near stations where many trains a day stop. These or other trains could reuse the energy in their starting phase or other use of this energy could be done. Although this technology would be part of the infrastructure and not of the rolling stock and thus not be a part of awarding services, it could be considered by a PTA under certain network conditions as an alternative to the respective on board equipment.
3. On-board use of braking energy in diesel-electric stock: Modern diesel locos or DMUs with electric power transmission can be equipped with the capacity to use some of the energy recovered during braking for auxiliaries (compressors, ventilation etc.) and comfort functions.
4. Control of comfort functions in parked trains: Parked passenger trains are often heated and lit all night. This consumes substantial amounts of energy. A possible solution is the development and implementation of an intelligent control tool for parked trains (e.g. pre-heating time of rolling stock as a function of external temperature, etc). Additionally, simple effective solutions include timers, manual control and instructions for maintenance and cleaning personnel. The energy consumption of parked trains is by definition not covered by direct performance indicators like “kWh per seat km” etc. and should therefore be addressed separately.

To ask for a specific technology is relevant when awarding services (rolling stock being provided by the TOC), and procuring rolling stock by the PTA. Quality and performance of these technologies can be described by specific performance indicators. Asking in a tender for specific technologies should be in compliance with European legal framework. It is not legally secure for a PTA to ask for a specific product or manufacturer of a technology. However, it is in compliance with the European legislation to require a technology if it is described functionally and leave it to the TOC or the manufacturer how to achieve the required or preferred performance values.

Within a competitive tendering procedure technologies could be asked for as requirements or as preferred solutions. Different solutions for similar technologies could be evaluated using specific performance indicators or a Life Cycle Cost (LCC) approach. In order to ensure a reliable basis for calculation for the TOCs (and manufacturers), it is advisable to provide them with information about the characteristics of the services.

In the sixth chapter, the economic and technological potentials of the highlighted technologies are described based upon effects on implementation, operational, maintenance and disposal cost, which could serve as guidance for selection and assessment. In general, innovative technologies and technologies, the reliability of which is still to be examined, should not be required but could be encouraged by qualitative criteria or incentives. A precondition is that the manufacturer accepts to guarantee a high level of reliability and a reasonable maximum level of maintenance and operational costs.

For more details see chapters 6.9 and 6.10!

Energy-efficient driving and driver training

Energy-efficient driving can reduce the energy consumption of trains significantly (5-10 %), provided that there is some spare time in the timetable and the reliability of operations allows the use this spare time regularly. Coasting, reducing maximum speed, using valleys and hills are the main elements energy-efficient driving styles. Eco-driving is a cheap and effective instrument which can be implemented and facilitated by low-tech measures and training programmes. The results of energy-efficient driving go into the overall energy consumption of the operation and shall thus be analysed by direct performance indicators. When awarding services the PTA may require or encourage assistance devices and a training concept as well as specific performance values for the training programme. A programme for energy-efficient driving should always be accompanied by an effective penalty/incentive system for punctuality.

In general operational measures like energy-efficient driving are legally secure to include in awarding. In order to be in compliance with the non-discriminative principle within a competitive tender procedure, the tendering document needs to include a description of the characteristics of the lines and services thus enabling the bidders to estimate the potential of energy efficient driving. In some countries the safety authorities may raise objections against certain driving advice systems because of safety issues at the driver's desk.

For more details on operational measures see chapter 6.11!

Noise emission

Noise emission has become a major problem for railway operations, today even including regional passenger services. The Environmental Noise Directive (END, 2002/49/EC) requires strategic noise maps in agglomerations and along major railway lines. Authorities must develop noise action plans if certain noise immission limits are exceeded. PTAs are likely to be involved in noise action planning and noise abatement measures for railway operations. Since 2006 a EU-regulation about the noise emission of conventional railway vehicles has been existing, the TSI Noise (2006/66/EC, L 37/1). Although this regulation formally only effects the interoperable network, regional passenger trains which run on this network must comply with the TSI Noise requirements. The TSI Noise defines noise emission values for new vehicles, differentiated as start-up noise, pass-by noise and noise at standstill, and also defines a methodology for measuring these emission values. PTAs may apply this methodology and require or encourage limit values according to the TSI, stricter or less strict (in case that old vehicles are accepted if they reach at least a certain standard). The PTA may use noise limit values as requirements, preferred options or using incentives for modernisation. As noise abatement by refurbishment of vehicles can be quite costly,

relevance and ambitions in terms of noise abatement should be weighted against the remaining lifetime of the existing rolling stock and other options of noise abatement. Besides the noise values which are regulated by the TSI Noise, regional railways may have problems with curve squealing and noise in stations.

Generally speaking, the additional costs of silent vehicles when being procured as new are reasonable. Also refurbishment of existing vehicles can be successful but costs depend heavily on the actual vehicle design and the target values. The PTA may apply incentives so that e.g. silent vehicles are used more intensively than loud ones, especially at night.

For more details see chapters 5.9 and 6.14!

Pollutants

The emissions of Nitrogen oxides (NO_x) and particulate matters (PM) are the main pollutant issue of railway diesel operations. The EU Air Quality Directive (2008/50/EG of 21st May 2008, OJ L 152/1, incorporating previous legislation) requires action by the authorities if certain immission values are exceeded. While particle immissions have broadly been being discussed since 2005, NO_x immissions may become at least as relevant in the near future. Both matters can cause serious health problems. Diesel tractive units of railways contribute to the problem and PTAs can take action on this problem by using one of mainly three options:

(1) electrification of lines

(2) reduction of energy consumption

(3) encourage the use of motors which fulfil advanced emission norms.

Options (1) and (2) are in line with general strategies for reducing energy consumption. With respect to option (3), for new vehicles or replacement engines the requirements of “stage IIIb” as defined by Directive 2004/26/EC are compulsory. “Stage IIIb” will be compulsory from 2012 onwards and may be used as a benchmark even before. PTAs may require or encourage the use of locomotives or DMUs which fulfil advanced emission values, re-motorisation of existing vehicles, the application of particle filters and catalyst aggregates, or the preferred use of “clean” vehicles in case of a mixed fleet.

For more details see chapters 5.8 and 6.13!

Finalisation of criteria, prioritisation, and weighting scheme

The main duty in phase B “Elaboration” is to select, to define and to prioritise the relevant EE/ENV criteria for the award project in question. The evaluation criteria, as well as their relative weight or calculation algorithm, have to be clearly defined in the awarding documentation. The evaluation factors must have a concrete connection with the specificity of the contract and have to be conclusive for evaluating the technical proposal.

It is recommended that apart from the price, the contracting authority takes also the life cycle costs (LCC) in consideration which are the costs related to servicing, maintenance, operational costs (energy/fuel consumption, spare parts, consumables) or costs related to demolition, dismantling or elimination of emissions/wastes.

A weight has to be assigned to each evaluation factor so as to adequately reflect:

- the importance of the technical or functional characteristic considered as representing a qualitative advantage in comparison to the minimum requirements, and which can receive supplementary points as compared to this minimum level; or,
- the value quantum of financial advantages that the PTAs can offer by undertaking additional commitments as compared to the minimum requirements foreseen in the Technical Specification.

After the relevant criteria have been selected, a review should be done in order to avoid contradictions and redundancies. Before an ITT is published, it should be checked whether all criteria are well defined in terms of evaluating the offers and monitoring the real-life performance. From this perspective the phases C to G of the reference awarding model need to be forecasted and projected already in the elaboration phase.

The assessment of the bids also includes the prices and the compulsory ecological standards depending on the requirements and weighting scheme defined in the tender document. As a result the most economical bid (in terms of cost-performance ratio) is accepted. It is important that the accepted tender not necessarily is the cheapest tender in terms of the "real price". If a tender wins many bonus points due to its advanced ecological and quality standards it may perform better in the assessment than cheaper tenders. In order to ensure a fair and transparent assessment of the offers, a scoring model or matrix should be developed. This model has to include all relevant criteria and their final weighting.

For an evaluation criterion to be legally secure, the calculation method, including score system, needs to be described in the tendering documents.

To fulfill the European principle of transparency requirements, weighting schemes used for the evaluation of tenders and incentives/penalties need to be defined in awarding documents as well as in the public service contracts including the method for their calculation. Also, in order to be in compliance with the European legislation, it is important that bonus and penalty levels are proportionate.

Weighting schemes may widely differ according to the individual needs of PTAs. Therefore in these Guidelines are only some examples and general advices given how weighting schemes and priorities could reasonably defined.[3]

For more details see chapter 6.16!

Publication of tender documents / timeframe

In case of competitive tendering the PTA has to publish the tender-documents in the Official Journal of the European Union. In addition to the specification of services and the assessment criteria, the tender floating period and the bid adjudication period are part of the publication. PTA should consider that depending on the required or desired environmental standards, bidders might need additional time for preparing their offers with respect to these standards. The latter also applies to direct awarding procedures.

For more details about the timeframe see chapter 3.2!

[3] In 4.15 we can provide examples which have been used by TSY and VBB. In the final version more examples from the test sites might be included.

4.3.3 Phases C to E – Response to tender, evaluation and awarding, negotiations

Main awarding phase:		Main associated actions at PTAs:	Actions at PTA concerning energy efficiency and further environmental criteria
C	Response to tender / quote request	Mainly bidding operators to work; PTA to answer bidders' questions	• Responses to bidders' questions for clarifications; forwarding the information to the other bidders. • Receipt of offers
D	Evaluation and awarding	Evaluation, decision and justification; communication of the result	• Evaluation of offers in terms of EE/ENV criteria • Assessment whether the selected offer is realistic and reliable in terms of environmental performance
E	Negotiations	Further negotiations and specifications; preparation of the contract	• Definition of more detailed specifications if necessary • Definition of verification and monitoring procedures if necessary • Detailed definition of incentive or bonus / penalty regimes according to the performance offered by the bidder

In the remaining phases, the inclusion of EE/ENV criteria, does not bring any major changes compared to a "regular" awarding process, and at least from the perspective of the PTA, the major steps within these phases follow the same principles regardless of the EE/ENV criteria. How to evaluate the EE/ENV criteria is also defined in the elaboration phase. Therefore the following phases are described in less detail compared to the previous phases.

In phase C ("Response to tender / quote request") it is the bidders' duty to compile their documents and calculate their offers according to the requirements and information provided by the PTA. The PTA may be asked for additional information, especially if EE/ENV criteria are a new feature of awarding procedures in the respective country. In a competitive tendering procedure the PTA is allowed to answer such questions provided that all competing bidders get the additional information.

In phase D ("Evaluation and awarding"), the first step for a PTA is to check whether the mandatory requirements (as defined within the elaboration phase) are fulfilled by the received offers. The next step is a preliminary quantitative evaluation of tenders (on the basis of the prioritization of criteria made before-hand). The results should be compared with pre-calculations of the PTA. Before the final evaluation and ranking of the offers unclear and not plausible data should be checked e.g. by questions to the bidding TOC or manufacturer.

After the validation of evaluation and ranking the operator can finally be chosen, the decision can be confirmed by the responsible bodies of the PTA, and the result of the tender can be published.

Basing on the offers and the criteria in the tender documents, a concept for the verification of EE/ENV data should be agreed upon by the successful bidder and the PTA. This concept could include field tests if necessary (see phase F).

It is important to note that within a competitive tendering procedure it is not legally possible to basically change the object of awarding. However, based upon results from questions from

the TOCs, some changes, dealing with the service and its organisation (operational, legal), may need to be taken into consideration. In some cases additional negotiations (phase E) might be necessary, as minor modifications and additional specifications might be needed. This could especially be the case when the PTA has asked the bidders for their individual concepts e.g. for environment-related improvements. The result of the negotiation with one bidder has to be circulated to all preferred bidders. In some countries, such negotiations within a competitive tendering procedure, are prohibited at all by national law.

In case of direct awarding or in-house provision, phases C, D and E do not need to be separated. Additional rounds of negotiations or consecutive decisions on single criteria are an option.

Advices how the offers can be evaluated with respect to the single EE/ENV criteria are part of the detailed description of the criteria (see chapter 6).

4.3.4 Phases F and G – Preparation of contract period, follow up during the contract period

F	Preparation of contract period	Verification of performance with selected operator; preparing of monitoring	• Verification of environmental performance (especially of vehicles) as far as it is possible and appropriate before starting the operation • Test runs for the verification of energy consumption
G	Follow up during the contract period	Monitoring and bonus / penalty awards on annual basis	• Monitoring of real-life energy consumption / environmental performance (application of bonus/penalty if necessary) • Verification and monitoring of operational measures • Verification measures as in phase F if further procurement or refurbishment is foreseen during the contract period • Verification and monitoring if environmental performance is affected by maintenance or vehicle quality • Identification and overcoming of obstacles for better environmental performance (in co-operation with the bidder when appropriate)

Between the final award decision and the start of the operation, the data which have been offered or guaranteed by the bidder (TOC or manufacturer) should be tested and verified. In some cases field tests might be necessary. Afterwards the results must be validated and agreed upon by the PTA and the bidder. The PTA can check whether the results comply with the specifications and requirements.

Depending on the criterion and the verified data, corrective actions might be taken into consideration (in case of non-compliance). The first reporting scheme can be established and the incentive/penalty scheme(s) be set in force if applicable.

During the contract period, i.e. after start of operation, further verifications, validations and compliance checks should be done according to the tender specifications and/or the agreements between PTA and TOC. This applies especially to criteria which have to be fulfilled or reported continuously such as energy consumption, training schemes etc. Depending on the criteria, results and agreements before, the penalty and incentive schemes will be applied. Corrective actions are needed if requirements are not fulfilled.

Advices how the performance can be evaluated with respect to the single EE/ENV criteria are part of the detailed description of the criteria (see chapter 6).

5 EE/ENV issues to be considered for the strategy and phase A "Preparation" (detailed description)

5.1 Political and economical relevance of saving energy and environmental criteria in passenger rail transport

There are several reasons why energy efficiency and other environmental criteria are an important issue for PTAs.

(1) Climate policy: The transport sector contributes largely to the emission of CO_2 and other greenhouse gases. In case of passenger transport, the railway emits less CO_2 thank e.g. the private car with a factor between 2 and 4, depending on the concrete technology, the occupancy, and the energy mix in the catenary. Thus modal shift towards the railways is an important means of climate policy. For this purpose it is indispensable to improve the quality and the image of railway services. Improved energy efficiency is a good argument to convince new passengers and also by this way a contribution to climate protection.

But also the railways themselves can become more efficient in terms of energy consumption and CO_2 emissions. Reducing CO_2 emissions of the railways directly contributes to climate protection.

Noise emissions have become a major obstacle for extension and upgrading of railway infrastructure. Therefore the abatement of railway noise emissions is, at least in some regions, necessary in order to accelerate modal shift or to make it possible at all.

(2) Risk for public finances: Regional passenger rail transport is in all European countries partially financed by public budgets. To provide public transport services is an important duty of governments and administrations because such services are a prerequisite for keeping modern societies in function. In spite of their positive role in the protection of the environment even the railways have a negative impact in terms of pollutants and noise. These impacts may imply risks for the public finances, even in the short-term perspective, when they are not tackled by effective measures. These risks may a. o. arise from the Environmental Noise Directive and the Air Quality Directive which force the governments to develop and execute plans for the abatement of noise and pollutants and may even provide vested interests to citizens in the neighbourhood of roads and railways to claim protective measures (see chapters 5.2, 5.8 and 5.9).

Rising energy prices (due to supply shortages and increasing prices for CO_2 emission rights) provide another risk for public finances. The costs of railway operations will increase. Although at first the TOCs pay for the energy consumption, depending on the contract and the institutional framework, at the end of the day the increased energy bill will to a great extent be paid by public budgets.

(3) Insufficient price signals: Although usually the energy costs should be borne by the contracted TOC, there are several reasons to justify that the PTAs influence the energy consumption by additional requirements and incentives even if this meant additional investment costs at the beginning:

- In some cases energy costs are borne directly by the PTA and not by the TOC; in other cases the energy costs are borne by the TOC but the PTA has to pay for the increase of energy prices during the contract period.
  In these cases the PTA has an immediate interest to reduce the energy consumption .
- In some networks of the European railways the consumption of electric traction energy is not charged according to the real consumption but e.g. as a fixed percentage of the track access fee.
  In these cases the PTA has an immediate interest to get more transparency about

the real energy consumption but also to reduce the energy consumption in order to lower the costs for the services in the future. Even if such institutional changes cannot be achieved, the political responsibility of the PTA in terms of energy security and climate protection remains.

- Actual energy prices do not sufficiently reflect the urgency of climate protection nor future shortages of energy supply. New railway vehicles will usually last for three or four decades. If their energy consumption is high, this will cause future additional costs either in form of high operation costs or because of an early replacement of the fleet.
  Although the later periods may seem to be out of the scope of an actual PSC, the same or other PTAs will then have to deal with the sub-optimal rolling stock. Therefore, reasonable additional costs for more energy-efficient vehicles should be accepted. In case of a PSC with a TOC that provides the rolling stock itself, these additional costs will usually be charged as additional operation costs (e.g. ct per train km). If the PTA procures and provides the fleet, this means additional investment costs but reduced operational costs. In the latter case it means also risk reduction for the PTA in terms of future usability, residual value and lifetime of the fleet.
- Cost calculations of bidding TOCs focus on the first period of operation (usually not more than $^1/_3$ of the vehicle's lifetime). That means that increased investment costs for more energy-efficient technology are only accepted by the TOC if they can be balanced by savings in the first period of operation.
  If the PTA gives additional incentives like e.g. a bonus per train km or additional scores at the assessment of bids, the amount of acceptable investment costs will be increased with the PTAs and the society gaining the revenues in later periods.

(4) Protection of the population: Inhabitants and people working in agglomerations or in the neighbourhood of busy railway lines suffer from pollutant and noise immissions. The protection of the population is a duty of PTAs as part of the overall government administrations. This is a reason why the PTAs may influence the pollutant and noise-related quality of rail passenger services. The respective EU regulations (TSI Noise and "Non-road directive", see chapters 5.8 and 5.9, 6.13 and 6.14) are almost only valid for the authorisation of new vehicles and may therefore not suffice to meet the requirements of air and noise protection. It is questionable whether and to what extent stricter authorisation requirements would be technically or economically feasible, but there is room for decisions like modernisation of existing vehicles, allocation of "better" vehicles to lines with the most serious environmental burdens.

(5) Innovation and backing for the railways: By using EE/ENV criteria the PTAs can trigger the railways' innovation process. This would be a very helpful backing for the railways in terms of their reputation, modernisation and prominent role in transportation policy. The PTAs may help to overcome market barriers for new technologies and positively influence the future innovation process in terms of energy efficiency and environmental effects.

(6) Ease of infrastructure development: The construction and the financing of new or enhanced railway infrastructure may be eased if more silent vehicles are used. Costly investments for noise protection can be reduced or avoided at all. Political resistance against new lines may be avoided. Thus more silent passenger trains simplify the way towards modal shift.

The relevance of the aspects given above may differ from region to region which can be reflected by the relative weights of the criteria proposed in chapter 6.

5.2 PTAs as actors of environmental policy: implications of new developments in the EU immission law

The national and regional governments of the EU Member States take action, although to different extents, on environmental issues in order to protect the population from negative impacts on their health and living conditions. The abatement of noise as well as of gaseous and particulate pollutants is at this of prominent relevance. Public Transport Administrations are entrusted by the governments with political duties and responsibilities in the field of transport policies. In many cases these activities are already seen as connected with environmental policy in terms of modal shift and the reduction of emissions of the transport sector. This involvement may be intensified in the future a. o. because of new developments in the EU immission law.

The European Environmental Noise Directive provides a new approach of noise abatement. The directive 2002/49/EC from July 25, 2002[4] requires authorities and member states in certain regions to measure and map noise pollution as a public service. Noise action plans are to be drawn up based on these assessments. The level above which noise pollution action plans have to be drawn up has to be decided upon by the member states. The railways (and the PTAs) should assume that where railway traffic significantly contributes to noise pollution, they will be required to limit the use of noisy railway vehicles or to take measures alongside the infrastructure. These requirements could be imposed in different ways, legal, political or regulatory. Thus the PTAs may not only become actors of environmental policies of the government but also addressees as they are, at least partially, responsible for the environmental performance of regional passenger services. Noise-differentiated track access fees and noise ceilings which might be invented by the infrastructure manager because of noise action planning could cause additional operation costs.

The EU Air Quality Directive (2008/50/EC of 21st May 2008) stipulates EU-wide limit values for the concentration of certain harmful pollutants.[5] The concentration of these pollutants should not exceed certain values or not more often than on a specified maximum number of days per year. Additionally, limits for yearly averages exist. Since 2005 such limits have already been valid for particulate matters (PM_{10}). From 2010 onwards similar limits for nitrogen oxides (NO_x) are applied. For particulate matters of very small size ($PM_{2,5}$) target and limit values (yearly averages) are defined for 2010, 2015 and 2020. If the local concentration of one or more of these pollutants exceeds the limit values, the authorities will have to take systematic measures for the permanent reduction of pollutants (air quality planning according to art. 23 of the Directive). As with the Environmental Noise Directive, PTAs may become both actors and addressees of air quality planning.

Further action and legislation on the European level can be expected. The Community pursuits the following goals with regard to the common environmental policy according to art. 191 par. 1 EEC-Treaty:

- The conservation and protection of the environment and the improvement of its policy;
- The protection of human health;
- The sustainable and rational use of natural resources;

[4] Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise

[5] The Directive 2008/50/EC replaces the Directive 1999/30/EC of 22nd April 1999. Some terms of the previous directive, including the limit values which have already been valid since 2005, are still valid for a transition period.

- The promotion of measures to solve environmental problems on a regional or international level.

The environmental policy of the Community is targeted on a high level of protection and is based on three guiding principles:[6]

- Precautionary Principle;
- Abatement of environmental impairments prior at their source;
- Polluter-Pays-Principle.

To achieve their goals, the Community applies Environmental Action Programs which determine the basic targets of the common environmental policy, taking into account the guiding principles. Different legislative measures, i.e. directives and regulations (currently 668) result from those Environmental Action Programs.

However, the Member States play usually a crucial part in the implementation of the guidelines of the Community, regardless of the character of the guidelines as regulation or directive. Attention has to be paid to the fact that “energy-efficiency” is not an independent policy field of the EC but rather part of the common environmental policy of the Community.

5.3 Basic decisions of PTA which could influence energy efficiency and environmental performance of rail passenger services

Besides the criteria which will be described in the 6th chapter of these Guidelines, there are some basic decisions (or fields of action) of PTAs which can have a major influence on the energy efficiency and the environmental performance of rail passenger services:

Quality of infrastructure (tracks, management of operations): Braking and accelerating for slow orders and stops which are not necessary for taking or releasing passengers have a negative impact on the energy efficiency. Such braking should be avoided by improving the infrastructure (elimination of slow orders, removal of level crossings, construction of flying junctions) and the implementation of management systems for train operations which allow to anticipate train path conflicts. Thus train drivers can be advised to reduce the speed in order to avoid stops and to reduce the energy consumption. The improvement of infrastructure and operations as described above has also a positive influence on the emission of pollutants and noise.

Integral Regular Timetable (ITF): The Integral Regular Timetable is the most successful timetable concept, especially for polycentric countries and regions. The idea is that all trains stop at defined nods shortly before minutes '00 and/or '30, release and take passengers to and from connecting trains and depart shortly after the respective minutes. Everywhere where such a timetable has been introduced, the number of railway passengers has increased substantially. Thus Integral Regular Timetable is very successful in terms of modal shift towards public transport, improving the occupancy of trains and by both effects avoiding energy consumption of the transport sector in general. One problem for the energy efficiency of the railways is that most trains brake or accelerate at the same time. That means that energy which is recovered when braking and fed into the catenary cannot be used by other trains and will be wasted as heat. Therefore the use of energy storage systems in fixed installations should be considered and maybe encouraged by the PTA.

Spare time: Spare time in the timetable is a decisive factor for both punctuality and the success of eco-driving. A spare time of 2 % allows for a reduction of energy consumption of up to c. 20%, depending on type of traction and operations. As usually the PTA defines the timetable concept before tendering or awarding the services, it decides about the saving potential. If the bidding TOCs are to propose timetable concepts on their own, timetabling

[6] See art. 191, par. 2, subsection 1 of the EEC-Treaty.

with a certain percentage of spare time could get additional scores. High velocity of travel should, however, remain the overall guideline for the timetable.

Stops on request: On branch lines or in rural areas stops on request are an option for accelerating services and reducing energy consumption, pollutants and noise. When applied stops for passengers at intermediate stations will be needed randomly so that the scheduled travel time can be reduced without refusing passengers from that areas. In some countries signalling systems exist which can be used by waiting passengers and tell the driver to stop. If there is no passenger, no energy is wasted for braking.

Weakening and strengthening of trains: On lines or networks where the occupancy of trains differs very much between rush-hour and other times or between "inner" and "outer" stretches of some lines, it is advisable to weaken or strengthen trains during the day on intermediate or terminus stations. Timetable concept and vehicle specifications should allow or encourage such manoeuvres, i.e. automatic couplers of self-propelled trains instead of screw couplers and shunting of coaches.

Avoiding of empty running trains: When a train runs empty, it means waste of energy and not to offer additional occasions for passengers to travel. Timetables with regular intervals usually provide good options to avoid empty running. PSCs should allow for some flexibility if the maintenance facilities of the awarded TOC are situated within in the scope of a third TOC. Thus empty runs because of regular maintenance could be avoided.

Vehicle concept: When a PTA is specifying the features of rolling stock to be procured or used by an awarded TOC, it should be aware of some general advantages and disadvantages of vehicle concepts in terms of energy efficiency and noise. It should be clear though that the decision for a particular service concept does not only depend on ecological considerations. The following table focuses on pros and cons in terms of EE/ENV criteria. Other considerations, e.g. in terms of maintenance and operation in general are neglected.

Table 5-1: Pros and cons for certain vehicle concepts in terms of EE/ENV criteria

Type of rolling stock	Pros	Cons	Cons may (partially) be balanced by ... / because of...
Railcars / multiple units (compared to loco-hauled trains)	• Better weight per seat ratio in case of short trains • Better ratio of energy recuperation when braking • More even distribution of axle loads (positive effect on reducing noise emission)	• Less flexibility for adapting train length to needed capacity	• If train consists of more than one MU can be coupled together or separated in very short time, flexibility can be similar to that of loco-hauled trains.
Double-deck trains (compared to single-deck trains)	• Better weight per seat ratio. • Smaller no. of axles per seat/train length means less sources of rolling	• Higher minimum capacity (may exceed traffic demand on some train runs). • Higher weight per train length may	• Single-deck trains may have lower noise levels but for a longer time than double-deck trains, if offering

	noise.	cause higher noise emission levels per train length (transit exposure level).	the same capacity. Thus average noise levels may be similar.
Articulated trains	• Better weight per seat ratio. • Smaller no. of axles per seat/train length means less sources of rolling noise.		
Single axles instead of two-axle bogies	• Better weight per seat ratio • Smaller no. of axles per seat/train length means less sources of rolling noise.	• Good concept for steering axles is needed in order to avoid noise and additional rolling resistance, especially in curves.	

The comments of the table above are only general advices. In chapter 6 of these GL some indicators and criteria are presented to compare even classes of rolling stock of different concepts. However, vehicle concepts with advantages in terms of EE/ENV criteria should not be excluded without good reason.

Electrification: Electrification has several inherent advantages compared to diesel operations when it comes to EE/ENV considerations:

- The traction equipment is lighter, especially because it is not necessary to transport the fuel on-board of the train.
- Electric trains can recover energy when braking and reuse it when accelerating; reliable solutions for this purpose are not yet available for diesel operations.
- The catenary may be fed with electric energy from renewable sources such as solar, wind or water energy, thus avoiding CO_2 emission to a great extent or even at all.
- Local pollution is almost 100 % avoided.
- Noise emission can be reduced (although not in every situation).

Electrification of lines could be a good alternative to the procurement of e.g. low-pollution diesel vehicles. On the other side, if electrification of a line or network is considered, this has got implications for awarding projects, e.g. duration of the contract, vehicle specifications, fleet strategy etc.

Diesel under wire: When diesel trains run under wire, the inherent advantages of the electric traction are denied. PTAs should clearly request that the awarded TOC uses electric trains on electrified networks. If the PTA accepts some flexibility, the TOC might be encouraged by incentives to use electric trains. Reasons why some flexibility would be appropriate in terms of "diesel under wire" can be:

- Provision of through trains for passengers, thus avoiding changes of trains

- Regular connections to the TOC's maintenance facilities
- Additional capacity during rush hours
- Spare trains for exceptional cases or in a pool of spare trains for both electrified and diesel networks.

5.4 Different methods of awarding services and vehicles by the PTA

EE/ENV criteria can, from the PTA's point of view, be included either in the Public Service Contract or in the procurement specifications of vehicles. How to include EE/EF criteria will therefore depend on the following situation:

1. Awarding of services, rolling stock provided by TOC
2. Awarding of services, rolling stock provided by PTA
3. Awarding of rolling stock by the PTA
4. Awarding of rolling stock by the TOC

Although the case of number 4 is not within the main scope of the ECORailS project, some of the examples covered in case 3 are of course relevant also when TOCs are procuring vehicles. Options to include environmental criteria when awarding rolling stock, from a TOC's perspective have also been well covered by the PROSPER project.

In general, the PTA as a contracting authority has procurement autonomy. This means that it is basically free to determine the requested scope of performance as long as direct and indirect discrimination does not occur while transparency and equal treatment are ensured.

In case of competitive tendering and depending on the national legal situation, there are more differentiated options for the process, e.g. restricted processes, competitive dialogue (with negotiations between the PTA and bidders selected to their preliminary offers).

In case of direct awarding or in-house provision the negotiations between the PTA and the chosen operator (TOC) or manufacturer are essential (see phases C, D and E of the reference model, chapter 4.3.3). Due to the lack of comparability of different offers the PTA has to enforce its interests and demands primarily during the negotiation process.

The differentiations mentioned above may have their reason according to specific circumstances in the respective countries or regions. When it comes to EE/ENV criteria, the main advantages and disadvantages of tendered and negotiated procedures are shown in the following table:

Table 5-2: Advantages / disadvantages of competitive tendering and direct awarding in terms of EE/ENV criteria

	Competitive tendering	**Direct awarding**
Pro:	• Functional approach • Open for ideas of bidders • Problems with one criterion may be outweighed by good result with other criterion	• Results may better fit to specific situation • Flexibility, to certain extent even after signing the contract • Innovations with mid- or long- term implementation time are feasible.
Con:	• Certain inflexibility • Results difficult to forecast • Restricted timeframe	• Result depends on bargaining power of PTA • External (better) ideas may be ignored

In case of competitive tendering, an early EU-wide public announcement can be made. This is not binding; however, the public announcement can be used for information about the desired EE/ENV standards of the offers.

5.5 How to charge energy costs

In terms of transparency and efficient patterns of incentives to reduce the energy consumption, the best solution would be if the TOCs paid their energy according to the real consumption and market prices. Especially for electric operations on the national networks, this situation has not been achieved yet. Energy meters and transparent billing systems are available at present while problems with international harmonisation may still exist.

The following inappropriate or at least sub-optimal situations for charging the energy consumption of regional passenger trains have been identified by ECORailS partners (some examples even applied to diesel operations):

- Consumption of electric energy for traction is charged as a fixed percentage of the track access fee, not regarding the real consumption;
- Energy consumption is known but energy costs are directly borne by the PTA (great share or even 100 %);
- Energy consumption is known to the PTA and paid for by the TOC, but the PTA has to pay for all increases of energy prices;
- Energy consumption is not known to the PTA and paid for by the TOC. The PTA has to pay for all increases of the energy consumption, based on a fixed percentage which refers to an agreed or negotiated assumption about the share of energy costs of the overall operational costs.

The examples show that in a lot of cases the risk of increasing energy prices is borne by public budgets while the incentives for the TOC to save energy are limited. It is clear that the weight, which should be given to energy efficiency criteria in awarding projects, may depend on the institutional situation which is relevant for the respective network and the inherent incentives. When preparing an awarding project the PTA may analyse the institutional situation in terms of energy supply and charging of energy costs, and whether there are options to improve the situation before the start of the new operation or at least during the contract period.

5.6 CO_2 emissions; renewable energy

Besides the need to reduce the energy consumption because of future shortages of fossil fuels, climate protection has become urgent. Therefore the reduction of CO_2 emissions should be a prominent objective of PTAs when awarding passenger train services.

The electric traction allows to use energy from renewable sources such as water, wind and solar. The energy mix in the catenary differs from country to country. For example in Denmark, Sweden and Norway electric trains run with a great share of energy from renewable sources, due to the geographic advantages and the energy policy of these countries.

PTAs (and TOCs) can push forward the use of renewable sources when they are willing and able to achieve contracts for the traction energy supply with a high share (up to 100 %) of "green power". The bargaining power depends on the organisation of the rail energy supply, the national energy market and the availability of "green energy" in the respective country. Clear rules for direct contracts between a TOC and an energy supplier which is independent from the infrastructure manager (IM) usually do not exist yet. So the possibility to use electricity from renewable sources depends on the good-will and the possibilities of the IM. In spite of that, such contracts already do exist, e.g. in Denmark and might be achieved in other countries as well. Within regional networks it might be easier to achieve direct contracts between TOCs or PTAs and provider of eco-electricity.

In any case, using electricity from renewable sources would be an important signal to the public and to the passengers in favour of the positive role that the railways can play in climate protection.

For non-electrified lines the situation is somewhat more difficult. EMUs equipped with batteries for service on branch lines might be a future option, thus enabling TOCs to use energy from renewable sources on non-electrified lines. Hybrid vehicles with combined diesel and electric propulsion would allow reducing the consumption of fossil fuels when operating direct trains between electrified and non-electrified lines. These options should therefore be considered when defining vehicle and operation specifications for such networks.

The use of hydrogen (fuel cells) and biogas has already been tested in railcars for regional passenger services. For these types of fuels a (regional) supply infrastructure is needed and these technologies could be an option within regional innovation and development projects. Biogas is a side product of agriculture and can be used similarly to natural gas. It is therefore "CO_2-neutral". Biogas engines also pollute much less particulate matters (PM) and NO_x than conventional diesel engines. With hydrogen there is absolutely no problem with PM and NO_x emissions, as far as the vehicle operation is concerned. Its effects on climate protection depend on the technology the hydrogen is produced with. It may be an option to use the production of hydrogen as a buffer for temporary surplus electricity from renewable sources like wind energy and then use the hydrogen for railway operations.

The use of agrofuel like vegetable oils is not highlighted by the ECORailS project as a means of CO_2 reduction because it is questionable whether such "biofuels" really contribute to climate protection if the whole upstream process is considered. Agrofuel agriculture may also have serious impacts on the global food supply. The effects on the climate and food supply, as well as the applicability for railway operations of "second generation" agrofuels is not clear yet either.

5.7 Energy efficiency: State of the art, economic aspects, present and foreseen trends

[This sub-chapter will be added in an update version. See also Deliverable 7 ("Integration of technological feedback from the User Platform and the consortium into the guidelines")]

(...)

5.8 Pollutants: legislation, state of the art, economic aspects, present and foreseen trends

When a PTA is preparing an awarding procedure which includes non-electrified lines, the relevance, the present situation, and the potentials for improvement should be assessed.

The most relevant matters which diesel engines emit are particulate matters (PM), nitrogen oxides (NO_x), carbon monoxide (CO) and hydrocarbons (HC). All of these matters may cause serious health problems, but PM and NO_x are the most prominent ones. Therefore the EU Air Quality Directive focuses on PM and NO_x concentrations in populated areas. Pollutants of diesel operations should get a relatively high relevance in the awarding project, if one of the following circumstances is given:

- The operations serve a densely populated area or an area with a lot of pollution caused by industrial production, ports or road transport;
- The operations serve an area with high air quality and this is to be protected;
- There are covered stations or stations in tunnels which are served by diesel trains;
- There are railway lines or marshalling yards which are heavily used and operated by diesel locomotives.

The relevance for criteria concerning pollutants should especially be high if the area to be served will be subject for air quality planning because of exceeded immission limits.

The present situation is mainly defined by the emission standards the diesel locomotives and DMU fulfil at present. Until 2003 there were no international regulations about the emissions of railway tractive units except for recommendations by the International Railway Union (UIC). These recommendations became binding for the member railways. Since 2006 new emission limit values for locomotives and DMUs have been invented step by step by EU regulations. These limit values apply to all new vehicles as well as to replacement engines. Usually actual figures about the real emissions from railway diesel engines are not available, but information about the norm which is fulfilled should be available. It is important to mention that not the age of the vehicle is decisive for its emission standards but the age of the motor which can be much younger.

Improvements of the emission standards of the diesel tractive units can mainly be achieved by encouraging the use of or requiring new locomotives or DMUs, by replacing the engines, or by additional aggregates like particle filters which reduce the emissions significantly.

In a more general view, saving energy at diesel operations, especially by operational measures, lightweight construction or energy recovery when braking, may reduce emissions proportionally. Electrification is also a means of reduction of pollutants but cannot be done everywhere.

It should be stated, however, that avoiding pollutants by new concepts for the internal combustion process or exhaust gas after-treatment causes significant increases of the energy consumption due to technical necessities.

DMUs which fulfil the European "Stage IIIb" standard are already available and being used in every-day operations. Heavy diesel locomotives (more than 560 kW rated power) only exist as prototypes so far.

5.9 Noise: legislation, state of the art, economic aspects, present and foreseen trends

[To be added later on, in conjunction with update of chapter 6.14.]

5.10 Good-practice examples

There are already some examples of good-practice in terms of making regional passenger transport in Europe more energy-efficient and environment-friendly. Such efforts effect e.g. noise emission limits for vehicles which were prescribed by the PTA, enhanced standards for emissions from diesel operation, the use of renewable energy or calculations of the life-cycle energy consumption of rolling stock. These outcomes were used during the elaboration of the Guidelines, and several good-practice examples will be presented on the homepage of the project (www.ecorails.eu).

When a TOC procures new vehicles, energy efficiency requirements for rolling stock are already standard although not necessarily basis of the decision to purchase a given vehicle or not[7].

[See also Deliverable 10 ("Integration of legal and economical feedback from the User Platform and the consortium into the guidelines").]

[7] Railenergy, SP1 Results report – WP1.1, 1.2, 1.3 Final report, Draft version

6 Detailed description of criteria, including legal aspects

The following issues are relevant for the inclusion of EE/ENV criteria in the awarding procedures by the PTA:

- how to insert the new specifications referring to EE/ENV criteria;
- how can targets be selected for the relevant EE/ENV performances, to be used both for incentive/penalty schemes and for the evaluation of the offers;
- how can a mechanism for incentives be designed and written in the awarding documents to reach an improvement of the EE/ENV performances of the TOCs and the rolling stock;
- how can a monitoring system be designed and managed to measure the EE/ENV performances of the regional rail services and rolling stock;
- how can penalties be applied by using the monitoring system;
- how can the system to evaluate the tenders be built; how can the criteria be weighted.

For the PTA the tendering process can be a rather costly and time consuming procedure, including the risk of appealing processes, especially if other criteria than only the price are applied. Hence EE/ENV specifications should be as transparent as possible leaving minimal room for misinterpretation. In the following the relevant criteria are described with respect to this requirement, as well as the main ways to include them in awarding documents and the main types of application cases.

6.1 General comments on the use of the described criteria

A PTA which wants to award energy efficient railway services or to procure energy efficient railway tractive units (locomotives or multiple units) may use different kinds of criteria. ECORailS proposes direct indicators, indirect indicators, technologies (or technological clusters) and operational measures. In chapters 6.2 to 6.4 some general advices are given how to apply the recommendations and criteria to different types of contracts or operations. In the subsequent chapters all criteria will be described in detail according to a logical structure, including text modules which reflect the legal situation of public bodies procuring services or rolling stock.

The most elegant criteria are direct performance indicators. A direct performance indicator shows directly the energy consumption (measured usually in kWh) of a traction unit in relation to a unit which refers to transport performance or operational performance. The big advantage of using direct indicators in awarding procedures is that it is left to the TOC or to the vehicle supplier with which technologies or solutions they want to reduce the energy consumption. Details are given in chapter 6.5 and Annex VI of these Guidelines.

But there are situations and considerations when it is not possible, not meaningful or not sufficient to use direct indicators. Therefore we propose to also consider indirect indicators, technologies and operational measures.

An indirect indicator describes a property of a vehicle which has a relevant or even decisive influence on the energy consumption of a train but does not describe the energy consumption itself. The main indirect indicator which is proposed in this document is “weight per seat” This criterion is obviously the most outstanding one (in terms of traction energy consumption) when passenger carriages for loco-hauled trains are to be procured independently from the locomotives or with the future perspective of being operated with other locomotives.

Despite of the advantages of indicators, it may be helpful to also use technological criteria which usually means to require special equipment for the rolling stock. The purpose would be a. o. (1) to assure that a certain level of energy efficiency will be reached, (2) to bring forward the development of certain technologies (e.g. energy recuperation on diesel trains), or (3) according to specific situations in terms of infrastructure. These purposes differ individually between the technological criteria described below (see chapters 6.7 and 6.9 sqq.). Furthermore, the knowledge of the technology which is available in order to enhance energy efficiency, helps the PTA to forecast or at least assume what results can be achieved by using energy efficiency criteria in the awarding. Some information will be given in the following chapters and in the annexes but for more detailed analysis please use the technical documents of the ECORailS project, provided on the website www.ecorails.eu.[8] If the providers offer different solutions for the same technological problem, specific performance indicators may be appropriate to evaluate these solutions. These specific indicators are described in the respective chapters (see also chapter 6.7).

Operational measures can be applied independently from the type of rolling stock although the actual results may differ. Operational measures aim at a more energy efficient use of the vehicles. The most prominent example is “energy efficient driving” which is therefore described separately in chapter 6.11. Operational measures may require additional features of the rolling stock, e.g. energy meters and certain control functions but these can usually be fitted without major changes to the vehicles. Operational measures provide a considerable potential for saving energy and can also be applied when old or second-hand vehicles are used. On the other hand, some pre-conditions in terms of timetabling, quality of infrastructure or training are usually necessary for operational measures.

All types of criteria mentioned above have their advantages and disadvantages and can be used in specific contexts or for specific purposes. All these types of criteria are useful for a comprehensive strategy for an energy-efficient passenger rail transport and should be combined in a well defined way when an awarding project is being planned.

The description of each criterion (indicator, technology or operational measure) is generally based on the following structure:

- General description
- State of the art including potentials and limits in terms of the positive ecological effects
- Pros and cons, potentials and limits in terms of methodology and technology, legal and economic framework (including relevant side effects)
- Specific performance indicator(s) if the criterion refers to a specific technology, cluster, feature etc. and is not an indicator in itself
- Detailed and exact definition
- Legally secure text module
- Comments on the use of the text module
- Advices and comments for evaluating the offers in terms of the criterion in question; including the weighting compared to other criteria of awarding

[8] Please see especially the Deliverables D 6 (“Technological overview with regard to energy efficiency and environmental performance, ready to be integrated into the guidelines”), and D 7 ("Integration of technological feedback from the User Platform and the consortium into the guidelines").

- Advices and comments for monitoring the performance of the TOC or the vehicles in terms of the criterion in question.

ECORailS proposes “legally secure” text modules because there is some concern on the side of the PTAs that inconsiderate wording may cause conflicts with national or European law on tendering or contracting out by public bodies. The proposed text modules are checked against the requirements of the actual European law and the national laws of the countries participating in the ECORailS pilot applications (i. e. Denmark, Germany, Romania and Italy)[9]. Nevertheless, please be aware that the European or national legislation may change or that combinations of different criteria, be they presented in these Guidelines or deriving from other considerations, may cause conflicts. Therefore neither the ECORailS consortium nor one of its partners will accept any liability for causes or legal disputes which may originate from the use of these text modules. We are convinced, however, that these text modules, together with the analysis of the legal situation (see chapter 2) and technical information provided in these Guidelines, will enable all PTAs of the EU to use criteria related to energy efficiency or other environmental effects in a legally secure way.[10]

6.2 Application to different types of contracts

The inclusion of EE/ENV criteria in awarding can, from the PTA's point of view, be included either in 1) the Public Service Contract or, 2) in the case of the PTA owning the vehicles, in the procurement of vehicles. How to include EE/EF criteria will therefore depend on the following situation:

1. Awarding of services, rolling stock provided by TOC
2. Awarding of services, rolling stock provided by PTA
3. Procurement of rolling stock by the PTA
4. Procurement of rolling stock by the TOC

In cases 1), 3) and 4) all criteria are relevant which concern quality and technology of the rolling stock to be used in the services in question. In cases 1) and 2) also or exclusively operational measures are relevant. Operational measures are measures which can be used to reduce energy consumption or emissions when using existing rolling stock, although the effect of these measures may differ according to the technical standards of the fleet. The direct performance indicators (e.g. kilowatt hour per seat-km) can be used either for assessing the energetic performance of the vehicles or for evaluating the overall performance of operation. All other criteria are relevant either for the assessment of vehicle technologies or for the operational performance. Relevance or weighting of the criteria described below may differ between the different types of contracts.

Although the case of number 4 is not within the main scope of the ECORailS project, some of the examples covered in case 3 are of course relevant also when TOCs are awarding vehicles. When a PTA applies EE/ENV vehicle specifications, the bidding TOCs will be in the situation of case 4, i.e. to procure rolling stock which fits to the EE/ENV-related requirements or wishes of the PTA. Options to include environmental criteria when procuring rolling stock, from a TOC's perspective have also been well covered by the PROSPER project (UIC Leaflet 345).

[9] See also the Deliverables D 9 ("Legal and economical overview including legal text modules for awarding ready to be integrated into the guidelines") and D 10 ("Integration of legal and economical feedback from the User Platform and the consortium into the guidelines").

[10] Please be aware that this document is the first draft of the Guidelines. The detailed confirmation that the proposed text modules are appropriate to the national law of the participating countries and to the practical needs of the PTA’s is part of further elaborations of ECORailS, especially of the Work Package 4 “Pilot Applications”.

In all cases given above, EE/ENV criteria can be applied. In case 1 it is within the scope of a PTA to specify requirements or incentives for the quality of the rolling stock, as the PTAs of the relevant network(s) may be confronted with the rolling stock procured for the actual contract for a period of more than 30 years. In spite of that, there are some differences in detail and in terms of relevance and/or priorities as shown in the following table. These are, of course, only rough estimations and priorities should be checked in detail for each awarding project:

Table 6-1: Relevance of types of criteria with respect of types of contract

Type of criterion / type of contract:	Direct indicators	Indirect indicators	LCC considerations	Technologies	Operational measures
Awarding of services, rolling stock provided by TOC	XX	(X)[a)]	X[b)]	X	X[c)]
Awarding of services, rolling stock provided by PTA	XX	0	0	0	XX
Awarding of rolling stock by the PTA	XX	X[d)]	XX	X	(X)[e)]
Awarding of rolling stock by the TOC	XX	X[d)]	XX	X	(X)[e)]

Remarks:

a) Indirect indicators such as "weight per seat" may here be relevant in case of loco-hauled rolling stock if the PTA has to consider the re-use of the rolling stock after the contract period.

b) LCC considerations are here merely a task for the bidding TOCs but may have a complementary function for the PTA: It has to make assumptions about the positive or negative consequences of their criteria in terms of LCC in order to forecast the range of results and prices per train km.

c) Here, operational measures may gain greater relevance if the calculation base and potentials for the direct indicators are not (yet) clear enough. Especially even if the consumption of the tractive units is known according to relevant service profiles but monitoring the actual performance seems to be difficult or not reliable.

d) Indirect indicators are relevant in case of loco-hauled rolling stock.

e) Although operational measures are, by definition, applicable with all kinds of rolling stock, the results may differ between actual configurations. Furthermore in some cases specific equipment is needed like e.g. energy meters. That should be considered when procuring vehicles and can in some cases have implications for the authorisation process.

6.3 Application to different types of operation

Several types of operation are used in regional passenger rail transport. The main categories to describe them are:

- Diesel operation vs. electric operation
- Loco-hauled trains vs. multiple units
- Service profiles (acceleration, speed, distances between stops): Suburban, Regional, Intercity *(see chapter 6.5 and Annex VI)*

EE/ENV criteria can be applied to all these kinds of operation, although the relevance and the effects may differ. Not every technology or operational measure can be applied to every type of operation or not in the same way to all types of operation. Applicability, effect and efficiency may differ according to traction, train configuration and service profiles.

More detailed information is given in the descriptions of the single criteria, using the categories mentioned above. In some cases both loco-hauled trains and multiple units can be considered as appropriate fleet concept. In such cases the different fleet concepts may also be compared with EE/ENV criteria.

The term "diesel operation" is not absolutely appropriate; "operation on non-electrified lines" would be better. The former term is used here in spite of that because this denomination is most often used and trains with alternative fuels or batteries are so far very rare examples. But in the mid-term perspective alternative concepts for non-electrified lines, including hydrogen, batteries or more ambitious electrification programmes, should be considered.

6.4 Main ways of including EE/ENV criteria

The aim of the ECORailS Guidelines is to accelerate the process of innovation within the railway industry, especially in terms of reducing energy consumption, pollutants and noise. The ECORailS team recommends to analyse which standards and technologies are certainly available at the time of starting the awarding project. As a general advice, we propose to use both, binding requirements where a certain standard can obviously been achieved and incentives for the invention of more enhanced technologies, in order to go beyond the existing standards and technology.

The criteria and targets to be included need to be easy to monitor and report. The bidders' options should not be restrained too much. There should be room for own suggestions regarding how to get better environmental performances. Also the weighting of the different requirements/criteria to each other (i.e. quality vs. energy efficiency) is important. For example penalties regarding bad punctuality should neither be too small nor to high in comparison to the bonuses for good energy efficiency.

Tender documents should in general not be too specific regarding required or preferred technologies since it could impose a risk for discrimination. Additionally, the requirement or rewarding of too specific technologies could lead to the exclusion of more efficient solutions or offers even if it was not discriminatory in the legal sense.

6.4.1 Requirements

Requirements are criteria that the TOC or manufacturer need to fulfill as minimum standard in order to be qualified for the contract. The evaluation of a requirement is easier compared to the evaluation of incentives and weighting since the TOC either fulfils the criterion or not. If a PTA decides to require a certain quality or level of performance it should be sure that the bidding TOCs or manufacturers can fulfil these requirements with reasonable efforts. Among the typical achievements which could be required by a PTA are: Monitoring energy consumption during contract period, application of energy-efficient driving, driver training, energy recuperation (electric traction), noise emission limits of vehicles, emission limits for pollutants in case of diesel operation. Even a maximum level of specific energy consumption could be required but this would need a sufficient database and analyses by the PTA in advance. The minimum standards base on the state of the art, prices and the prospective limit values. Compliance with these standards is mandatory for the bidders and has to be monitored strictly during the duration of the service contract. It has to be clear to the bidders that a breach of the minimum standards will cause sanctions which will be fixed in the service contract.

6.4.2 Higher scoring for preferred solutions or better performance

The PTA can name preferred options in the ITT if it is not certain in advance that these options can be fulfilled by the TOC or manufacturer. A bidder who offers such a solution may

get a bonus (e.g. additional scores) when the offers are evaluated and thus get the contract even with higher prices for e.g. the train kilometre. The preferred options and the weighting systems must be announced in advance. The options (solutions) should be described functionally, thus leaving flexibility to the bidder. The weight of such quality criteria should depend on the PTA's priorities, availability on the market, inherent incentives for the bidder and the relative weight of "competing" criteria. The application of EE/ENV criteria in such a weighting system is similar to other quality criteria like e.g. special comfort functions for passengers. Examples for preferred solutions in terms of EE/ENV could be reduced noise emission levels of the vehicles, the use of particle filters or on-board energy storage advices. Also in case of preferred options the advanced standards which the PTA and the successful bidder have agreed upon must be monitored, and the bidder will face sanctions if the agreed standards are breached.

6.4.3 Penalties

If the performance quality which had been requested or agreed upon is not realised during the contract duration (operation period) the PTA may apply a penalty scheme. This penalty scheme should be announced or agreed upon in advance and must be reasonable for both sides. Penalty levels need to be proportionate. When it comes to energy consumption the actual performance may be negatively affected by conditions which are out of the scope of the PTA and the TOC, e.g. bad infrastructure conditions, major construction works, disturbances in operation caused by the infrastructure manager (IM) or by another TOC, unexpected high occupancy or force majeure. The risk of such influences should be shared by PTA and TOC in an appropriate way. It is not reasonable to apply a penalty scheme for mal performance if the reasons are not under the responsibility of the TOC. The typical evaluation period would be one year (timetable period). The penalty scheme might be temporarily suspended during special events or major construction works.

6.4.4 Incentives (bonus/malus)

Incentives for good performance or improvements during the contract duration can be used if the TOC has different options to improve e.g. the energetic performance. The conditions for the incentive scheme (or an integrated bonus/malus scheme) need to be announced or agreed upon in advance. Bonus and malus levels need to be proportionate. Usually a reference level (or range) would be the base. In case of better performance the TOC may get a special reward, for example a higher price per train km or a bonus related to the annual compensation. The PTA may clarify in the contract that the reward will not be given even when the good performance was prevented by bad circumstances which are not in the scope of the PTA (e.g. disturbances in operation caused by other TOC, force majeure etc.). An incentive scheme could also be used to encourage investments by the TOC during the contract period like e.g. procurement of new vehicles or refurbishment of the existing fleet. So an additional amount per train km could be offered if the TOC invents new rolling stock on the network which fulfils advanced (but clearly defined) EE/ENV criteria. This type of incentive could be used if availability, reliability and economic determinants were not sufficiently clear at the time of ITT or signing the contract.

For a good relationship between the PTA and TOC it is generally better to motivate through incentives instead of a situation where the TOC has to pay penalties on a regular basis.

6.5 Direct performance indicators (traction energy consumption)

Generally speaking, the use of a direct indicator is not only the most elegant, but also the most legally secure way to integrate the energy efficiency in procurement procedures for vehicles and in awarding procedures for Public Service Contracts in passenger rail services.

The reason is that, if you use an indicator, the providing company has the choice to develop and present its own solutions whereas, if a particular technology is prescribed, other solutions will be excluded and providers may consider themselves discriminated. Another argument may be even more important and that is that in the field of energy efficiency it is not yet clear which solutions will prove to be the best ones in the middle- or long-term run. In order not to hinder this process of seeking it is advisable to use indicators wherever it is appropriate. Furthermore, such direct indicators show the interdependent result on an ensemble of aggregates, technologies and solutions of the fleet while the positive result of a specific solution could be balanced by a not very intelligent combination with other features.

Although ***"kWh per passenger km"*** is the most relevant indicator in terms of climate protection and in the political discussion about transport modes, it does not seem viable to use this general indicator in an awarding procedure for passenger transport services as it is highly related not only to the technology and intelligent operation but also to the occupancy. The PTA may also set incentives for efforts of the TOC to improve occupancy, but it seems to be better to analyse and monitor energy efficiency and occupancy separately. In most cases we recommend to use "kWh per seat km" or "kWh per train km".

The indicator ***"kWh per seat km"*** will be the most appropriate one for most applications in the context of awarding rail passenger services or rail vehicles (EMUs, DMUS, railcars), as it can be applied to (the comparison of) different types of trains and operational concepts. Some side conditions should be defined with respect to the convenience of the passengers, e.g. seat pitch, width of seats and the calculation of multi-purpose areas, corridors, restrooms etc. These definitions have to be made anyway, independently from energy consumption matters, when a PTA is asking for bids, because the number of seats in a given car body has relevant implications for both the passengers' comfort and economics. However, the calculation, simulation and verification of "kWh per seat km" will usually base on the value "kWh per train km" and then calculated according to no. of seats etc.

The indicator ***"kWh per train km"*** can be used if class and configuration of the train compositions are defined very clearly. It is obvious that trains may otherwise consist of 2, 3, 4 or more coaches with very different levels of energy consumption. Additionally the standard designs of multiple units offered by the vehicle suppliers may differ at least slightly in terms of length, width and space for passengers. So this indicator may typically be used if the PTA provides the rolling stock and/or has very clear specifications about the train capacity. In this case the vehicle suppliers may offer their standard designs and if they have more capacity than required, usually implying more weight of the train consist, this may be balanced by energy efficient traction technology. So this indicator may be useful in certain situations. However, it should be considered that in times of high transport demand trains may consist of two or even more multiple units or loco-hauled compositions. In these cases the calculations should be based on single train sets but the supplier should guarantee that double or triple units do not cause disproportionate increases of energy consumptions due to inappropriate control functions. The indicator "kWh per train km" is, however, the base for the calculation of "kWh per seat km" (see above).

When it comes to passenger transport the indicator ***"kWh per gross tonne km"*** only makes sense when locomotives are to be procured independently from the carriages the locomotives are supposed to haul. "Gross tonne km" describes the weight of the train without the locomotive, multiplied with the distance the train is hauled. If fixed train compositions are considered, the indicator "kWh per seat km" should be used at least additionally. Thus it is also possible to compare loco-hauled trains with multiple units. As with "kWh per seat km" the actual values can be simulated and verified on the base of tests or simulation with trains. Then "kWh per train km" can be converted to "kWh per gross tonne km".

In case of diesel operation the amount of fuel is usually measured in litres. As the energy content of diesel fuel can easily be re-calculated to kWh (the actual factor depending on the quality of the fuel), usually the unit "kWh" is used.

In order to get meaningful results when comparing the energy consumption of e.g. different types of trains, the PTA must take some effort, and some methodological restraints should be respected:

- If the consumption is related to “seat km” or “train km”, the train configuration and/or the interior design have to be taken into account. In case of “seat km”, it is clear that some side conditions should be defined with respect to the convenience of the passengers, e.g. seat pitch, width of seats and the calculation of multi-purpose areas, corridors, restrooms etc. But these definitions have to be made anyway, independently from energy consumption matters, when a PTA is asking for bids, because the number of seats in a given car body has relevant implications for both the passengers’ comfort and economics.
- For simulation and verification of the energy consumption all relevant side-conditions and parameters have to be clearly described. These specifications shall be included or referred to in tendering documents and contracts.
- It should be checked whether offers and simulations provided by TOCs or vehicle suppliers are really comparable and use correct methodology.
- It means some considerable effort for the PTA to select and describe the stretch of the network in a sufficient way which will be the reference for comparing or verifying the energy consumption of the rolling stock.
- In most cases the technology which is necessary for monitoring the energy consumption should be specified and required (e.g. energy meters).
- Per definition (according to the standardized Railenergy methodology) the indicators given above do not include comfort functions for the passengers. These have to be defined and analysed separately (see chapter 6.10).
- Trains also consume energy when parked for some time between services. This energy consumption is not negligible, but has to be analysed separately from the traction energy (see chapter 6.10).

A standard test cycle for the evaluation of the energy consumption of a railway vehicle does not exist, and it would not even be meaningful to define a single standard test cycle as the operational conditions differ very much between networks and operations, and the rolling stock should usually be optimised for specific types of services. In order to get meaningful results when comparing the energy consumption of e.g. different types of trains, it is essential to make sure that the side conditions are harmonised to a sufficient extent. Among others the following side conditions may be considered: timetable, speed limits, gradients, ambient conditions, curves, occupancy, comfort functions and passenger comfort definitions. These variables are not to be neglected as differing definitions of side conditions in a simulation may lead to bigger differences in the calculated energy consumption than the difference between the energy consumptions of two different classes of traction units actually is in reality.

A methodology for calculating direct indicators (performance values) is currently under development within the Railenergy project (duration 2006-2010). This is a joint project of UIC, UNIFE and other partners. With respect to the direct indicators used in these Guidelines, PTAs may profit from at least three approaches of the Railenergy project:

(1) The definition of Standard Service Profiles (SSP)[11] which can be used to describe the energetic performance of a traction unit or a train independently from a specific network or operation;

(2) A standardised method to describe the service profiles ("defined infrastructure under defined operational conditions");

(3) Compilation of data about the energy consumption of the existing railway fleet according to the standardised methods mentioned above.

(1) The SSPs are a proposed standard, applicable for the specification and verification of energy consumption of new rolling stock, or for the efficiency improvement of existing rolling stock. The criterion used for the energy consumption of rolling stock is the total net energy consumed at pantograph over a predefined operational profile, which is either taken from a standardised profile valid for the specific category of trains or from the actual future operation of the train. Six preliminary SSP's have been agreed upon in the Railenergy project which can already be used for the procurement of vehicles or the contracting out of services. Three of them are relevant for regional passenger rail transport:

(a) "Suburban"

(b) "Regional"

(c) "Intercity".

Although the brand "Intercity" is in most countries used for long-distance trains which are run without state subsidies or Public Service Contracts, train services with similar service profiles are awarded by PTA's in many cases (e.g. in Germany, Denmark, Sweden or France).

Alternatively to using an SSP, the PTA or the TOC may use the operational profile of the specific line or network for which the rolling stock shall be used. This allows for tighter calculation of the energy consumption and the costs of the operation and makes it easier to monitor the energy consumption once the service has been awarded. On the other hand it requires some effort to analyse the operations in question and to describe them according to the standardised method (see below).

(2) The Railenergy project is developing a standardised method to describe service profiles which may be the SSPs or the individual ones used by a PTA or TOC for a specific procurement project. According to the method developed and standardised by Railenergy, the following parameters have to be defined clearly for the operation of the train ("in-service" mode; "out of service mode" please see chapter 6.10 of the Guidelines):

Infrastructure: longitudinal profile, speed profile, curves, tunnels, electric power supply system;

Diesel fuel: diesel fuel specifications[12];

Operational requirements: train and propulsion system, timetable, pay load, driving style, regenerative braking, comfort functions (in-service);

Environmental (ambient) conditions: ambient temperature, humidity, intensity of sunlight, average head wind.

The methodology for using energy performance values like e.g. "kWh per seat km" is being developed and is assumed to be available in 2010.

It is difficult to define a standard method since how to value energy efficiency is largely dependent upon case-specific financial and political parameters. However, a basic approach is to start with the (estimated) energy cost in relation to the total cost of the (current) contract

[11] Railenergy, Deliverable 2.2.3 – Definition of standard service profiles, Draft version, 23/07/2008

[12] In the Railenergy papers the „Diesel fuel specifications" are part of the infrastructure description, but this assignment is not followed here.

for the services that is to be awarded and relate this to the energy saving that is to be achieved or the energy saving potential of a certain technology or operational measure. For example, if the energy costs are estimated to 25 % of the total cost for the services, a proportionate bonus level for reduction of energy consumption by 10 % would be 2,5 % (0,25*0,1). The same method could be applied for calculating the weight that is to be used for the evaluation of tenders. Based upon this calculation, the levels need to be further calibrated based upon case specific parameters. Reducing the bonus/weight levels may for example be relevant if the TOC bears the energy costs since this means that there is already an inherent incentive for the TOC to reduce its energy cost. Increasing the bonus/weight levels can then be relevant if the PTA bears the energy costs or if there is strong political and financial support for ambitious environmental goals. Increasing the weight is also recommended if subsidies for energy prices exist. A simplified example of a bonus/malus scheme is presented in the table below.

How to include in the awarding procedure

A direct indicator can be included in the awarding of services and rolling stock. In order to be legally compliant to European legislation, the indicator needs to be described in the awarding document and public service contract as well as the methodology for calculating this. If available it is also recommended to provide information about the current energy consumption on the line/network in question ("baseline"). The methodology of the baseline information needs to be consistent with the calculation method of the direct indicator used in the awarding procedure and for penalty/incentive schemes. Methods for calculation of incentive and/or weight for evaluating also need to be defined and described in order to fulfill the principle of transparency.

A direct indicator can be included within a competitive tendering as well as in a direct awarding procedure as a requirement, used as an evaluation criterion (within a competitive tendering procedure) or as bonus/malus scheme (applicable when awarding of services). A combination can also be considered, e.g. a minimum level can be required and the TOC/Manufacturers that reach a certain level below the required can get a higher score more points in the evaluation of the tenders or be compensated during the contract period.

When requiring a certain maximum level of energy consumption, too ambitious requirements should be avoided. Instead low consumption levels can be included as preferred options or encouraged by incentives. A reason for this is that it may reduce the number of contenders in case of competitive tendering which may lead to increasing costs for the PTA. The relevance of incentives based on direct indicators for energy consumption depends on the way the traction energy supply is managed and the consumption is charged.

Requirements or incentives call for the need to monitor the real consumption. For this a penalty scheme needs to be implemented in order to monitor the compliance to the required or agreed consumption level. Methods for monitoring need to be identified and described along with the necessary measures (i.e. implementation of energy meters). In case of awarding of rolling stock, it is not recommended to evaluate the keeping of the contract during the real operation of the rolling stock because of the variability of the energy consumption due to different driving styles that could cause variation between different drivers (drivers are not under the responsibility of the manufacturer of the train).

In the awarding procedure, the indicator must be considered in most of the steps. The most important tasks are described in the table below.

Steps for including in awarding procedure	
Steps independent of awarding procedure	• Establish a methodology for calculation of energy consumption, either based upon real situation from current services or elaborated through SSP. • If existing vehicles to be used and electric traction, energy meters need to be installed. • Incumbent TOC should be required to provide the PTA with data that concern the direct indicator (e.g. in contract or through political decision).
Procuring of rolling stock	• Require declaration of traction energy consumption from manufacturer according to the defined methodology • Require energy meters to be installed • Evaluate the tenders in terms of data about energy consumption, based on LCC approach or as weight for evaluation of the tenders
Awarding of rail services, vehicles provided by PTA	• Follow steps relevant for procuring of rolling stock (if existing vehicles to be used – energy meter is required) • Include energy use according to the chosen relevant direct indicator as an incentive/penalty system o Identify energy saving potential o Estimate the value of the contract o Construct compensation levels • Describe requirements regarding maintenance
Awarding of rail services, vehicles provided by TOC	• Require energy meters to be installed • Require energy use to be presented in the tender according to the agreed baseline • Include maximum energy consumption of vehicles as requirement *Or:* • Include energy use according to the chosen relevant direct indicator as a weight criterion used for the evaluation of the tenders (only relevant in a competitive tendering procedure) o Calculate the weight to be used (based on energy costs or political relevance of energy efficiency in relation to total operational costs) *And/Or:* • Include energy use according to the chosen relevant direct indicator as an incentive system o Identify energy saving potential based on baseline o Identify the value of the contract o Construct compensation levels

An example for an incentive (bonus/malus) scheme for the overall energy consumption is given below. It includes the result of both improved vehicle and propulsion technology, and operational measures. The energy consumption of stand-by and comfort functions should be defined and analysed separately.

Level	Monitored energy consumption in relation to the required baseline	Penalty/Incentive (in relation to annual compensation)
Penalty Level 2	> 7,5%	2,5 %
Penalty Level 1	2,5 to 7,5 %	1,25 %
Incentive Level 1	-2,5 to -7,5 %	1,25 %
Incentive Level 2	< -7,5 %	2,5 %

Table 6-2: Example of bonus/malus scheme, energy cost estimated to 25 % of total cost

(For further details see Annex VI!)

6.6 Indirect performance indicators

In the context of ECORailS, an indirect indicator describes a parameter which has a major or substantial influence on the energy consumption of a train but does not describe the energy consumption itself. The mass of a vehicle is especially decisive in regional passenger transport with its frequent stops and a high share of energy consumption for acceleration.

The indirect indicator "weight per seat" can be used for the procurement or description of passenger carriages for loco-hauled trains, especially when it is intended to procure or operate them independently from the locomotives. When it comes to multiple units or the comparison between entire train sets, the direct indicator "kWh per seat km" should be preferred. Also in this case the passenger comfort functions must be defined (e.g. distance between seats, calculation of multi-purpose areas etc.).

In recent years major progress has been made with respect to mass reduction in passenger railway equipment. Main fields of mass reduction are:

- Lightweight materials and design for carbody and interior equipment
- Smaller and lightweight equipment for comfort functions
- New vehicle concepts (e.g. double-deck carriages, articulated trains)

Not all of these measures can be applied in a specific awarding project, e.g. for comfort reasons or specific operational conditions.

When using an indirect indicator the compliance to the required indicator needs to be tested at the delivery of the vehicles. The test modules for the inclusion of the direct indicators for assessing the quality of the rolling stock can also, in a simplified way, be used for the indirect indicator.

6.7 Specific indicators

Different technologies / solutions / equipments which are implemented for the same purpose may be compared by specific indicators. These indicators must be defined individually for each cluster or technology. Specific indicators can be used for qualifying specific technologies (solutions) and operational measures. These indicators can show

- The effect of the applied technology (or operational measure) on the overall traction energy consumption of the tractive unit;

- The efficiency of the technology (or operational measure) with regard to its specific purpose;
- The effect on the weight of the vehicle (additional weight / reduction of weight; related to weight per seat);
- The effect on the noise emissions of the vehicle;
- The noise emissions of the aggregate itself;
- The effect on the emission of pollutants.

Other criteria for assessing particular technologies or operational measures are their economic potential, the implementation time and RAMS indicators. These criteria are not considered here as "specific indicators", but the economic potential depends a. o. (on the respective effects) on the energy consumption.

For example, if different technologies for recuperative braking shall be compared, the recuperation rate (recuperated energy compared to the overall traction energy) may be used as specific indicator. Of course, operational, ambient and infrastructural conditions should be harmonised for this purpose.

The specific indicators for the technologies and operational measures which are highlighted by the ECORailS Guidelines are described in chapters 6.9 to 6.12. An additional overview is given in Annex VII "Overview: specific indicators (monitoring parameters) for technologies and operational measures".

6.8 Lifecycle cost and cost benefit analysis

In order to compare the trade-off between investment and operational as well as maintenance costs of different technologies and to find the best solution for a specific use case, all costs that occur during the lifecycle or at least the duration of the respective contract should be considered when selecting technologies or operational measures.

For these calculations two related methodologies with different focus exist:

- Calculation of lifecycle cost (LCC) which focuses on the whole lifecycle of a product;
- Cost benefit analysis (CBA) concentrating on the effects during a contractual period.

The aim of **lifecycle cost** analyses is the calculation of all costs of a specific product during its lifecycle including production/investment costs, costs for operation and maintenance as well as recycling and disposal costs. All costs are added up. The total sum of all accrued costs for a specific product is the relevant parameter for comparison purposes with other products. LCC analyses concentrate on the costs during the lifecycle of the evaluated technology independent of the parties involved.

LCC analyses can be applied to the vehicle, to specific equipment (e.g. an aggregate), or to operational measures for which changes of the vehicle, the infrastructure or the maintenance facilities are required.

In contrast to a LCC a **CBA** focuses on the monetary effects of a given technology or operational measure in comparison to other technologies/operational measures from the point of view of a specific involved party, e.g. the PTA, the infrastructure manager or the operator, during a given period, i.e. in most cases the duration of the contract.

The aim of a cost-benefit analysis is the identification of the additional costs and benefits of the analysed technologies and operational measures for the involved parties (PTA, TOC, IM). Only monetary benefits should be considered in the cost-benefit analysis. These benefits are mostly reduced operation and maintenance costs as well as avoided investment costs (e.g. obsolete sound protection measures for residents, avoided depot extension for additional vehicles due to lower maintenance demand, etc.).

In terms of awarding of regional passenger rail services and vehicles, the main application cases are:

- Procurement of vehicles (by PTA or TOC): LCC analysis
- Awarding of services, rolling stock provided by TOC: LCC analysis of the vehicles which are offered; CBA analysis of all costs during the contract duration
- Awarding of services, rolling stock provided by PTA: CBA analysis of all costs during the contract duration.

Some further remarks can be added to this general statement:

(1) In all cases, including awarding of services with rolling stock provided by the TOC, a LCC analysis of the vehicles can be helpful. The main purpose would be to estimate additional or reduced costs of EE/ENV requirements so that the consequences for the bidders' prices, the relative weights of the criteria and the long-term consequences for the vehicle fleet can be assumed.

(2) LCC analyses should also be applied for assessing the cost consequences of specifically required or offered equipment, in all cases where the vehicles are to be assessed.

(3) In all cases assumptions about the operational patterns are prerequisites for LCC and CBA analyses. That means that the definition (requirement, assumption) of operational measures will have consequences for the cost-related analysis models.

For lifecycle cost analyses as well as cost benefit analyses the relevant costs are mainly:

- Investment costs for infrastructure, vehicle equipment as well as supplementary equipment
- Operational costs
- Maintenance costs
- Refit costs (only CBA with analysis period greater than lifespan of specific item)
- Recycling costs (only LCC where necessary)
- Disposal costs (only LCC where necessary)

The main difficulties of both methods (LCC and CBA) are the determination of the operational conditions and the failure rate beforehand. Especially the operational costs and to a lesser degree the maintenance costs are variable and strongly dependent on the operating program and fielding conditions. Therefore the calculation should be made for specific operating scenarios corresponding with the planned usage conditions during the investigated period. Therefore the important operational characteristics (e.g. number of vehicles used, mileage per vehicle, service profile, etc.) should be collected for the respective scenario, so that common indicators (e.g. time-dependent and mileage-dependent maintenance cycle, operational costs per train-km, etc.) can be used. Similarly, the failure rate needs to be estimated based on available experiences and assumptions.

As far as the operational costs are concerned, the assumptions about the energy consumption can be based on the analyses of the direct indicators. With regard to LCC analysis mainly kWh per train km or gross tkm are relevant (see chapter 6.5). Also the definitions and assumptions about stand-by and comfort functions as well as operational measures should be consulted (see chapters 6.10 to 6.12).

A practical problem is that today most of the necessary indicators for future technologies are yet undetermined. Some estimates can be found in the literature but the main source for the necessary data will be the suppliers. For technologies that are already in use the individual operators should have the relevant data for their specific use cases. A PTA compiling awarding documents should be aware of this situation and challenge the bidders to commit themselves to specifications concerning LCC components.

Methods and forms for LCC calculation requirements can be based on the specifications of CEI / EN 60300-3-3 /2005 (Application guide LCC evaluation). Important elements are:

- LCC concept (par. 4.5):

  A LCC model is a simplified situation of real circumstances. An LCC model can be developed in a custom manner according to the goals. In order to estimate total life cycle costs it is necessary to split the LCC on cost elements (par. 4.5.2).
- The calculation method through analogy: by estimating on the basis of past experience to reflect the effects of new technologies. This is one of the least complex methods (par. 4.5.3.3).
- Diverse categories of resources (kWh, diesel, man-hours) can be converted into costs (par. 4.5.3.4).
- If LCC data are required by the PTA for the procurement or assessment of a series of vehicles, the LCC calculation needs to be part of the awarding documentation (tender, contract). The form should be edited according to the above mentioned definitions and provide clear options for the comparison of the offers.
- The awarding documentation will foresee the verification modalities (optimal conditions, operational conditions); the testing conditions must be specified in the awarding documentation. The contract will foresee the responsibilities of the bidders for the fulfillment of the provided data.

The majority of the technologies and operational measures for enhanced energy efficiency which were analysed by ECORailS seem to have a positive impact on the lifecycle costs. This is especially valid for those technologies and measures which are described in detail in the following chapters (6.9 to 6.12).

6.9 Features and equipment of the vehicles to be used

When describing the vehicles to be procured or to be used in the operations to be awarded, PTAs may require specific technologies which are promising additionally to comparing the energy consumption according to direct indicators. In these cases PTAs could preferably request compliance with some parameters (e.g. LCC, weight, energy consumption) thus leaving it to the industry to find the appropriate solutions or stimulate the manufacturers to achieve better performances for well defined parameters.

A first selection of such technologies is highlighted in this chapter.

General description

Braking energy recovering by super capacitors on-board equipment

By this technology it is possible to store the energy released when braking and use it during the next acceleration of the vehicle. Each time the vehicle brakes, the energy storage devices (super-capacitors) are loaded again. During the next acceleration, the stored energy is released. This additional energy lowers current demands from the network, for the same traction effort. The technology can be used for both electric and diesel traction (the latter if electric power transmission is used).

Braking energy recovering by super capacitors in fixed installations

During the braking phases some trains already in service and almost all of the new electric trains or locomotives are able to return energy to the overhead-line if this can receive it (e.g. when other trains are in traction phase and quite near to the braking train). On some networks the operational situation does not allow the reception and immediate re-use of energy. For this reason, the new energy storage technologies, such as super-capacitors, could be considered and collocated in fixed installation near stations where many trains a

day stop. These or other trains could reuse the energy stored in their start phase or other use of this energy could be done. Power supply optimization system for storage in fixed installation can be in substations or along the track and it operates on purely electrical basis.

On-board use of braking energy in diesel-electric stock

Modern diesel locos or DMUs with electric power transmission can be equipped with the capacity to use some of the energy recovered during braking for auxiliary and comfort functions. In modern diesel-electric 3-phase locomotives the Diesel engine drives a generator feeding the DC link. The DC link feeds the traction inverters as well as the auxiliaries and the train bus supply. During braking, the traction motors feed the recovered power into the DC link. This additional power can either be converted into heat in braking resistors or used for other consumers, namely auxiliaries (compressors, ventilation etc.) or the train bus supply (supplying the comfort functions in passenger trains). The power management is usually performed as follows: The recovered braking power is fed into the DC link. The part of this power that can be used for auxiliaries or train bus supply is drawn from the DC link, the rest is dissipated in the resistors. The resistor is automatically "switched on" if the voltage in the DC link exceeds a certain limit value.

Control of comfort functions in parked trains

Parked passenger trains are often heated all night. This consumes substantial amounts of energy. A possible solution is the development and implementation of an intelligent control tool for parked trains (e.g. pre-heating time of rolling stock as a function of external temperature, etc). Besides the installation of an automated controlled system, simple effective solutions include timers, manual control and instructions for maintenance and cleaning personnel.

Existing solutions mainly differ with respect to the following features:

- Centralised control device for the entire train
- Possibility to operate lighting and heating at one third or half intensity
- Special programs for anti-freezing or preheating operation.

Potentials of the highlighted technologies

Energy savings potential

The potential for saving energy has been estimated, by specifying a range of possible values (without using fixed values and fixed ranges) from worst to best case taking into account the different foreseeable application contexts.

The estimations of the potential are based on the evaluations already available in technical literature, on partners' expert judgements and on evaluations in previous and ongoing projects (EVENT, TRAINER, Railenergy).

Pollutants emissions saving potential

The potential for saving pollutant emissions has been estimated, by specifying a range of possible values (without using fixed values and fixed ranges) from worst to best case taking into account the different foreseeable application contexts.

The potential estimates are based on the evaluations already available in technical literature, on partners' expert judgements and on evaluations in previous and ongoing projects (EVENT, TRAINER, Railenergy). Also a simulation tool, based on the Railenergy guidelines, has been used.

In the table below a summary of the environmental and economic potentials together with estimating implementation time regarding the chosen four technologies can be found. A more comprehensive compilation can be found in D7.

Potential		Braking energy recovering (onboard equipment)	Braking energy recovering (fixed installations)	On-board use of braking energy in diesel-electric stock	Control of comfort functions in parked trains
Energy saving potential	Electric	20-30 %	5-10 % (DC-systems)	-	3-5 % (Med) 4-9 % (Nordic)
	Diesel	Up to 35 %	-	2-5 %	
Pollutant emission potential	Electric	Depending on energy mix	Depending on energy mix	-	Depending on energy mix
	Diesel	35 % (CO_2)	-	2-5 %	3-5 % (Med) 4-9 % (Nord)
Economic potential (LCC)	Implementation Cost	Medium	High	Medium	Low
	Operational Cost	Lower	Lower	Lower	Lower
	Maintenance Cost	Low	Low	Low	Low
	Disposal Cost	Low	Medium	Low	Low
Implementation Time		5-10 years	< 5 years	1-5 years	1-5 years

Table 6-3: Summary of potentials, technologies chosen for pilot catalogue

Compliance to legal framework

Asking for technologies should be in compliance with European legal framework, but there is some risk involved. For example, it is not legally secure for a PTA to ask for a specific manufacturer of a technology. However, referring to the case *Concordia Bus* (C-513/99), even though only one supplier could provide rolling stock equipped with a specific technology, it is in compliance with the European legislation to require this. Based upon input from the ECORailS User Platform, asking for technologies could instead be done through describing different technological solutions that could be of interest for the services in the awarding documents and leave it to the TOC how to solve the energy consumption.

When awarding of services through competitive tendering procedure it is of importance every contender receives the same information about the effect of energy saving potential in order to avoid giving the incumbent TOC an advantage. For example if rolling stock is provided by the PTA which is equipped with a system for braking energy recovering this should be clearly specified in the awarding documents together with a description of the service profile.

How to include in awarding procedure

To ask for a specific technology is relevant when awarding of services, rolling stock provided by the TOC and awarding of rolling stock by the PTA.

Technologies could be asked for as requirements or within a competitive tendering procedure also used for evaluation of the tenders. In the latter, there are two methods possible. Evaluate according to scoring model, where the TOC/Manufacturer who offers vehicles equipped with a energy saving technology will receive a bonus in the evaluation. Or the PTA could evaluate the offers according to a Life Cycle Cost (LCC) approach (see chapter 6.8). Unfortunately, the exact LCC costs for a single technology are currently not available. However manufacturers of certain technologies usually know the LCC for their products. Also, the economic potential is described by WP2 based upon effects on implementation, operational, maintenance and disposal cost, which could serve as guidance. In general as stated by WP2 innovative technologies (like onboard energy storage) and for technologies where the reliability is to be checked, should not be required.

Regardless if vehicles are provided by TOC or PTA, the contenders need to be able to calculate the operating costs (based upon the potential energy savings) in order to avoid giving the incumbent TOC a competitive advantage. Therefore, when awarding services through a competitive tendering procedure, the characteristics of the services also need to specified (stops, line profile etc.) in the awarding documents. Therefore when awarding of services, rolling stock provided by PTA, in the awarding documents, it is important to describe the implemented technologies.

The specification of a limit or reference value for specific RAMS (Reliability Availability Maintainability and Safety) indicators is relevant for the procuring organisation. These reference values should be fulfilled by the proposed rolling stock and may optionally combined with bonus/penalty clauses in case the effective value of the indicator will be less or more than this limit value.

Phase B: Preparation of awarding documents

1. Describe in detail the technology in question
2. Drafting text for minimum standards
   - Require the relevant technological type to be installed – *e.g. "the rolling stock is to be equipped with system for braking energy recovery*"
   - Description of the required technology(s)
3. Drafting text for advanced criteria (i.e. evaluation criteria)
   - The total cost for the rolling stock will be evaluated according to a LCC approach [description of methodology]
   - The inclusion of [technology] in the rolling stock that is to be used for the services will be valued to [weighting scheme] in the evaluation of the offers
4. Drafting text concerning how the criteria will be evaluated (yes/no, LCC, weighting scheme)
   - When awarding rolling stock, criteria (minimum and advanced) can be evaluated according to a life cycle costs (LCC) approach.
   - When awarding services, the technology can also be evaluated according to a scoring model according to which a TOC which offers the specified technology will receive a bonus in the evaluation. How to weight the criteria depends upon the

energy and pollutant emissions saving potential, length of the contract, estimation of energy/fuel costs in relation to the total costs, energy charging system and internal or external environmental goals. For weighting the criteria several options is available:

- Maximum score to the best tender
- Maximum score to tenders that reach a settled threshold
- Proportional scoring
- Complex functions

5. Drafting text how the criteria will be monitored during the contract phase.
   - There is no need for monitoring; however it could be of interest to monitor the consumption with and without the technology for internal reasons and future procurements. If so, the TOC can be asked to deliver this data.
6. Describe the baseline, calculated in the preliminary considerations phase.
7. Validation and reporting of text modules for all above items

6.10 Stand-by and comfort functions

The term “comfort functions” refers to those elements that are important for on-board people (passengers and personnel) like lighting system or the system which regulates the inner climate. This cluster includes all technologies concerning a new management of comfort functions oriented to avoid wasting electricity. The idea, on which these technologies are based, is adapting the energy consumptions to the different demand situations and avoiding the heat dispersions through the use of insulating materials.

Other important factors for the energy consumption at stand-by times are**:**

- timetable;
- total average duration of the pre-heating or pre-cooling period;
- load profile (electrical power consumption and voltage, interior temperature increase or decrease and time, etc.) for the pre-heating or pre-cooling period;
- total average duration of the cleaning period;
- load profile for the cleaning period;
- total average duration of the parking/hibernating period;
- load profile for the parking/hibernating period.

Comfort parameters (air temperature, air speed, relative humidity, temperature of interior surfaces, normal and extreme exterior operating conditions, pre-heating and pre-cooling conditions and performances, …), affecting HVAC performances and consumption, can be used as specified in the EN 14750 (urban and suburban rolling stock) and EN 13129 (main line rolling stock) for each climatic zone, or directly specified by the customer.

6.11 Energy-efficient driving and driver training

General description

Energy efficient driving styles base upon running smoothly without braking and accelerations more often than necessary and without running maximum speed when the train is on time.

In view of the barriers impeding a fast diffusion of advanced driving advice systems, non-technological short time efforts to promote energy efficient driving are especially promising. Many measures including training programmes for drivers can be implemented at good cost-benefit ratio and meet virtually no barriers. A considerable part of the reduction potential offered by energy efficient driving might be exploited by non-technological or low-tech measures (databases, systems based on GSM-R, laptop technology, etc). The following driving styles for energy efficient driving can be applied: Coasting, reducing maximum speed, using valleys and hills.

Compliance to legal framework

In general operational measures are legally secure to include in awarding. In order to be in compliance with the non-discriminative principle within a competitive tender procedure, the tendering document needs to include a description of the characteristics of the lines and services. This is important for all contenders in order to take the potential of energy efficient driving into consideration. There can also be legal issues, for example safety issues at the drivers desk.

How to include in awarding procedure

This criterion is only relevant when awarding of services (vehicles provided by the PTA or TOC).

The most straightforward way is to require the TOC that a certain amount of their drivers need to be educated in energy efficient driving and/or require relevant software/hardware. It can also be used for evaluation of tender where the contenders are asked to present their own strategy for educating their drivers in energy-efficient driving. Alternatively, additional scores could be offered to bidders which educate their drivers in eco-driving. Even not reducing energy consumption by itself, it could also be required that energy meters are installed in the vehicles. Through this the driver can control the energy consumption according to his driving style.

For monitoring purposes there is no need for constant monitoring. Instead relevant monitoring activities may include that the TOC are to annually report the number of drivers participating in training program and/or number of vehicles equipped with a system. However it should be mentioned that energy-efficient driving could be suitable to combine with an incentive system for the TOC to reduce energy consumption (see direct indicator). It could also be interesting for the TOC to implement an internal incentive system so that the drivers may be compensated.

Phase B: Preparation of awarding documents (to be done by PTA, could be partly or fully outsourced if relevant)

1. Describe the line according to the analysis in preliminary considerations phase. This need to include an analysis of the characteristics of each line (altimetry and planimetry features, speed limits, distance between stops, etc.) and of the recovery times in the timetable, the study of existing saving energy margins and definition of the most opportune driving strategies is required
2. Drafting text for minimum standards
   - Require the equipment of system for calculating the most energy efficient driving or require the TOC to educate the drivers in eco driving (or participate in training program provided by the PTA). – example:

     "The TOC is to educate the drivers in energy efficient driving according to [specification of training program]. For a specific year, at least [%] of the drivers must have participated in training program within [number of years] years before the specific year."

- Description of the required system or training program

3. Drafting text for advanced criteria (i.e. evaluation criteria)
   - Require the TOC to present its strategy for reducing energy consumption through energy efficient driving. Example:

     "In the bid, the TOC is to present its strategy for reducing energy consumption through energy efficient driving. The strategy should include description of training program, frequency of training, number of drivers participating etc."
4. Drafting text concerning how the criteria will be evaluated (yes/no, weighting scheme)
   - Describe the weighting scheme for evaluation criteria. Relevant input for construction scoring model is the energy saving potential (estimated to 5-10%), estimation of energy/fuel costs in relation to the total cost , charging system for energy costs and internal or external environmental goals. Several options for weighting of the tenders:
     - Maximum score to the best tender
     - Maximum score to the tender that reaches a settled threshold
     - Proportional scoring
     - Complex functions
5. Drafting text how the criteria will be monitored during the contract phase.
   - Number of drivers participating in training program or number of systems implemented
6. Validation and reporting of text modules for all above items

6.12 Further operational measures

Operational measures clusters	Required, or planned to be required in awarding (or anyway implemented)
Cluster 2: Energetic optimization of timetable	• Periodic scheduling, one of the main pillars of the "Integral Regular Timetable" could be viewed as speed harmonization. • All the lines tendered have cadenced timetables • Informal negotiation during the negotiation phase for signing the service contracts.
Cluster 3 Speed harmonisation	
Cluster 4: Optimization of train operation by control centre	
Cluster 5: Energy meters	• Under study as new way of paying the cost of electricity • In some countries, e.g. Germany, this is already required for new locomotives or if a new TOC wants to use the electrified network.

Cluster 6: Management and organization	• Eco-management is under study as a way to save energy costs, too.
Cluster 7: Passenger information systems	

Table 6-4: Further operational measures

6.13 Pollutants

Altogether 4 EU Directives regarding non-road mobile machinery (NRMM) are in force:

- Directive 97/68/EC
- Directive 2002/88/EC
- Directive 2004/26/EC
- Directive 2006/105/EC

The main purpose of the NRMM-directive is to define the maximum exhaust emission respectively the definition of limit values for different non-road mobile machineries. The amount of the values depends on the kind of engine used in the respective vehicle. The definition of NRMM includes all vehicles for passenger transport or transport of goods with an internal combustion engine. Road vehicles are not scope of the directive. Beside separation into vehicle classes there is a development of exhaust emission values. This means that the maximum values are lowered by time in order to force the manufacturers to advance their engine technologies. One of the reasons for the directive is to define standards in order to keep the non-road modes of transport eco-friendly. The directive also defines the test methodologies. In case of railway vehicles a NRSC-the test cycle has to be applied. The limit values presented in the table below apply to new railway vehicles (DMUs or locomotives), but also to new engines replacing older engines in existing vehicles.

Vehicle category	Stage	CO	HC	NOx	Particles
Railcars / DMUs	IIIa (2006)	3,5	4,0		0,20
Railcars / DMUs	IIIb (2012)	3,5	0,19	2,0	0,025
Locos (130 kW < P < 560 kW)	IIIa (2007)	3,5	4,0		0,2
Locos (560 kW < P < 2.000 kW)	IIIa (2009)	3,5	0,5	6,0	0,2
Locos (P > 2.000 kW)	IIIa (2009)	3,5	0,4	7,4	0,2
Locos (P > 130 kW)	IIIb (2012)	3,5	4,0		0,025

Table 6-5: Emission levels for rail vehicles as defined in the NRMM-directive[13]

The main options for a PTA are to require either certain technologies or certain emission standards with reference to the actual or recent norms.

[13] Source: directive 2004/26/EC; p. 15 et sqq.

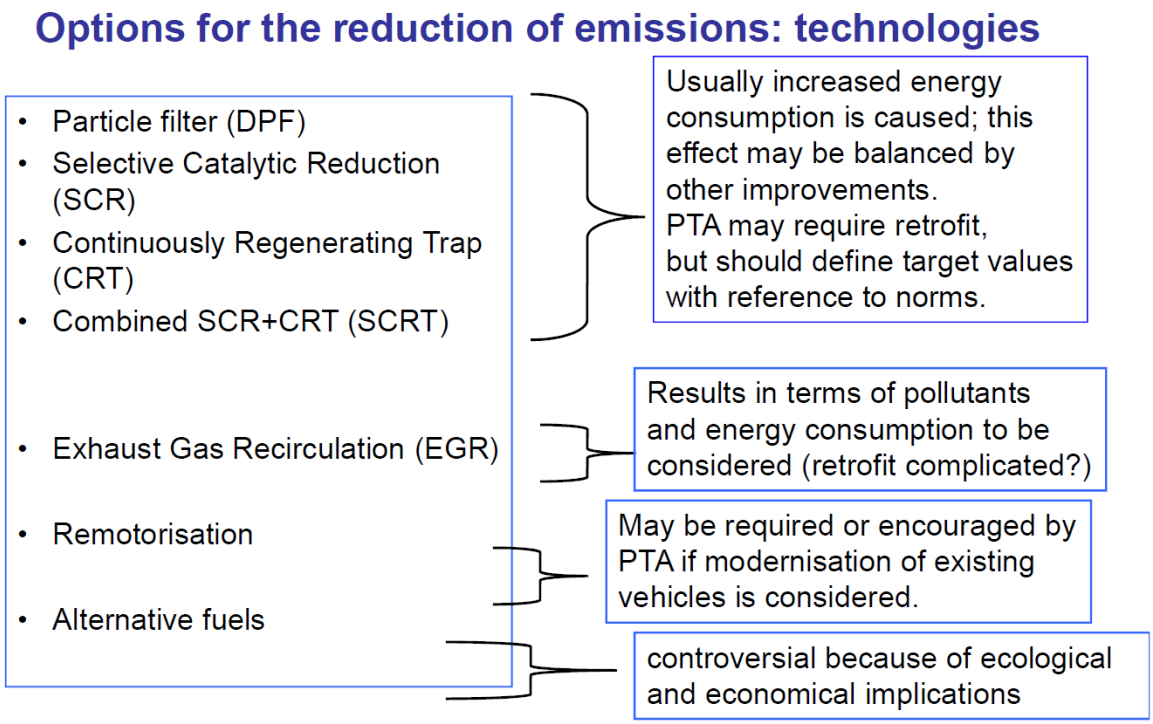


Fig. 6-1: Options for the reduction of emissions: technologies.

Emission values are mainly subject of vehicle specification. Options could be:

- New vehicles required, fulfilling Stage IIIb
- Existing vehicles allowed, but Stage IIIb (IIIa, UIC II) required (alternatively Stage IIIa but with NO_x or PM value of Stage IIIb)
- Existing vehicles allowed, but replacement (Stage IIIa) or remotorisation (Stage IIIb) required within x years
- Vehicles with old standards allowed, but share of train km restricted step by step to e.g. 20 % in e.g. 2016
- No strict requirements but improvements encouraged by incentives
- TOCs asked for modernisation concept with respect to target values; qualitative assessment.

The main options for verifying or monitoring the keeping to the contract are:

- Test certificates of engines required.
- Modernisation of fleet can easily be verified.
- If operation of certain vehicle categories is restricted to e.g. a limited share of train km, additional documentation is needed.
- Maintenance standards to be considered

The relevant operational measures for reducing exhaust emissions are basically the same as for the reduction of the energy consumption. Considerations concerning the relevance of pollution may lead to a bigger weight of such measures within the assessment scheme for the bids.

6.14 Noise

The so-called TSI Noise (Technical Specification for interoperability relating to the subsystem 'rolling stock – noise' of the trans-European conventional rail system, 2006/66/EC) came into force in June 2006. The TSI Noise regulate noise-emission limits for rail vehicles on the trans-European conventional rail network. Also the relevant test procedures are defined within the TSI. Networks for regional rail services are often not part of the trans-European conventional rail network. But article 1 paragraph 4 of the directive 2008/57/EC announces that the scope of the TSI may be extended in the future. Thus also networks for regional rail service could be scope of TSI Noise eventually which is already the case in some member states.

With regards to the content the TSI Noise sets noise emission limits for rail vehicles for freight transport and passenger transport. Concerning passenger transport, locomotives, multiple units and coaches are mentioned. In the field of passenger vehicles the noise emission values apply only to new vehicles. In case of refurbishment the TSI just requires that the noise emission after modernisation is not higher than before. It is not required to modernise existing vehicles in order to fulfil the values for new rolling stock.

Type of value [dB (A)]	DMU	EMU	Diesel loco	Electric loco
Pass-by noise (80 km/h)	82	81	85	85
Starting noise	83/85</≥ 500kW	82	86/89 </≥ 2.000kW	82/85 </≥ 4.500kW
Stationary noise	73	68	75	75

Table 6-6: Noise emission limits for rail vehicles for passenger services[14]

The pass-by noise has to be measured at 80 km/h and at maximum speed and then re-calculated to 80 km/h. Both values must fulfil the required limits given in the chart above.

In the case of noise it is essential that the requirements in terms of measuring, definition of noise values and track conditions are respected. Noise values which are measured according to previous national regulations may deviate significantly from values measured according to TSI Noise standards.

14 Source: TSI Noise (2006/66/EC); table 3 et sqq.

Comments on TSI Noise and their use by the PTA:

- Tractive units (locos, MUs), fulfilling TSI Noise requirements are c. 5-10 dB(A) more silent than previous ones.
- Announcement of 2nd step does not seem to be very ambitious, but it is necessary to differentiate between vehicle categories and concepts (e.g. normal FLIRT vs double-deck FLIRT)
- PTAs should use TSI methodology even if differing values are considered.
- No standardised methodology exists for the assessment of curve squeal and tonality.

Costs of noise abatement („rules of thumb“):

- If applying systematical acoustic management, there will not be considerable additional production costs, but…
- …in some cases additional costs for materials;
- …increased engineering costs (design process), meaning that additional costs per vehicle heavily depend on scale of series production;
- potentials depend on spare space and weight limits in each particular case.
- Later refurbishment for noise reduction is usually much more expensive.

How to choose targets?

- Targets depend on noise situation in the area and along the line.
- Targets should be defined with reference to emission norms.
- Targets depend on rolling stock strategy: new / old / modernised.

How to monitor the contract?

- Test certificates of engines required.
- Modernisation of fleet can easily be verified,but renewed test certificates should be required.
- If operation of certain vehicle categories is restricted to e.g. a limited share of train km, additional documentation is needed.
- Maintenance standards to be considered

6.15 Maintenance

(...)

Maintenance duties should be considered when criteria are defined

When the rolling stock belongs to the PTA and the TOC operates these vehicles, it is also relevant from a technological point of view how the maintenance aspects can be integrated into the service contracts, in particular who performs the general overhaul of vehicles and who pays for this. These aspects could be relevant in particular for diesel engines where bad maintenance by the TOC could cause more emissions, energy consumption and costs for the general overhaul. An option to deal with it could be a maintenance contract between PTA (as fleet owner) and a service operator or – as already done in some cases – the manufacturer of the vehicles.

[Further elaboration needed during the pilot applications.]

6.16 Review of selected criteria and overall weighting scheme

[Further elaboration needed during the pilot applications.]

7. Conclusion, further steps and open questions

The present document is the test version of the ECORailS Guidelines. It will be tested in four pilot regions:

- Berlin-Brandenburg (Germany)
- Øresund (Denmark)
- Lombardy (Italy
- Timisoara (Romania)

The final version of these Guidelines will be published in spring 2011, basing on the test results, feedback from stakeholders and further elaborations.

The final version will also provide information about

- Test results
- Potentials for enhancing energy efficiency according to the experiences during the pilot applications
- Potentials for reducing noise and pollutant emissions
- Factors which might be influenced in the future
- General comments on the scope of PTAs in the field of energy efficiency and other environmental effects of railway operations.

The ECORailS team intends to add the analysis of five further technologies in an update version of this deliverable.

Glossary

Air Quality Directive

The Air Quality Directive, 2008/50/EC of 21st May 2008 sets limit values for the concentration of some toxic matters. The most relevant of them for railway transport are particulate matters (PM) and nitrogen oxides (NO_x). If the concentration of the regulated pollutant matters exceeds the limits on too many days of a year, the authorities are obliged to develop and execute Air Quality Plans.

Auxiliaries

Equipment needed to operate the traction equipment, but not producing tractive or dynamic braking efforts themselves (e.g. cooling fans, oil and water pumps, and compressor). In the context of this standard, heating and / or air conditioning of the leading driver's cab is included in the auxiliaries (definition by Railenergy).

awarding, awarding procedure

Procedure in which the right or the contract to operate public passenger transport services on a particular route, network or in a particular area, is given to a transport company by a competent authority (PTA). It is also the procedure used by a competent authority to buy capital investments (like the rolling stock). Awarding can be done through either competitive tendering, direct awarding or through in-house provision.

Baseline

[Specific terminology used in the ECORailS project]

= Totality of **current** data which influence the costs, energy consumption and environmental conditions associated to a vehicle and/or to a public passenger railway transportation service. These *current data* mainly refer to:

- The technical characteristics of vehicles (traction and haulage) and their equipment;
- Infrastructure characteristics (length, profile, distance between stops, restrictions, etc.);
- Mode and conditions for operation and maintenance (vehicles, infrastructure, driving style, etc.);
- Transport service conditions (number of trains, train configuration, frequency, number of passengers, costs (fuel, energy, labor), infrastructure, competition conditions, legislation, norms, etc.).

The influence upon costs, energy consumption and environmental conditions can be estimated / calculated / measured, by expressing it through performance indicators (direct/indirect) or specific indicators. The data from the new awarding procedure will be substantiated taking into consideration the Baseline, and in the end will also be compared against it.

Call for tenders

The starting point of a competitive awarding procedure. It is published in printed journals and other means asked by European or national law. In the call, the PTA declares the object and the key facts of the tendered service or product; the conditions that the transport operators or manufacturers have to comply with when submitting their tenders are declared, too.

Cluster

A cluster is a group of → technologies or operational methods which are developed or used with the same or similar objective in terms of reduction of energy consumption. The definition of clusters is a heuristic method to analyse objectives and potentials of different approaches. The technologies and operational methods which are grouped in a specific cluster may be competing or co-acting with each other. A cluster may consist of a lot of elements (technologies / methods) while other clusters may consist only of one element.

One example for a cluster is the recuperation of "braking energy" which might be done with different methods, especially when it comes to diesel operation. Another example for a cluster is "Eco-driving / driver training" to which several elements belong which partially co-act.

Comfort systems

All equipment consuming energy, but belonging neither to the traction equipment nor to its auxiliaries, mainly in passenger cars: heating, air conditioning, toilets, information and entertainment systems, laptop supplies etc. (definition by Railenergy)

Compensation

Any benefit, particularly financial, granted, directly or indirectly, by a competent authority from public funds to a transport operator who signs a public service contract with the PTA . The compensation has to cover the net financial effect on costs incurred for the transport operator in complying with the public service obligations or the tariff obligations.

Competitive tendering

Awarding procedure where the competent authority (PTA) may evaluate the offers of a number of interested transport operators or rolling stock providers in a public and transparent way. According to the EU law, three different procedures may be used: *open*, *restricted* or *negotiated with publication of a contract notice* . In the *open procedure* an invitation to tender is published and every interested company may take part and submit offers; in a *restricted procedure* tenders may only be submitted by the operators selected and invited by the PTA following pre-defined criteria; in a *negotiated procedure with publication of a contract notice*, the PTA chooses the companies to negotiate the awarding among those which have answered to a public invitation.

Contracting out

The decision by a PTA to provide a public transport service through an external operator. A public service contract has to be signed between the PTA and this operator. The operator can be chosen by competitive tendering or directly.

Decibel (dB, dB(A))

The way in which the acoustic power of a source spreads in the environment is described by the size called acoustic intensity or superficial density of the acoustic power and which represents the power passing through a natural imaginary surface element in the direction in which the sound waves propagate; this size is measured in W/m^2. The threshold of audibility is when the acoustic intensity has the value $I_0 = 10^{-12} W/m^2$. The sound is most frequently characterized by a size called acoustic intensity level which is defined as the common logarithm of the ratio between the acoustic intensity and the intensity corresponding to the threshold of audibility.

The unit of measure for the acoustic intensity level is **Bell** symbolized by *B.* The name of this unit was given in honour of Graham Bell, the inventor of the telephone. In order to avoid decimals the sound intensity level is usually expressed in tenths of Bell – decibels [*dB*]. So, the 1*B* acoustic intensity level of a sound which has the acoustic intensity $I = 10^{-11} W/m^2$ is comparatively expressed with the acoustic intensity of the threshold of audibility I_0 by: $1B = 10dB = 10 \cdot \log_{10}\left(\frac{10^{-11}}{I_0}\right)$ Logically it results that the acoustic intensity level of the threshold of audibility is 0 d*B*.

The acoustic intensity level of a common conversation is: $60dB = 10\log_{10}\left(\frac{10^{-6}}{10^{-12}}\right)$

The notion of noise depends on its perception on the perception organ, the ear. The physical characteristics established to define the sound and that influence the human body are: frequency and the acoustic intensity level. The ear perceives only sounds in the audible field in the range 16 – 1600 Hz. The acoustic intensity level, measured in [*dB*] considers the physiological behaviour of the ear. In order to measure, using tools endowed with a moderation filter „A", which answer in frequency, is the same with that of the ear, the acoustic intensity level is expressed by the so called measure unit "well-balanced A decibel" and it is symbolized *dB*(A). The technical literature specifies the application of both units with the specification imposed by the method.

Direct awarding, direct contracting

Awarding procedure where the PTA awards the public transport services to an operator without competitive tendering. The details are negotiated directly between the PTA and the TOC. For this procedure the PTA is not requested to publish a contract notice. The use of direct awarding is an optional choice of the competent authorities for rail services (other than metro and tram) while for other passenger transport modes this is only allowed under special circumstances. National legislation can still prohibit the use of direct awarding of rail services.

Direct indicator(s)

In the context of ECORailS, a direct indicator shows directly the energy consumption of a traction unit in relation to a unit which refers to transport or operational performance. The unit of the enumerator is "kWh" (kilowatt hours) while the denominator is given as (e.g.)

"pkm" (passenger kilometer) or

seat km or

train km or

gross tonne kilometer (gross tkm).

In order to get meaningful results when comparing the energy consumption of e.g. different types of trains, it is essential to make sure that the side conditions are harmonised to a sufficient extent. Among others the following side conditions may be considered: timetable, gradients, ambient conditions, curves, occupancy, comfort functions and passenger comfort definitions. Details are given in chapter 6.5 and Annex VI of the Guidelines.

Generally speaking, the use of a direct indicator is the most elegant way to integrate the energy efficiency in procurement procedures for vehicles and in awarding procedures for Public Service Contracts in passenger rail services. But there are situations and considerations when this is not possible, not meaningful or not sufficient. Therefore we propose to also use → indirect indicators or requirements for → solutions, → technologies or → clusters.

EE/ENV criteria

Energy efficiency and environmental criteria are key elements for the sustainable energy policy. These criteria in awarding processes force bidders or directly contracted TOCs to propose means or services with less energy consumption or less emissions. Binding or advised inclusion of such actions reduces the specific energy consumption or provides better performance for the same energy input, cut specific energy supply costs, increases competitiveness, reduces the greenhouse gas emissions, the local air pollution and noise annoyances. Due to their most prominent relevance, the ECORailS project focuses on energy efficiency, CO_2 emissions, pollutants and noise although further dimensions of EE/ENV criteria might be considered.

Electric power supply

Generation and distribution of electric energy to the train: power stations, high voltage transmission lines, substations and their switchgear, catenary lines (definition by Railenergy).

Environmental Noise Directive (END)

The directive 2002/49/EC from July 25, 2002 requires authorities and member states in certain regions to measure and map noise pollution as a public service. Noise action plans are to be drawn up based on these assessments. The directive currently specifies which information shall be provided about noise pollution *(see Annex III)*.

Gross tonne kilometer (gross tkm)

It is obtained by multiplying the gross tonnage of a train by the number of kilometres covered. The weight is generally determined by adding the weight of the load to the actual weight of each vehicle. If the train consist is modified during the journey this must be regarded in the calculation. In case of passenger transport a notional weight for the “payload” should be used.

(See also UIC Leaflet 410!)

Hybrid (train etc.)

A hybrid traction unit has two sources of power: one source can be a diesel engine and the other can be an electric motor and/or an energy storage system (like, batteries, capacitors etc.). Also the use of fuel-cell technology is an option. With a conventional diesel electric hybrid multiple unit, the fuel consumption can be reduced by regenerative braking or switching off the hydrocarbon engine when idling or stationary.

Indirect indicator

In the context of ECORailS, an indirect indicator describes a parameter which has a major or substantial influence on the energy consumption of a train but does not describe the energy consumption itself. A typical example for such an indirect indicator is “weight per seat” which can be used for the procurement or description of passenger carriages for loco-hauled trains.

Infrastructure

Fixed installations of the railway: tracks, power supply, signalling, communication etc. (definition by Railenergy)

In-house provision

It is a special case of direct awarding where the public transport services are awarded to an internal operator.

Integral regular timetable (ITF)

Regular timetable with the additional quality that at all major nods of the railway network trains from all directions arrive at a short time before minutes 00 or 30 of every hour and depart a short time after. Thus optimal connections are realised for passengers from and to all directions.

Internal operator

An internal operator is a legally distinct entity over which a competent local authority, or in the case of a group of authorities, at least one competent local authority, exercises control similar to that exercised over its own departments.

Invitation to tender (ITT)

See →*call for tender*!

K-factor

Factor of the transmittance (ratio between radiant energy transmitted and total radiant energy incident on a given body)

Key performance indicator (KPI)

Key Performance Indicators are quantifiable measurements, agreed to beforehand, that reflect the critical success factors of an organization. Whatever Key Performance Indicators are selected, they must reflect the organization's goals, they must be key to its success, and they must be quantifiable (measurable) (from management.about.com)

Loco-hauled train

The traditional passenger train comprises a collection of coaches with suitable motive power attached in the form of a locomotive. The train is made up of sufficient vehicles to carry the traffic offering and provided with enough power for the job. A good deal of flexibility is possible with locomotive haulage. As long as the train weight remains within the capacity of the locomotive(s), any number of vehicles can be attached, although limits will be imposed by platform or siding lengths. Locomotives themselves can also be flexible, many being designed to cover a range of duties.

The advantages for locomotive hauled trains mean that they are the best option for many railway operators. In spite of that, in quite predictable operations like commuter services or metro lines, multiple units may be more efficient.

Source: http://www.railway-technical.com/tr-ops.shtml#LocomotiveHauledTrains *(shortened and slightly changed)*

Multiple unit (MU)

A powered train (or part of the train) of fixed consist (group of vehicles coupled together). The fixed consist of a multiple unit comprises both passenger compartments and propulsion aggregates.

Operational measure

Management, administrative or re-engineering action to reach specific goals mainly based on existing infrastructure and existing rolling stock without any notable investment or inventory needs.

Operational performance

In case of passenger railway operations: Figures to describe quantitatively the services which are provided, but independent from the occupancy. Main parameters: seat km, train km, gross tonne km.

Procurement, procuring

Procurement Part of Speech: *noun* Definition: obtainment Synonyms: acquirement, acquirement, acquisition, appropriation, attainment, procuring.

Procuring Part of Speech: *noun* Definition: obtaining Synonyms: acquiring, acquisition, addition, gaining, procurement.

Source: Roget's 21st Century Thesaurus, Third Edition, Copyright © 2010 by the Philip Lief Group. (http://thesaurus.com)

Public Service Contract (PSC)

The PSC is the legally binding act that confirms the agreement between the two contractors and in which the competent authority requires the public service operator to comply with quality standards and technical specifications. The PSC must be in accordance to national

law, but the actual standards and requirements may be stricter, e.g. in terms of environmental effects, than required by national or European legislations. The requirement concerning standards and techniques has also to be included in the tender documents.

Public Service Obligation

(1) Requirements defined or determined by a competent authority in order to ensure public passenger transport services in the general interest that an operator, if it were considering its own commercial interests, would not assume or would not assume to the same extent or under the same conditions without reward.

(2) Public service obligations are the objects of a public service contract: the number of runs to be done by the transport company, the rolling stock to be used, the fares to be applied, etc.

Radiant energy

Energy in the form of electromagnetic waves. *Note 1:* Radiant energy may be calculated by integrating radiant power with respect to time. *Note 2:* Radiant energy is usually expressed in joules.

radiant power:

The rate of flow of electromagnetic energy, *i.e.,* radiant energy. *Note 1:* Radiant power is usually expressed in watts, *i.e.,* joules per second. *Note 2:* The modifier is often dropped and *"power"* is used to mean *"radiant power"*. *Deprecated synonyms* **flux, radiant flux.**

The term "radiant energy" is most commonly used in the fields of radiometry, solar energy, heating and lighting, but is also sometimes used in other fields (such as telecommunications).

Rail services

RAMS (Reliability Availability Maintainability and Safety)

Regular timetable

A timetable in which trains that belong to the same route are scheduled with fixed, periodic time intervals between their train paths (from joernpachl.gmxhome.de/glossary)

This timetable is based on two fundamental elements:

- Standardisation of routes, stops and running times
- Repetitive schedules (trains follow each other at regular intervals).

Rolling stock

all sorts of railway vehicles, with or without propulsion system, including vehicles for passenger or freight transportation (definition by Railenergy).

Single-train simulation

Simulation of the run of one train over a part of infrastructure, without inclusion of effects of other trains (definition by Railenergy).

Solution

Suppliers may develop different solutions for the application of the same technology. One example is that more than one supplier offers super-capacitors for the on-board storage of energy. Asking for a specific solution can be very clause to asking for a specific product and thus cause legal problems for a PTA issuing a tender.

Specific indicator for the assessment of a specific technology or a specific solution

Different → technologies or → solutions which are implemented for the same purposes may be compared with specific indicators. These indicators must be defined individually for each cluster or technology. If you want to compare different technologies of recuperative braking you may use e.g. the recuperation rate (recuperated energy compared to the overall traction energy). Of course, operational, ambient and infrastructural conditions should be harmonised for this purpose.

Standard service profile (SSP)

Technology

The same purpose may be pursued with different, often competing technological approaches. For instance recuperative braking may become a big issue for diesel operation in the short- or mid-term perspective. Actually different (competing) types of technology are being tested or developed such as electric braking with super-capacitors for the storage of energy, or hydraulic braking using compressed fluids for the storage of energy, or electrical braking with fly-wheels for the storage of energy. Different companies may develop different specific → solutions for the same technology.

PTAs or TOCs may require certain technologies (or → clusters) in their awarding procedures if direct or indicators do not seem to be sufficient. Additionally the analysis of (or knowledge about) available technologies is essential for PTAs when they want to know which energy savings can be achieved, at what costs this might be possible and at what levels of reliability. With respect to certain technologies even more dimensions should be analysed.

To require a technology or one technology out of a group (→ cluster) in a tender is in most cases not likely to cause problems with European legislation for competitive tendering, but this should be checked before issuing the tender (see chapters 6.7 sqq. of the Guidelines.

Tender

The proposal made by a transport operator which answers to a call published by a PTA. The tender must follow the requirements which are given in the call and in its annexed documents. The time limits enclosed in the awarding documents must not be exceeded.

Tendering

Short for competitive tendering

Tonne

metric tonne (abbreviation: “t”; 1 t = 1,000 kg), to be distinguished from the british “ton” (“long ton”; abbreviated as “ton”) which has 1,016.0469088 kg

Total railway system simulation

Simulation of several trains over one or several parts of infrastructure (railway network), including effects of train performance, power supply characteristics, operational constraints (time table, conflicts between trains) (definition by Railenergy)

Traction equipment

Equipment directly needed to produce tractive or dynamic braking effort (e.g. transformer, converters, motors, gearboxes) (definition by railenergy)

Traction unit, tractive unit

One or several railway vehicles with a propulsion system (definition by Railenergy)

Train

Consist of several vehicles, including at least one traction unit, all coupled and running together (definition by Railenergy).

Transmittance

1. the act or process of transmitting
2. the ratio of the radiant energy transmitted by a body to the total radiant energy received by the body

source: Webster's New World College Dictionary Copyright © 2010 by Wiley Publishing, Inc., Cleveland, Ohio. Used by arrangement with John Wiley & Sons, Inc.

Transport performance

Wagon consist

Consist of vehicles without any traction unit (definition by Railenergy; as “wagon” usually refers to freight vehicles, ECORailS should perhaps use “carriage consist”; please comment!)

Abbreviations

dB, dB (A) – Decibel, Decibel A-weighted

CO_2 – carbon dioxide

DMU – Diesel Multiple Unit

EACI – Executive Agency for Competitiveness and Innovation

EE – energy efficiency, energy-efficient

EE/ENV – energy-efficiency and environment-related (criteria)

EMU – Electric Multiple Unit

ENV – environment-…

IEE – Intelligent Energy Europe

IM – Infrastructure Manager

ITT – Invitation to tender

KPI – Key Performance Indicator

kWh – kilowatt hour(s)

MU – Multiple Unit

NO_x – Nitrogen oxide(s)

Pkm – passenger kilometre

PM – particulate matter

PSC – Public Service Contract

PTA – Public Transport Administration

RAM - Reliability Availability Maintainability

RAMS - Reliability Availability Maintainability and Safety

SSG – Site Stakeholder Group

SSP – Standard Service Profile

SWG – Site Working Group

Tkm – tonne kilometre

TOC – train operating company

UIC – Union Internationale des Chemins de Fer *(International Union of Railways)*

UITP – Union Internationale du Transport Public *(International Public Transport Union)*

UNIFE - Association of the European Rail Industry

References

This document is mainly based on elaborations of the ECORailS project, namely the following Deliverables (published on the following website):

http://www.ecorails.eu/index_36d75fd866cd14b05686001d5948df21_de.html)

D 6 (WP 2 "Technologies"):

"Technological overview with regard to energy efficiency and environmental performance, ready to be integrated into the guidelines"

(Nov. 2009)

D 7 (WP 2 "Technologies"):

"Integration of technological feedback from the User Platform and the consortium into the guidelines"

(May 2010)

D 9 (WP 3 "Legal frame and awarding procedures"):

"Legal and economical overview including legal text modules for awarding ready to be integrated into the guidelines"

(Dec. 2009)

D 10 (WP 3 "Legal frame and awarding procedures"):

"Integration of legal and economical feedback from the User Platform and the consortium into the guidelines"

(June 2010)

D 19 (WP 6 "Dissemination"):

"1st draft of the Guidelines"

(Jan. 2010)

Please refer to the references given in the documents mentioned above. In the following we list the literature and references which are mentioned in these Guidelines or are of prominent relevance for their application:

CEI/IEC: Norme International / International Standard – 60300-3-3, Gestion de la sûreté de fonctionnement – Partie 3-3: Guide d'application – Evaluation du coût du cycle de vie; Dependability management – Part 3-3: Application guide – Life cycle costing, 2nd edition, 2004-07, Genève, 2005

UIC: Environmental specifications for new rolling stock , Leaflet 345, 1st edition, Paris, June 2006

UIC: Composition and calculation of the weight and braking of passenger trains, Leaflet 410, 6th edition, Paris, August 2006

Annex I: European law relevant for awarding and tendering

The law of the European Community contains requirements on "how" to award. The subject of the awarding is left to the discretion of the contracting authority. The contracting authority has to define, describe and procure the services needed. In principle, the Community does not regulate by law the subject of the provisions. This is prohibited explicitly by the EEC-Treaty and would violate the basic principle of subsidiarity. It is possible, though, that the Community develops and discusses their own positions and applies pressure and influences social debates by their actions respectively. This becomes apparent in the above mentioned possibilities of the Member States to focus on environmental aspects in their procurement activities, for instance the environmental guidelines with regard to awarding procedures. Eventually, the Community has a broad field of activity concerning environmental and railway policy. This is mostly done by the Commission.

1 Primary legislation

Currently the Treaty of Lisbon is the relevant Treaty of the European Community. The Treaty came into force 1st of December 2009.

Basically the principles of the European Treaty have to be observed at awarding procedures. This applies for awarding of regional rail transport as well.

The main principles of the European Treaty concerning the single European market are:

- Non-discrimination;
- Proportionality;
- Transparency;
- Equal treatment.

The European procurement directives or the minimum standards for awarding expressed in the regulation (EC) No. 1370/2007 follow these principles. This means that the principles of the European legislation can be used for interpretation or for the closure of regulatory gaps.

2 Secondary legislation

European legislation for railways

The goal of the common *transport* policy (for all modes) is to remove obstacles at the borders between Member States so as to facilitate the free movement of persons and goods. To that end its prime objectives are to complete the internal market for transport, ensure sustainable development, manage funding programs and develop international cooperation. It is also concerned with laying down the conditions under which non-resident carriers may operate transport services within a Member State.

The main focus of European *railway* policy is the opening of the transport market, interoperability and harmonisation of safety requirements of the national networks and the development of (trans-European) networks.

The instruments of the Commission to realise their objectives are:

- Legislation;
- Compilation and provision of data and knowledge;
- Exchange of 'best or good practice'-examples;
- Development of guidelines;
- Encouragement of innovations in the field of science and research;
- Harmonisation of standards [e.g. TSI (Technical Specifications of Interoperability)].

Concrete legislative measures are derived from Green- and White Papers, which are summaries of different discussion levels and give basic orientation for the transport sector and which are further substantiated to directives, regulations and decisions.

Essential legislation in the field of railways are at present:

- Regulation (EC) No 1370/2007- substantial level of transposition in Member States necessary,
- Directive 2001/14/EC – only basic regulation concerning network access, crucial level of transposition in Member States necessary,
- TSI (Technical Specifications of Interoperability) - several harmonized standards [e.g. Commission Decision 2006/66/EC concerning the technical specification for interoperability relating to the subsystem `rolling stock - noise' of the trans-European conventional rail system – high level of concretization of the regulation.]

Relevant legal framework for the award of transportation services (regional rail transport)

The relevant legal framework for the award of transportation services in regional rail passenger transport – i.e. basically "how" to award – in the EC found expression in

1) the European secondary legislation regarding the financing and awarding of public passenger transport services by rail and by road (Regulation (EC) No 1370/2007),
2) the European secondary legislation regarding public procurement (Directive 2004/17/EC – Utilities Directive and Directive 2004/18/EC - Services Directive = European procurement directives),
3) the European primary legislation, here, the basic principles of the Treaty establishing the European Community (EEC),
4) national (regional and/or local, if any) provisions regarding the awarding of public transportation services, especially resulting from transposition or concretization of European secondary legislation,
5) existing jurisdiction, primarily of the European Court of Justice (ECJ),
6) the interpretation of European Community Law by the Commission Interpretative Communication on the Community law applicable to contract awards not or not fully subject to the provisions of the Public Procurement Directives (2006/C 179/02).

The succeeding explanations focus solely on European legislation. Transpositions in national law and concretizations remain out of consideration.

a. Regulation on public passenger transport services by rail and by road (Regulation (EC) No 1370/2007)

The „Regulation of the European Parliament and of the Council on public passenger transport services by rail and by road" has its legal basis in the guidelines of the Treaty establishing the European Community (EEC) regarding the common transport policy (Art. 91 EEC-Treaty) and the common competition policy (Art. 109 EEC-Treaty) and replaces the

predecessor rules Regulation No (EEC) 1191/1996 and Regulation (EEC) No 1107/1970. The regulation intends to raise the efficiency and attractiveness of public regional passenger transport. For the first time, the regulation includes provisions which regulate the allowable financing and the awarding of public services in the sector of passenger land transport in the European Union on an area-wide basis. The directive came into force on 03.12.2009. Considering the awarding of services in regional rail transport the regulation rules in Art. 5 par. 1 that the procedure has to be executed according to the guidelines of the regulation. However, the depth of control is quite small. Art. 5 par. 3 specifies merely that:

> *"The procedure adopted for competitive tendering shall be open to all operators, shall be fair and shall observe the principles of transparency and non-discrimination."*

As long as the provisions of the European procurement directives (see No. 2) are applied in awarding procedures, the provisions are observed automatically. On the other hand, the wide guidelines of the regulation offer a far greater scope for the Public Transport Authorities (PTA) considering the design of the awarding procedure compared to the stricter European procurement directives. At the same time PTAs are able to procure transportation services in regional rail passenger transport by direct awarding as long as national legislation does not forbid. In this case the maximum contract period is reduced from 15 to 10 years. A prolongation up to 50% (or, in some cases, even longer) is possible with regard to longer amortisation periods.

Generally, the regulation applies to the Member States directly without legislative transposition. However, a large room to manoeuvre remains. Those wide scopes, e.g. regarding the awarding procedures or possible restrictions of direct awarding through national legislation, are a manifestation of the general principle of subsidiarity according to Art 5 EEC-Treaty. This article rules that the European Community takes action only in those areas (also by legislative means) if and as far as it is not possible to achieve the aims of the considered measures by the Member States themselves.

Considering the subject of the service contracts in regional rail transport to be awarded (the „what") the regulation contains only compulsory statements on how the contract has to be specified regarding financing especially to avoid overcompensation. The regulation allows in Art. 4 par. 6 explicitly the inclusion of environmental criteria into the contract:

> *"Where competent authorities, in accordance with national law, require public service operators to comply with certain quality standards, these standards shall be included in the tender documents and in the public service contracts."*

b. European procurement directives (Directive 2004/17/EC – Utilities Directive and Directive 2004/18/EC - Services Directive = European procurement directives)

Objective of the European procurement directives is to guarantee a transparent and non-discriminatory public procurement ensuring of the fundamental freedom of the Community on the basis of a common competition policy and the regulations of the Single Market (Art. 53, 62 und 114 EEC-Treaty). In contrast to Regulation (EC) Nr. 1370/2007 the awarding procedure is regulated in great detail. However, attention should be paid to the fact that the European awarding procedures apply only for contracts in the sense of those directives. The following aspects are relevant for the awarding of regional rail passenger transport:

- For the most part, application of the directives is not compulsory: According to category 18, rail services are non-priority services (Art. 21),
- The Regulation (EC) No 1370/2007 governs the awarding of public service contracts (including concessions) in regional rail transport starting 03.12.2009.

As far as the guidelines of the European procurement directives serve as a rule for awarding procedures, also the (far less strict) specifications of the Regulation (EC) No 1370/2007 are met (see above in section 1). Opposite to Regulation (EC) No 1370/2007 transposition of the

European procurement directives into national law in the sense of a standardization of national legislation has to be achieved in 2006.

There are no statements with regard to the subject of the service to be awarded. On the other hand, the directives basically allow freedom of manoeuvre for the contracting authority to specify the subject of the award, e.g. considering energy-efficiency or pollution. In general, the requirements have to be non-discriminatory. For example, the specification of a particular pollution filter (in the sense of a specific producer) would not be allowed. However, the specification of a maximum level of pollution or cleaning method would be permitted, even if these limits were stricter than required by European or national regulations of emission limits.

The establishment of specific environmental evaluation criteria for the appraisal of the offers is possible. The procurement directives define that the environmental standards

- can be associated with the subject of the contract,
- do not admit unlimited scope of action for the public authority,
- have to be mentioned explicitly in the contract notice and the tender documents,
- have to be consistent with the basic principles of EU-legislation.

At an earlier stage of bid assessment it is also feasible to assess the reliability of the bidder and, if necessary, to exclude bidders, e.g. because of registered violation against environmental law or the lack of expertise with regard to the implementation of environment management systems (EMAS[15]).

Recital 5 of Directive 2004/18/EC shows the prominent position of environmental aspects in the directive:

> *"This Directive therefore clarifies how the contracting authorities may contribute to the protection of the environment and the promotion of sustainable development, whilst ensuring the possibility of obtaining the best value for money for their contracts."*

Recital 29 describes the freedom of the public authority with regard to the subject of the contract (the „how"):

> *"Contracting authorities that wish to define environmental requirements for the technical specifications of a given contract may lay down the environmental characteristics, such as a given production method, and/or specific environmental effects of product groups or services. They can use, but are not obliged to use appropriate specifications that are defined in eco-labels, such as the European Eco-label, (multi-)national eco-labels or any other eco-label providing the requirements for the label are drawn up and adopted on the basis of scientific information using a procedure in which stakeholders, such as government bodies, consumers, manufacturers, distributors and environmental organisations can participate, and providing the label is accessible and available to all interested parties. Contracting authorities should, whenever possible, lay down technical specifications so as to take into account accessibility criteria for people with disabilities or design for all users."*

Finally, Art. 27 par. 1 of the Directive 2004/18/EC specifies further responsibilities with regard to environmental aspects:

> *"A contracting authority may state in the contract documents, or be obliged by a Member State so to state, the body or bodies from which a candidate or tenderer may obtain the appropriate information on the obligations relating to taxes, to environmental protection, to the employment protection provisions and to the working conditions which are in force in the Member State, region or locality in which the works are to be*

[15] Regulation (EC) No 761/2001 of the European Parliament and of the Council of 19 March 2001 allowing voluntary participation by organisations in a Community eco-management and audit scheme (EMAS).

carried out or services are to be provided and which shall be applicable to the works carried out on site or to the services provided during the performance of the contract."

The European lawmaker underlines by the guidelines mentioned above the high relevance of environmental protection for the Community. The guidelines express the obligation to incorporate environmental aspects in the definition and execution of common policy and measures (especially to promote sustainable development) stated in Art. 11 EEC-Treaty.

3 Jurisdiction for interpretation of Common Law

Especially the European Court of Justice (ECJ) emphasised the permissibility of environmental assessment criteria in awarding, as long as they are non-discriminatory and they are associated with the subject of the contract (see ECJ on the legal matter C-513/99 - *Concordia Bus* and ECJ on the legal matter C-448/01 – *Wienstrom*). The jurisdiction of EJC leads to the guidelines of the European procurement directives as described above.

Annex II: National legislation and peculiarities

(Summary of country reports for countries participating in ECORailS: Sweden, Denmark, Germany, Hungary, Romania, Italy)

Legislation

In the countries participating in the ECORailS project, there are no prohibitions regarding the use of a certain procedure of awarding for regional railway services.

In Italy a governmental decision ruled that by the end of 2007 all regional rail transport has to be awarded by tender. However, partly because of some bad experiences, very few competitive tenders have in reality been conducted. Therefore the legislation now leaves it to the regions to decide which awarding procedure to use. In Romania and Hungary the organisation of railway services is centralised and nearly all railway services are conducted by the nationally owned railway company which is awarded directly. Also in Sweden and Denmark, parts of the regional railway services are operated by the national railway companies. However in Sweden, the counties are responsible for awarding of the railway services within the respective county border and some regional PTAs also cooperate with each other when awarding connecting services. In Denmark, about 27 % of the railway services are today awarded through competitive tendering, organised by the national PTA Trafikstyrelsen, while the remaining services are directly awarded by the government to the national operator DSB. In Germany regional rail services are awarded by regional PTAs through competitive tendering although direct awarding also occurs.

Regarding energy efficiency legislation and policy on the national level there is no legislation directly concerning railway transport in the participating countries. General environmental strategies that do exist, concern the transport sector as a whole and not explicitly the railway sector. There are examples of some countries, for example Romania, which have funding programs for rolling stock in order to modernize the fleet. In Sweden there is a policy (but not legislation) that all energy for electric traction should come from renewable energy source.

See also table "Examples of national peculiarities in the countries participating in the ECORailS" on the next page!

Examples of national peculiarities in the countries participating in the ECORailS	
Denmark	• Majority of the services is awarded through direct awarding between government and state owned TOC DSB. In 2009 27 % of the services were awarded through competitive tendering by national PTA - Trafikstyrelsen. • State owned TOC, DSB, is obliged to provide the rolling stock to the TOC which wins a tender.
Germany	• Regional PTAs responsible for awarding of services. • Increasing number of competitive tenders, but most services are currently operated on the base of directly awarded contracts. • Rolling stock is usually awarded and provided by the TOCs. Very few PTAs own vehicles and provide them to the TOC.
Hungary	• All services except for the Budapest area is awarded through direct awarding between government and state owned TOC MAV. • National and regional passenger rail services will be open to actors within EU in 2012.
Italy	• Regional authorities responsible for choosing awarding procedure. • Direct awarding most common but competitive tendering also occurs: till now 15% of the regional rail market was tendered out. • In general rolling stock is awarded and provided by the TOCs
Romania	• CFR-SA functioning as PTA and TOC (Internal operator) under contract with the Ministry of Transport and Infrastructure. • Parts of the network are considered non-interoperable for which private companies participate in auction tenders.
Sweden	• Majority of regional services included within the interregional traffic where state operator SJ so far has the exclusive right to operate profitable lines. • Regional PTAs award rail services within county borders (sometimes in cooperation with other PTA:s) usually through competitive tendering however direct awarding also occurs. • Rolling stock usually owned by the PTAs through a jointly owned rental company.

Annex III: The Environmental Noise Directive (END), 2002/49/EC of July 25, 2002

The European Environmental Noise Directive provides a new approach of noise abatement. The consequences of this approach for the railways cannot exactly be foreseen today. The directive 2002/49/EC from July 25, 2002[16] requires authorities and member states in certain regions to measure and map noise pollution as a public service. Noise action plans are to be drawn up based on these assessments. The directive currently specifies which information shall be provided about noise pollution but the level above which noise pollution action plans have to be drawn up has to be decided upon by the member states. Furthermore, there is no European regulation to specify which minimum targets have to be attained. The directive only refers to national immission limits. Nevertheless, railway companies should assume that where railway traffic significantly contributes to noise pollution, they will be required to limit the use of noisy railway vehicles or to take measures alongside the infrastructure. These requirements could be imposed in different ways, either legal, political or regulatory.

Above all, the following requirements are relevant for railway traffic:

Up to June 30, 2007, noise maps were required for

- Metropolitan areas with more than 250,000 inhabitants and
- Main railway lines with a frequency of more than 60,000 trains per year (equivalent to an average of around 3 to 4 trains per hour and direction)

Up to June 30, 2012, additional noise maps are required for

- Metropolitan areas with over 100,000 inhabitants and
- Main railway lines with a frequency of more than 30,000 trains per year (equivalent to an average of around 1.7 trains per hour and direction)

The Environmental Noise Directive dictates to give information about two different noise levels – L_{den} and L_{night}. "den" in L_{den}" stands for "day, evening, night" which means that it is a noise level for 24 hours, combining three different measures, namely L_{day} (12 hours), $L_{evening}$ (4 hours) and L_{night} (8 hours).

The strategic noise maps are required to show, using intervals of 5 dB (A), which areas are affected by noise of the respective noise levels and estimations about the number of inhabitants living in those areas. The noise maps shall give detailed information on both L_{den} and L_{night} and show the contribution of each type of noise, e.g. railway noise, industrial noise, road noise etc. Where national noise immission limits exist, the strategic noise maps should also show where these limits are exceeded at present.

In metropolitan areas, the effects of noise must be determined for all railway lines when noise maps are compiled. The maps have to be checked and updated if necessary every five years, and additionally when there are significant developments in the noise situation. The competent authorities are obliged to draw up noise action plans. The concrete measures and the noise reduction targets are at the discretion of the authorities, but they should take into account the relevant limits of national law and most urgent areas in accordance with the results of the strategic noise mapping process. Quiet areas should be protected against increased noise.

The time limit for drawing up the plans is July 18, 2008 and July 18, 2013 respectively, according to the noise mapping phase. To date, there are no legal requirements as to which noise pollution reduction targets should be met. However, depending on local conditions (noise pollution, sensitivity of the population, density of the population, track noise),

[16] Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise

considerable reduction measures can be planned. These measures could affect the railways even though, taken by themselves, their noise emissions do not cause the immission threshold values to be exceeded. In annex V of the directive 2002/49/EC, explicit measures for the following fields are given:

- 'traffic planning,
- land-use planning,
- technical measures at noise sources,
- selection of quieter sources,
- reduction of sound transmission,
- regulatory or economic measures or incentives'.

Based on these suggestions, or even exceeding them, it can be assumed that the authority responsible for the noise immission protection will choose one or more of the following possibilities for controlling the situation:

- Influencing the planning approval procedures when rail lines are upgraded or newly constructed;
- Agreeing track-side noise reduction measures with the infrastructure operator, and participate in the costs if necessary;
- Agreeing operative measures with the infrastructure operator, if necessary including different types of restrictions on the use of noisy railway vehicles;
- Imposing regulatory conditions on the infrastructure operator, for example noise contingents;
- Reaching agreements with the train operating companies (TOCs) that make most use of the line in question, or that are particularly responsible for the noise pollution;
- Imposing regulatory conditions on those TOCs;
- Reaching agreements with the Public Transit Authorities (PTAs) on measures for avoiding noise emissions (vehicle quality, changes to timetables, investments in infrastructure, other operational measures).

As far as heavily frequented rail freight lines are concerned, it will not be typical for the environmental authorities to require a TOC to carry out measures since particularly those lines are generally used by several TOCs. The environmental authorities, however, can also directly contact the PTA over emissions originating from their regional passenger railways. Particularly for railways, which together with their infrastructure are owned by local or regional authorities, it is conceivable that they will be contacted directly.

The extent to which railways will be affected by noise action plans is not yet clear, but it is likely that the consequences can be severe. Also commuter lines in urban areas with dense traffic will probably be affected, as dense traffic means a lot of trains and noise emissions and those lines serve agglomerations and cross a lot of sensible areas, like residence areas, schools, hospitals and so on.

Although 60.000 or 30.000 trains per year do not seem to be a very high usage of a train line, such lines contribute to the overall noise burden and may therefore be affected especially in agglomerations or in the neighbourhood of industry or roads.

In general environmental authorities, public transit authorities, infrastructure managers and train operating companies should negotiate for a common approach and find the most effective and most economical way to reduce railway noise in the respective region.

(Source: Extract from: Matthias Pippert, The Political and Economical Relevance of Rail Noise Abatement; in: A. Bracciali/M. Pippert/S. Cervello, Railway noise: the contribution of wheels, 2009, pp. 116-165)

Annex IV: The Air Quality Directive, 2008/50/EC of 21st May 2008

[Description of the Air Quality Directive will be added later on.]

Annex V: Steps and examples for elaborating the criteria

Phase B: Preparation of awarding documents (To be done by the PTA, could be partly or fully outsourced)

1. Describe the baseline, calculated in the preliminary considerations phase.
2. Drafting text for minimum standards
   - Drafting required criteria – example

     "*The energy consumption [according to the baseline] of the vehicles used for the services is not to exceed [specified value] per [indicator]"*
   - Drafting text for penalty scheme for non-compliance to the required energy consumption. The levels need to be proportionate.
3. Drafting text for advanced criteria (i.e. evaluation criteria, bonus/malus system).
   - Drafting text for compensation levels for incentive scheme. The levels need to be proportionate and should take into consideration energy charging systems for electric traction and the estimation of energy costs in relation to the total cost. Example:

     "If [indicator] is lower than [baseline] for a certain year, the TOC will receive economic compensation for the year specified. Decreased energy consumption [indicator] is valued to ____ € per [unit below the baseline]. The maximum level of compensation is ____ € per [unit, i.e. train km and time period] in the awarded service package."
   - Drafting text for weighting scheme. Example:

     "*The energy consumption is to be presented in the tender based on energy consumption per [indicator] according to the baseline. The energy consumption will in the evaluation be valued to [weighting system]."*
4. Drafting text concerning how the criteria will be evaluated ➔ *Phase D (Evaluation phase)*
   - Requirements will be evaluated through Yes/No.
   - Weights for evaluation of tenders should be based upon the estimated potential to reduce the consumption and the estimated energy costs in relation to the total costs for the contract. For weighting the criteria several scoring models are available:
     - Maximum score to the best tender
     - Maximum score to tenders that reach a settled threshold
     - Proportional scoring
     - Complex functions
   - Describe how the specified energy consumption will be verified. A combined test is suggested with acceptance by the customer of the prototype in controlled conditions.[17] ➔ *Preparation of contract period*
5. Drafting text how the criteria will be monitored during the contract phase. ➔ P*hase F (Contract period).*

   Drafting text for monitoring is needed if a bonus/malus system is used in the contract, i.e. if an incentive is used or a penalty scheme is implemented for non-compliance to the required indicator.
   - In order to monitor the consumption, the necessary technology for monitoring (e.g. energy meters) must be required.

[17] Specified in chapter 5.5 of Deliverable 7 ("Integration of technological feedback from the User Platform and the consortium into the guidelines")

- The awarding documents must describe the methodology for monitoring (e.g. constant monitoring with compensation/penalties being based upon the overall annual consumption, or a specifically measuring period).

6. Validation and reporting of results

Annex VI: Additional information on direct performance indicators

1. Different approaches to calculate, to test, and/or to monitor the energy consumption

There are mainly four different approaches to calculate and to test (or monitor) the consumption of traction energy of railway rolling stock:

(1) According to a Standard Service Profile (SSP); test runs on certified test facilities, with certified reporting;

(2) According to a service profile which has been specifically defined by the PTA; test runs on certified test facilities, with certified reporting;

(3) According to a defined timetable on a particular line; test runs on this very line with certified reporting. The test line may be that one the rolling stock is dedicated to, but could also be another one with similar profile but better conditions for testing.

(4) Real energy consumption of a specific operation during a specified period of time.

If new rolling stock shall be procured (by PTA or by TOC), options (1), (2) and (3) are applicable. In all cases, the test line and the test conditions should be the same for all "competing" vehicle designs. When defining the service profiles the side conditions which are described below ("Analysis of the current service profile") should be analysed and defined.

If the PTA wants to award a service with rolling stock provided by the TOC, a two-step approach could be appropriate. Firstly, the rolling stock which is offered by the TOC should be described and analysed according to one or more of options (1), (2) or (3). Also in this case the test definitions should be identical to all bidders. The second step would be the calculation and monitoring of the energy consumption in real operations (option (4)), thus including operational measures. Although the vehicle design has a big influence on the real energy consumption during the operations, option (4) also presents the effects of good or bad maintenance and of the consistent application of operational measures like energy-efficient driving. On the other side, for the pre-calculation of the energy consumption of the real operations, the consumption patterns of the rolling stock need to be known. The energy consumption of the rolling stock can be verified before starting the operations while the real consumption of the whole operation can only be tested a certain time (e.g. one year) after start of the operation.

If the PTA provides the rolling stock for the services to be awarded, only option (4) is relevant for the assessment of the bids. In spite of that, the bidding TOCs need to know the consumption pattern of the provided rolling stock according to one of the options (1), (2) or (3). So the PTA will be requested to provide the respective information to all (qualified) bidders. If the PTA procures the rolling stock purposely for the actual services to be awarded, the information which results from the procurement process can be used. If existing rolling stock will be used, the PTA will have to realise calculations and measurement campaigns in order to provide the necessary information for the bidding TOCs.

2. Analysis of the current service profile

If the PTA considers using a direct indicator for the assessment of the energy consumption, it is essential to analyse the relevant parameters of the services in question. This includes three groups of parameters:

- Characteristics of the train

- Characteristics and conditions of the line and
- Ambient conditions.

The energy consumption of a railway vehicle can be defined as the amount of energy that, through the diesel fuel tank or the electrical supply collector (pantograph), flows to the train, irrespectively of how that energy is used, minus regenerated energy that flows back, through the electrical supply collector (pantograph), to the overhead contact line.

The energy consumption of a train depends on the energy consumption of the following equipments:

- Traction system, e.g. traction motors, transformers, converters, auxiliary traction equipments (mechanical fans and pumps, etc.), electrical line filters, gearboxes, axles and wheels, etc.; their energy consumption (dissipated energy) could be more than 45% of the total consumed energy;
- Auxiliaries, e.g. mechanical fans, air compressors for pneumatic brake systems and other pneumatic actuators, doors closing systems, etc.
- Comfort functions, e.g. heating, ventilation and air conditioning systems (up to 10% of traction power could be spent for air conditioning), etc.

In particular the energy consumption depends on the real efficiency of each of these equipments related to their instantaneous operational parameters and their maintenance conditions. Some of them consume energy also during standstill and parking phases (through pantograph or through a special heating terminal).

Basic parameters that influence the energy consumption for traction purposes are the **characteristics of the train**:

- **Length and weight (train fully equipped for service operation without passengers on board);**
- **Pay load weight;**
- **Maximum speed;**
- **Service acceleration and deceleration rate;**
- **Additional resistance (e.g. curves and gradients);**
- Traction and electrical braking effort versus speed;
- Resistances to forward motion versus speed;
- Wheel diameter at new and maximum wear values;
- Factor for rotating masses or dynamic mass;
- Braking energy recovery capability and its efficiency (where applicable);
- Braking energy storage capability and its performance, e.g. see **Fehler! Verweisquelle konnte nicht gefunden werden.**, (where applicable);
- Tilt systems (where applicable).

The characteristics given in bold letters can be influenced by the PTA or depend on the individual line the train is dedicated to. The characteristics given in normal letters depend on the technical concept and the design of the rolling stock and are thus within the scope of the manufacturer.

In line with the definitions of the Railenergy project, the comfort functions should be defined and analysed separately from the energy which is needed for traction and traction auxiliaries. In spite of that, the energy consumption resulting from comfort functions will be incorporated in the "Real energy consumption of a specific operation during a specified period of time" *(see option (4) in the first paragraph)*.

The **characteristics and conditions of the line** that affect the energy consumption are:

- Longitudinal profile (total length, mileage points and altitude of stations as well as start and final points of each section, with different gradient;
- Speed profile (permanent speed limits and temporary speed restrictions);
- Position of tunnels, section and length;
- Curve radius;
- Nominal characteristics of the electrification systems (AC/DC, voltage, frequency);
- The mean voltage at the pantograph.

All of these characteristics are within the scope of the PTA or the infrastructure manager (IM) which should provide the according information.

With reference to the real set of characteristics and conditions of the line, it is possible to define a **specific service profile** *(relevant for options (2) and (3) in the first paragraph of this annex)*.

The use of a reference service profile *(see option (1))* might be a possible alternative. For this purpose the most appropriate **standard service profile** out of the following ones can be selected:

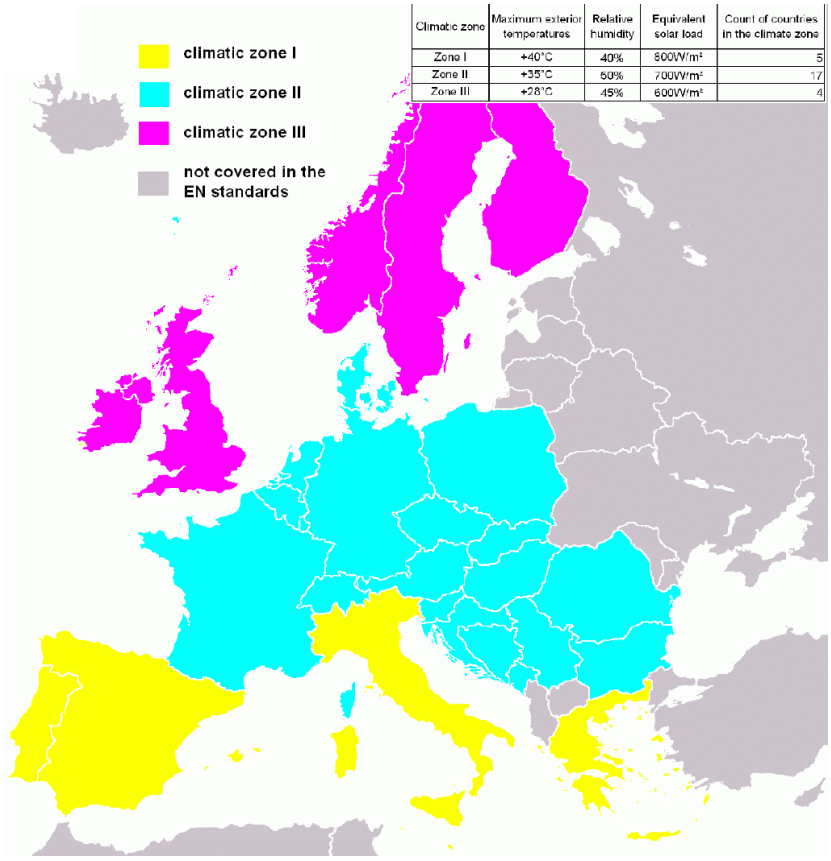
- Suburban;
- Regional;
- Intercity.

These standard service profiles are currently being developed by the Railenergy project.

The concerned **ambient conditions** are:

- Altitude (above sea level);
- Air pressure;
- Front wind velocity (average front wind in operation);
- Temperature (mean value, minimum value in winter season and maximum value in summer season);
- Relative humidity;
- Equivalent solar load (intensity of sun light in W/m^2).

The parameters for the last three bullet points can be identified referring to the specifications of the European standards climatic zones (e.g. see Fig. 1) defined by EN 14750 (urban and suburban rolling stock) and EN 13129 (main line rolling stock).



Climatic zone	Maximum exterior temperatures	Relative humidity	Equivalent solar load	Count of countries in the climate zone
Zone I	+40°C	40%	800W/m²	5
Zone II	+35°C	60%	700W/m²	17
Zone III	+28°C	45%	600W/m²	4

Fig. 1: European standard climatic zones [15]

From a general point of view one train on a network needs energy for the journey from A to B. If there are no trains disturbing it, it is possible to calculate the energy consumption considering the parameters and conditions defined above. For this purpose, a clearly defined, measurable, calculable, verifiable and commonly accepted energy consumption evaluation for a specific service profile and a specific driving style can be applied.

If other trains are running on the same network the calculation is more difficult because other trains may disturb the run and cause delays, therefore the energy consumption is partly out of the control of the train itself.

In the latter case, it is advisable to conduct test runs on lines with similar profiles but more simply side conditions *(see option (3))*. Also the analysis of the real energy consumption *(see option (4))* will be complicated, and appropriate tolerances should be defined.

3. Baseline indicators

There are two main reasons why it could be helpful for a PTA to analyse the current energy consumption on the line(s) which it intends to award ("baseline"): firstly in order to be able to estimate the potential for saving energy during the next contract period (or by procuring new vehicles), which is in turn relevant for the weighting of the EE criteria; secondly in order to provide basic information for the bidding TOCs about the current situation and operating conditions. Thus the TOCs can better calculate their energy consumption and costs. These purposes imply that two kinds of information are relevant:

(1) The real energy consumption of the respective services

(2) The technical standard of the rolling stock which is currently being used as well as the operational standards of the line(s).

The best option would be to have measured data about the direct indicators (kWh per seat km, kWh per train km, kWh per gross tonne km). The direct indicators can be measured dependent or non-dependent on the load factor starting from the real energy consumption (kWh or l) measurement.

Alternatively the present energy consumption could be estimated by using data about the vehicle classes, their relevant features in terms of EE criteria and their share of the operational performance. In this case the database should include (as far as available):

- Overall amount of train km;
- Locomotive classes used for which amount of train km (or gross tkm);
- DMU/EMU classes used for which amount of train km;
- Real energy consumption on the operated lines;
- Data by vehicle classes:
  - energy consumption of existing traction units (locos, MUs),
  - carriages in operation (including weight per seat),

In order to calculate the baseline in terms of kWh per seat km (or per train km or per passenger km respectively) each transport service and for each traction unit series, in addition to the measured values of the energy consumption, it is necessary to know the following parameters about the traffic:

- Passenger km;
- Seat km;
- Gross tkm hauled in regional passenger operation.

It is also important to monitor the regularity of operations or the average commercial speed, to take into account the effects of unforeseen speed restrictions that are under the responsibilities of the infrastructure manager (IM) or other irregularities modifying the planned operation. In many cases it may be possible to use the data which are collected by the IM for the assignment of the responsibilities for delays.

4. The monitoring system for evaluating the keeping of the contract

As far as the specific testing of rolling stock is concerned *(see options (1), (2), and (3))*, the variability of the energy consumption due to different driving styles would cause problems if the evaluation of direct performance indicators took place during the real operation of the rolling stock. In case of test runs the driving styles which are recommended by the manufacturer should be applied. The actual driving styles during the real operations depend on the training and behaviour of the drivers and on side conditions. These circumstances are not within the scope of the manufacturer and should not influence the testing of the EE quality of the vehicles.

In both cases a monitoring system to evaluate the keeping of the contract should foresee:

- the specification of a limit or reference value for the direct indicator “energy consumption per seat km” (or per train km)[18] to be fulfilled by the proposed rolling stock (optionally combined with bonus/penalty clauses in case the effective value of the indicator will be less or more than the defined limit value);

[18] This direct indicator refers to the KPI2 of the Railenergy project : « Energy consumption per offered capacity (kWh / seat km) with the specification about the number of passenger per m^2 considered to calculate the standing seats».

- to ask the manufacturers or the TOCs for calculating and providing their best offered value for KPI2 and KPI4 (again as foreseen for the RAMS indicator).

In any case the PTAs have to specify all the characteristics and conditions mentioned in chapter 2 of this annex with a sound methodology and reference to the state of the art.

In order to clearly measure the energy consumption in a commonly accepted and agreed (legally secure) way, the specified line or for the selected reference track, a combined test could be performed during the commissioning phase (acceptance by the customer of the prototype) in the following controlled (during the test) conditions:

- Respect of the driving style suggested by the manufacturer or the TOC
- Test runs according of the specified timetable;
- No other trains disturbing the test (respect of timetable without any delay);
- Agreed energy meters to measure the energy consumption[19] with: different payload (train fully equipped for service operation but without passengers on board, maximum payload, estimated payload); an agreed overhead contact line voltage (e.g. minimum and/or nominal value); an agreed energy receptivity (where relevant) by the overhead contact line (e.g. completely receptive and/or not receptive overhead contact line, to consider the extreme conditions);
- Evaluation of the energy consumption (kWh per seat km or per train km) (on the basis of the simulated payload condition) and comparison with the offered values.

Combined tests for a new class or series of vehicles is anyhow foreseen for other purposes (e.g. the authorisation process by the national safety authority in case of a network linked to the national network or from the Ministry of Transport or other local authorities in case of railway infrastructure which is not under national control). The results of previous tests, related to previous contracts, could be evaluated by PTAs if made available by previous customers because they have the property of these results, as provided for by EN 17025.

The description of the monitoring system for the energy consumption in the real operation should refer to the cases already identified before:

- Network technically unlinked with other networks and the awarded services are the unique ones on this network;
- Network linked to other networks or used by trains with different characteristics and/or operated by different TOCs.

In the more complicated technical environment described by the second bullet point, the variability of the energy consumption is not only due to the different driving styles but also to the delays of trains caused by other TOCs or by the IM. The consumption and recovery patterns of the other trains should also be considered.

For the monitoring of the real operational performance appropriate energy meters on-board of the locomotives or MUs should be used. The resulting data can be used for the verification of the level of energy consumption which was agreed upon in the contract, or for the application of the bonus/penalty clauses specified in the contract.

[19] The compliance with TSI and CENELEC standards under the definitions of EN 50463 and UIC-leaflet 930 should be considered. For further information see chapter 5.4 of ECORailS Deliverable 7 “Integration of technological feedback from the User Platform and the consortium into the guidelines”

Annex VII Overview: specific indicators (monitoring parameters) for technologies and operational measures

In Table 1 and Table 2 the correspondence between the most suitable monitoring parameters and the clusters of technologies and operational measures is summarised.

Clusters of technologies	**Specific indicators (monitoring parameters)**
T1: Train formation or typology	• Weight per seat • Average axle weight • Vehicle weight
T4: Use of particular materials or structures for mass reduction	
T2: Noise and vibration reduction	• Noise emissions
T3: Optimization of comfort functions	• Energy consumption with and without the technology • K-factor (e.g. as specified by EN 14750 or EN 13129)
T5: Improvement of traction equipment efficiency	• Efficiency of the transmission system • Average value of power required from electric substation • Energy consumption • Electric energy at the pantograph during the service braking from specified initial speeds (where applicable)
T7: Reduction of energy consumptions	
T8: Reduction of exhaust pollutants	• Pollutant emissions • Energy consumption in a specified service profile
T10: Revamping of existing vehicles	• Energy consumption before and after the modernization • Noise emissions • Weight per axle or vehicle weight • Pollutant emissions
T11: Unconventionally propelled locomotives or Multiple Units	

Table 1: Specific indicators (monitoring parameters) suitable for clusters of technologies

Clusters of operational measures	**Specific indicators (monitoring parameters)**
M1: Training program to raise awareness of personnel	• Energy consumption before and after the application of the measure
M2: Energetic optimization of timetable	
M4: Optimization of train operation by control centre	
M5: Energy meters	• The measures in these clusters are monitoring systems on their own
M6: Management and organization	
M8: Noise reduction	• Noise emissions

Table 2: Specific indicators (monitoring parameters) suitable for clusters of operational measures

Annex VIII: Approaches for the evaluation of economic potential and implementation time of technologies and operational measures

Economic potential

Economic potentials (on LCC basis) have been evaluated by the following approach:

- Implementation Cost (IC): it represents the initial investment for onboard equipments and/or for infrastructure changes required by the technology or operational measure:
  - High: > 1% of initial investment of the vehicle,
  - Medium: 0,1% ÷ 1% of initial investment of the vehicle,
  - Low: < 0,1% of initial investment of the vehicle;
- Operational Cost (OC): it is represented by vehicle running costs directly caused or influenced by the technology or operational measure (energy cost and costs for operating personnel):
  - Higher in comparison with a situation without solution implementation,
  - Similar in comparison with a situation without solution implementation,
  - Lower in comparison with a situation without solution implementation;
- Maintenance Cost (MC): this category includes all kinds of cost to repair failures and/or to prevent potential problems that could compromise operational service; they include materials and technical personnel costs:
  - High: > 1% of initial investment of the vehicle,
  - Medium: 0,1% ÷ 1% of initial investment of the vehicle,
  - Low: < 0,1% of initial investment of the vehicle;
- Disposal Cost (DC): costs related to the end-of-life of technical equipment; it includes demolition, disposal and selling off costs:
  - High: > 1% of initial investment of the vehicle
  - Medium: 0,1% ÷ 1% of initial investment of the vehicle
  - Low: < 0,1% of initial investment of the vehicle

Implementation time

The implementation time given in these Guidelines for a specific technology or operational measure is a global estimation of:

- *development time* for the availability in the railway market;
- *administrative time* for the procedures to issue purchase orders to acquire specific equipments involved by a technology or by an operational measure; in particular it involves:
  - financial time, availability of financial sources,
  - technical time, procedures exploitation,
  - legal time, integration into the set of regulations, (clarification of safety issues with Safety Authority and working rules with trade unions to be verified in advance),
  - management, acceptance of environmental responsibility;
- *construction time* for the specific equipments involved by a technology or by an operational measure;
- *installation time* to assembly the specific equipments.

The proposed ranges for the total time horizon are:

- Short time: < 1 year;
- Mid time: 1÷5 years;
- Long time: 5÷10 years;
- Perspective: > 10 years.