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

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8.1. Transnational comparison tables[1]

8.1.1. Description of the four test sites

TOPIC	BERLIN	TIMISOARA	ØRESUND	LOMBARDY
Geography	• plain • big city (3869 inhab/km^2) + lower density outskirts (87 inhab/km^2)	• plain + hills • mixed urban+rural • 60.1 ab/km^2	• international • 2 dense urban + smaller urban + sparse rural • 176 ab/km^2 (more on Danish side)	• S3: plain; VC: mixed • S3: dense urban (6193 inhab/km$_2$) VC: mixed (432 inhab/km$_2$)
Economy and Society	• GDP 1% below EU27 average (Berlin), 18% below EU27 average (Brandenburg) • developing industrial + services • 21% inhab ≥ univ (BE) 13% inhab ≥ univ (BB)	• GDP/ab ½ EU27 average • 2nd developed in Romania all sectors • 18% inhab ≥ univ	• GDP 20% over EU27 average • developed area • 33% inhab ≥ univ or other high level	• GDP 35% over EU27 average • developed area (services, industry) • 12% inhab ≥ univ
Regulatory framework	• 2 Fed. States acting as PTA (strong links) • VBB, owned by PTAs: awarding manager, coordinator of transport services • ongoing tendering for services	• national Ministry acts as PTA • direct award CFR • tenders on non interoperable lines • publicly funded tenders for CFR vehicles	Sweden: • regional PTAs • competitive tender • Transitio provides rolling stock (PTA) Denmark: • Ministry as PTA • direct award admit • DSB TOC provide rolling stock	• Region acting as PTA • direct awarding (after competitive tendering test) • part of rolling stock owned by the Region supported by the IM

[1] Author: ALOT, Brescia (Italy).

TOPIC	BERLIN	TIMISOARA	ØRESUND	LOMBARDY
Institutions	• 2 Federal States • 14 administrative districts (Brandenburg) • 5 municipalities (Berlin, Potsdam, Cottbus, Brandenburg/H., Frankfurt/O.)	• 4 counties + 12 municipalities	SE: 1 region + 33 municipalities DK: 2 regions + 46 municipalities	• S3: 7 municip. • VC: 48 municip. • 3 levels: Region, Province, municip.
Traffic	• RE6, RE7 missing • Berlin: dominant versus Brandenburg • 42% load factor (average Berlin + Brandenburg)	• 0.04€/paxkm • 56% load factor	• regional • international commuting • increasing	• VC: low traffic, 0.05€/paxkm, 26% load factor • S3: crowded, 0.04€/paxkm, 40% load factor • short trips
Infrastructure	RE6: - 83% diesel, 17% 15kV/16.7Hz AC - 168 km - 85% single, 15% double - <200/00, - 92% max 120 km/h, 8% max 250 km/h RE7: - 100 % 15kV/16.7Hz AC - 181 km - 100% double - <200/00 - 65% max 160 km/h, 28%max 120 km/h, 7% max 100 km/h	• TJ: diesel, 39 km single secondary line , <20 0/00, max 80 km/h • TC: electric AC, 98 km single (7.9 double main railway, <200/00, max 120 km/h	• Nivå-Kastrup: electric AC50Hz, 44.3 km double, max120 160kmh • Elsinore-Malmö: electric AC 50Hz and 16.7 Hz, 60.8 km double, max120 180kmh	• VC: diesel, 103 km single, 200/00 mountain, 100/00 plain, 60-90 km/h • S3: electric DC, 21.5 km 4 tracks < 90/00, 85-120 km/h

Lines involved in the Pilot Applications: Berlin-Brandenburg: RE6, RE7; Timişoara: TJ (Timişoara – Jimbolia), TC (Timişoara – Caransebes); Lombardy: VC (Valcamonica), S3.

8.1.2. Baseline

TOPIC	BERLIN	TIMISOARA	ØRESUND	LOMBARDY
Baseline Service	• RegioExpress • every 60/120min • 65 km/h • RE6: 108-216 seats, 1stop/8 km, 1.9 mio trainkm • RE7: 457 seats, 1stop/ 5.8km, 2.4 mio trainkm	TJ: • R 6 pairs, • commercial speed 46.96 km/h • 54-340 seats, • 1 stop/5.57 Km, • 468 trainkm/day TC: • R and RE 32 trains, • commercial speed 62.27 • 123-436 seats, • 1 stop/11.56 Km, • 3,146 trainkm/day	• profile not specified • every 10 min in common section • 53-56 km/h • 176-639 seats • 1 stop/3.5 km	VC: • RE, R, S every 120 min. each • 60, 42, 52 km/h • 68-200 seats • 1 stop/3, 3, 9 km • 1.1 mio trainkm S3: • S every 30 min • 36 km/h • 363-875 seats • 1 stop/1.7 km • 0.59 mio trainkm
Rolling stock	• RE6: recent DMU • RE7: old loco + 4 coaches 2 decks	• TJ: mixed (see) • TC: mixed (see)	• IR4 + ET EMUs • 1 deck • recent	• S3: EMUs 2 decks 11 years • VC: old DUs + 2 new DMUs
Energy consumption	• meters: yes • RE6: Euro IIIA 14.1 kWh/km, 0.065kWh/seatkm • RE7: no recovery 12.7 kWh/km 0.027kWh/seatkm	• meters: yes	• meters: yes	• meters: no • VC: Euro IIIA 7.4–15.1 kWh/km 0.1 kWh/seat*km • S3: recovery 16.7 kWh/km 0.037kWh/seatkm

Lines involved in the Pilot Applications: Berlin-Brandenburg: RE6, RE7; Timişoara: TJ (Timişoara – Jimbolia), TC (Timişoara – Caransebes); Lombardy: VC (Valcamonica), S3.

TOPIC	BERLIN	TIMISOARA	ØRESUND	LOMBARDY
Actual awarding documents / procedures	• ongoing competitive tendering • use EE/ENV criteria in present awarding documents is unknown	• present awarding documents • no use EE/ENV criteria	• coordinated SE +DK tendering for service • in SE ENV requirements	• public service contract RL-TRENORD • no use EE/ENV criteria
Economic framework	• confidential	• EU law compensation incl. profit	• gross cost at tendered subsidy	• net cost 7.22€/km • VC: fuel 6% costs • electric lines: energy 8% costs
Stakeholders' expectations	PTA: • public budgets • energy prices • legal actions for noise TOC: • economic impact • competition Manufacturers: • preparation • competition	• how legally bind suppliers during entire life cycle • manageability • whether projects target are attainable in Timisoara	• ready to use document • no external search • help for right weighting	• convincing potentials and advantages • PTA: fear of bureaucracy and side effects (slower trains) • manufacturers: high weight to EE/ENV in the awarding of rolling stock

8.1.3. Description of the tests

TOPIC	BERLIN	TIMISOARA	ØRESUND	LOMBARDY
Kind of ECORailS test	1. Guidelines test (workshops) 2. criteria for tendering virtual lines RE 74, 75, 76 3. simulated consumption	1. Guidelines test (workshop) 2. simulated awarding of 10 EMU+10 DMU 3. tests on existing rolling stock 4. comparative calculations	1. Guidelines test (workshop) 2. Simulated awarding of services no scoring 3. simulated consumption	1. Guidelines test (workshop) 2. tests on existing rolling stock 3. framework agreement incl. contract changes
Applied laws	• EU and national • political instruments for climate protection	• EU • national esp. about public acquisition • Government Decision about noise	• EU + national • environmental action plan (SE)	• present EU, national and regional
Awarding text prepared	• evaluation criteria for the awarding of services	• procurement specifications • contract	• changes of the specifications in the present awarding doc.	• contractual clauses beginner and advanced
Agreement planned	• agreement among the participants to the workshop process	• to be specified	• feedbacks internal and to the Government	• agreement between Region and TOC (+ IM) for implementation of ECORailS
Changes needed	• no legal problems	• EU should impose ECORailS criteria • local procurement law (award criteria) • how legally bind suppliers during entire life cycle	• no	• EU should impose ECORailS criteria • new way of charging electricity

8.1.4. Achieved results (energy consumption)

TOPIC	BERLIN	TIMISOARA	ØRESUND	LOMBARDY
Compared to current awarding	up to 9%	10.5 %	12.9 %	8 % - 10 %
Compared to currently used rolling stock	evaluated during the workshop process with the stakeholders	15.6 %	no change of rolling stock in the pilot	no change of rolling stock in the pilot (10% monitored)
At system level	evaluated during the workshop process with the stakeholders	27.56 %	15 % reachable with additional investments	15 % reachable by implementing the agreed mid-term plan

8.2. Berlin site workshops[2]

This paragraph gives more details of the workshop process performed during the Berlin Pilot Application: the key discussion points and the main findings of the 12th March 2010, 10th June 2010 and 30th September 2010 workshops are reported, while the final evaluation and conclusions reached in the 27th January 2011 meeting are described in the D14 main text.

8.2.1. 1st Berlin Test Workshop, 12 March 2010

An Information and Preparation Workshop took place on 29 January 2010. This workshop gave the opportunity to the stakeholders to introduce to each other, to get familiarised with the ECORailS project and its goals and to formulate their expectations to the workshop process.

The 1st Berlin Stakeholders Group Test Site Workshop took place on 12 March 2010. Most of the participants of this workshop already took part at the Information and Preparation Workshop. The main goals of the workshop were

- to elaborate a current knowledge and information base for regarding EE/EF criteria (indicators, weighting, costs, potentials, risks)
- to discuss aspects for minimisation of PTAs' and TOCs' risks regarding energy consumption and CO2, exhaust and noise emissions

The following leading questions had been discussed:

- What information is needed by a PTA regarding the categories infrastructure, operation, vehicle technology and administrative law to introduce EE/EF criteria into the awarding process for public rail transport services?
- What will be the right strategies and target values to the PTA's regarding old, new and upgraded vehicles?
- What is the status quo of addition and forwarding of energy costs in current service contracts? What conclusions can be drawn to the indexing of energy prices?
- What is the status quo of energy consumption, emission of noise and pollution? What are the target values of emissions of green house gases, noise and exhaust gases?

<u>Main results of the discussion</u>

- A general environmental concept including was requested from the bidders during the test awarding procedure (network "Stadtbahn"). It was weighted with nearly 2%. The requirements were given not as a minimum standard. The limit values of TSI Noise have been fulfilled by all vehicles, but the requirements of the awarding were slightly stronger and have not been fulfilled. A stepwise increase of limit values for noise is not foreseen.
- At an early stage information is necessary about aimed more ambitious energy and environmental political goals of the PTAs and their specific demand. The industry needs between 3 and 5 years for realisation of long-term strategies including authorisation.

2 Author: TSB, Berlin (Germany).

- The main goal of the ECORailS Guidelines will be the canalisation of the interdependencies between PTAs, industry and TOCs. The guidelines should enable the PTAs for developing of calculable strategies regarding the environmental effects. LCC considerations seem to be interesting for PTAs in advance of an awarding procedure. They give them the possibility for realistic estimations about the technological potential regarding the costs. The PTAs have to use and further develop certain planning instruments, e.g. urban development plan, noise action plan, short distance transport plan.

Main focus "Noise"

- The research on different noise emission relevant influences, e.g. rolling noise at the straight track, noise in curves, propulsion noise, track quality and maintenance status of vehicles, is ongoing. Current results have to be considered for future awarding procedures. It has to be proved whether noise measurements are possible at certain high deposition points of the network.
- For future awarding procedures, noise target values which are a bit more ambitious than TSI Noise should be required. Furthermore the weighting of the noise criterion amongst the other environmental criteria should be discussed.

Main focus "Exhaust gas emission"

- Due to cost risks from the industries' and TOCs' point of view retrofitting of vehicles is hindered by the short duration of service contracts, by probably necessary new authorisation and by the small number of units to be retrofitted.
- Regarding exhaust gas emissions limit values were not required during the latest awarding procedure. Values of exhaust emissions are available for the Stadler DMU GTW 2/6.

Main focus "Energy consumption"

- The energy costs are shared by 20 % of the total costs per train km. For the current service contracts the risk of rising energy prices is covered by the PTAs according to this fixed share. Therefore the PTA is not participating on decreased energy consumption of the TOCs and rising energy prices are risky for the public budgets.
- As being a basis for calculation of the offers, the TOCs are not about to provide the PTAs with energy consumption data in the current situation. But, information about energy consumption will be of public interest in the near future.

8.2.2. 2nd Berlin Test Workshop, 10 June 2010

The 2nd Berlin Test Workshop addressed the underlying strategy of regional PTAs in Berlin and Brandenburg regarding energy and the environment, as well as a discussion of how to prepare an awarding process accordingly.

Key results

PTA representatives stressed that current awarding procedures are unsuited for innovation, a claim that was confirmed by industry representatives in attendance, saying there is very little demand for existing green technology for fear of costs.

In order to promote innovation in regional awarding, the SWG and SSG reached the following key conclusions:

- There are numerous political statements of intent, as well as several more informal development plans relevant to environment- and energy-related aspects in the awarding of regional public transport contracts. Many of these include ambitious targets in terms of energy and environmental protection. Compared to the average duration of transport contracts, however, the planning periods they address are often too short.
- More negotiation about and integration of development plans is needed both on a political and administrative level into a combined planning of transport and energy and other environmental matters.

Further conclusions on individual topics:

Indicators

- Detailed and comparable information on tracks, train and external factors is needed with regard to the indicator kWh/seat km.
- The actual energy consumption of TOCs is regarded as a trade secret and thus protected, making an effective monitoring of energy consumption difficult.
- An estimation of LCC-costs via simulation, however, is possible, as attending academics confirmed.

Retrofitting

- Retrofitting of motors or vehicles poses the risk that vehicle licenses will not be renewed.
- The guidelines should contain information on when retrofitting might necessitate applying for a new vehicles license.

Weighing criteria

- The importance of individual environmental criteria varies according to region, with noise being more of a concern in dense, urban areas such as Berlin, than in Brandenburg, where energy consumption is more of an issue.
- There need to be ways of weighing criteria in the awarding process according to regional requirements.

Elaboration

- There need to be incentives encouraging TOCs to take offers beyond minimum requirements and invest more money in the beginning in hope of higher profit later.
- The guidelines will contain 10 sample technologies, including associated time frames and saving potential ranging from low to high investment costs.

Other

- Purchase quantities of vehicles containing innovative technology need to be large enough.
- Interim arrangements can be included in awarding and contracts.
- The varying interests of all involved parties – PTAs, TOCs and industry –, as well as their stakes in improving the environmental performance of regional rail transport became more apparent.
- The guidelines should include more best practice examples from other European countries.

- Industry representatives commented on the insights into the market potential of innovative green technology in railways gained through the workshop but stressed the importance of sufficient time frames.
- Models of how to weigh criteria should be explained using best practice examples.
- PTAs criticized a lack of transparency when it comes to data on actual energy consumption and the criteria according to which consumption should be monitored.

8.2.3. 3rd Berlin Test Workshop, 30 September 2010

Feedback on the potentials identified and presented by members of the Site Working Group:

Energy

- Energy potential is very much dependent on terrain, driving style, training and motivation on the part of the personnel involved.
- Monitoring energy consumption in the face of the German classification of energy consumption as a trade secret remains problematic. Still both industry, as well as TOCs confirmed, that it is technically possible to monitor energy consumption using technology such as DBs TEMA-boxes, provided a consensus regarding the release of data can be reached.
- PTA representatives stressed the importance of LCC-calculations using simulation, in order to minimise the risk associated with rising energy costs. However, a long-term calculation of energy costs based on simulations was declared problematic by PTAs, TOCs and manufacturers.
- TOCs admitted to aiming at an amortisation of vehicles by the end of the first contract period.
- The SWG emphasised the importance kWh/seat km as a project indicator but conceded the possibility of introducing a ranged indication of energy saving potential: For a train of x to y number of seats, energy savings of up to z kWh are possible.

Segments of the guidelines as shown above were tested against the sounding board of the SSG. Discussion among the Stakeholder and Site Working Group yielded the following further results:

- Risk and saving potential both need to be split evenly between PTAs and TOCs.
- TOCs can only commit to whatever the industry offers in terms of environmentally friendly technologies.
- Monitoring of emissions, energy consumption and other criteria is both technically and legally problematic, making payment per seat km difficult.
- TOCs confirmed, that a bonus/malus system would create a considerable incentive.

Noise

- A concentration of efforts on so-called hot-spots within the area of Berlin is no longer conducive towards noise pollution goals. Both tracks and vehicles need work in order to reduce noise pollution sufficiently.
- A management approach towards noise blurs the line between “desired” and “absolutely required” noise values, defining requirements from a noise-oriented point of view and increasing the importance of carefully defining how criteria are weighed.

- Monitoring requires test tracks for fair and comparable data.
- According to industry information, TSI -5dB/-2dB up to a speed limit of 80km/h is already technically possible without significantly increasing costs.
- The usual time frame of awarding procedures of 5 months is usually not long enough to identify and procure innovative technologies.

Emissions

- PTAs commented on a shrinking German market for Diesel-operated vehicles, making the market for improved diesel-motors less attractive.
- The production and disposal of vehicles also involves energy consumption and emissions, which should factor into consideration on whether or not to replace existing vehicles.
- The extent of bonus and penalties should be established on an individual basis.

8.3. Øresund site calculation report: baseline and saving potentials[3]

8.3.1. Purpose and scope

The purpose of this report is to establish a baseline and calculate the energy consumption for the Øresund traffic on the Danish side, also called "Kystbanen". Furthermore the purpose is to identify realistic saving measures and calculate the overall energy saving and CO2 reduction potentials that could result from such measures.

This result is then used for predicting to which extent the ECORailS guidelines could possibly support Trafikstyrelsen in setting energy or environmental requirements in future invitation to tenders for regional rail traffic and how to evaluate such tenders. This last part is more an indirect indication of the impacts from setting environmental requirements and having a joint European guideline.

The scope of the calculation is the total traffic on the Danish side of Øresund, Kystbanen, this traffic is operated by DSBFirst using Øresund trainsets (Litra ET, two-system electric multiple units) and regional trainset from DSB (Litra ER, electric multiple units).

8.3.2. Methodology

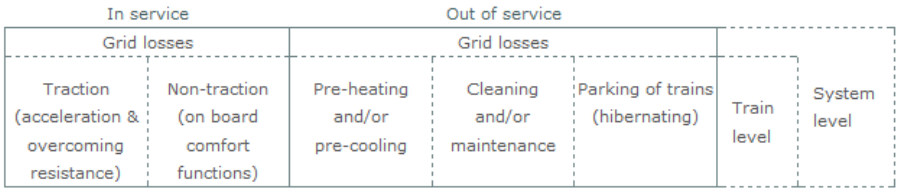
The calculation methodology applied in this report is taken from the EU project Railenergy which has just finalised the development of an online decision support tool which is freely available at www.railenergy.eu/calculator/calculator.aspx.

The energy calculation methodology is in line with the principles within UIC/UNIFE TecRec 100_001 (http://tecrec-rail.org/100_001) as well as the UIC leaflets 330 (environmental performance indicators) and 345 (environmental specifications of new rolling stock).

The CO2 calculation methodology is in line with the principles within UIC leaflet 330 and the standards set out in the final draft CEN/TC320 WG10 (Methodology for calculation and declaration on energy consumptions and GHG emissions in transport services (goods and passengers transport)) which has just been issued 2010-12-17.

8.3.2.1. Calculation principles

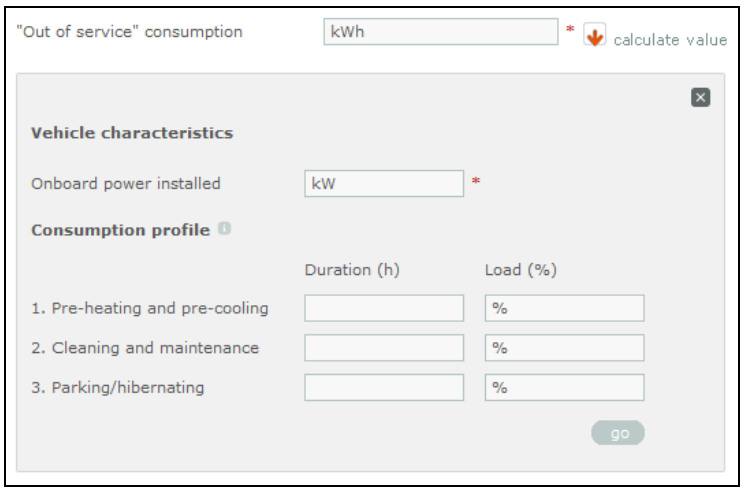
It is based on the following normal breakdown of energy consumption into "in service" and "out of service" and divided into system level and train level, see figure below:



This means that the overall system boundaries are the "point of common coupling", i.e. the substation inlets into the railway system. For Kystbanen the energy is measured onboard with meters mounted on each trainset but the billing from BaneDanmark is including the rail grid losses.

[3] Author: Mads Bergendorff (Macroplan, Denmark) for TSY (Sweden).

For the “out of service” energy consumption the following structure is applied (screen shot from the Railenergy Calculator):



This enables a quick and precise overview of the parked trains’ energy consumption.

8.3.2.2. Information sources

Data for this report comes from two sources within DSBFirst which is the contractual operator on the line. One part is from the main office and one part is from the maintenance workshop “Helgoland” in the northern part of Copenhagen. Here the maintenance workshop engineers have assisted in identification of energy consumption characteristics for parked trains whereas the main office has assisted with the electricity consumption through the rail grid system.

Some default values and technology knowledge have been taken from Railenergy (www.railenergy.eu) as well as the UIC project EVENT (www.railway-energy.org).

8.3.3. Collection of data

The data collection is divided into the baseline configuration (technical and operational) and identification of energy saving measures.

8.3.3.1. Technical and operational configuration

This survey covers the ER and ET trainsets in service for DSBFirst. DSBFirst operates a fleet of 20 ER and 90 ET EMU train sets for the Øresund contract in total. For the Danish contract part “Kystbanen” DSBFirst maintain 22 ER trainsets and around 90 ET trainsets at their workshop “Helgoland”. The maintenance workshop is now organised in a new daughter company DSB Vedligehold as of January 2011.

Basic data

Data	ER	ET
Seat-km (millions)	367	1 421
Nominal power per HVAC in passenger sections (kW)	23	30 (cooling) 24 (heating)
Number of HVAC units in passenger sections per trainset	4	3
Nominal power per HVAC in drivers cabs (kW)	4	3,5 (cooling) 4 (heating)
Number of HVAC units in drivers cabs per trainset	2	2
Nominal power installed (kW)	100	80
Estimated maximum utilisation of this nominal power 80% (kW)	80	64

The main saving potential comes from parked trains where ER trains are parked both during night and day-time and ET mainly is parked during night. Typically night time parking is dedicated to heating only.

For these screening calculations it is assumed that the HVAC units are the only energy consuming non-traction component on-board. In reality the HVAC units consume 80-90% of all electric energy on-board thus the estimate is a conservative indication of the total saving potential.

The energy needed for the HVAC will of course vary due to weather and seasonal changes.

"Out of service" data

Data	ER		ET	
Out of service load profile	Present	Alternative	Present	Alternative
1. Pre-heating / pre-cooling	100	100	100	100
2. Cleaning / maintenance	100	50	100	50
3. Parking / hibernating	50	25	33	33
Average time distribution per 24 hour per train	Hours		Hours	
Operational time scenario	Low parking	High parking	Normal parking	
1. Pre-heating / pre-cooling	0,50		0,50	
2. Cleaning / maintenance	1,25		1,25	
3. Parking / hibernating	10,25	14,25	5,25	
Total out of service	**12,00**	**16,00**	**7,00**	

The "out of service" load profile for ER and ET has been determined in corporation with the maintenance engineers at DSBFirst Helgoland. The values represent conservative estimates for the saving potentials which means that savings could be higher in reality.

The very high parked train hours for ER are due to the fact that these trainsets mainly serve as rush hour traffic capacity. In agreement with the maintenance engineers at DSBFirst Helgoland, two scenarios for parking have been developed: *Low* and *High*. At the moment the *High* scenario is closer to reality than the *Low*.

8.3.3.2. Energy saving measures

The energy saving measures for both train types can be divided into technical measures (upgrading the hardware e.g. components) and operational measures like eco-driving, parked train management and intelligent on-board energy management through different procedures, settings or software changes.

Due to the relatively short period for contracting (7 years) no technical modifications have been considered even though this should not be neglected. The following operational measures should be considered for the kind of service and rolling stock in question:

Measure	Saving potential	Comment
Eco-driving level 2 (on-board device)	8%	In service only, ready for implementation
Parked train management	18-47%	Out of service only

The price of electricity in Denmark is 1,0347 DKR per kWh.

8.3.4. Analysis

The following table is the result of three runs in the Railenergy Calculator:

- ET (normal scenario)
- ER (high parking scenario)
- ER (low parking scenario)

The energy saving measures from section 8.3.3.2 have been applied.

Energy saving result data based on Railenergy Calculator	ER	ET
PER YEAR	Savings	Savings
High parking scenario (ER)		Normal scenario (ET)
In service	8%	8%
Out of service	47%	18%
Total	27%	10%
Low parking scenario (ER)		
In service	8%	
Out of service	46%	
Total	22%	

Total potential savings for the Danish Øresund traffic (ET and ER low scenario):

PER YEAR	Energy savings
In service	8%
Out of service	29%
Total	12,9%
Total energy costs savings	7,1 million DKR

Due to the changing seasons there will of course be a very different need for heating and cooling between summer and winter. To some extent the control units of the current HVAC's takes this into account. This should be further investigated before the potential can be assessed with higher precision.

8.3.5. Conclusions

Based on the analysis provided using the Railenergy Calculator, it is clear that there are significant saving potentials from the "out of service" energy consumption (parked trains) for the Danish part of the Øresund traffic (Kystbanen). The results could for some sound even surprising but this confirms the big potential for energy saving when the trains are parked.

Total potential savings for the Kystbanen traffic assuming "low parking" scenario and conservative estimates applied:

PER YEAR	Energy savings
In service	8%
Out of service	29%
Total	12,9%
Total energy costs savings	7,1 million DKR

The CO2 savings are similar since no change in electricity mix is foreseen.

The results confirm some simple observations:

- The saving potential for out of service is much higher for ER than for ET due to the longer stand still as the ER mainly serves as rush hour capacity.
- The impressing 8% energy saving from GreenSpeed will in this case not be the prime driver for cost reduction; the parked trains have simply a too high share to neglect.

The saving potentials from out of service are very depending on the assumptions/observations of the actual routines at the workshop; further attention should be given here and re-confirmation from the workshop would improve the reliability of the saving potential. Especially the hours for each mode as well as the installed power would benefit form a re-confirmation.

The results finally confirm that it would be feasible even in the short term to save more than 10% of energy within the current contracted traffic for the Danish part of Øresund. The long term goal of 15% could also be reachable using stronger steering of operational energy consumption but probably needs also some technical measures for which additional investment costs could be needed.

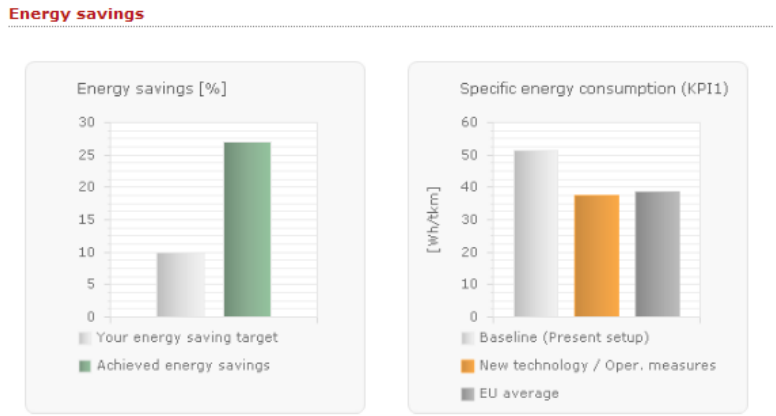
Due to the changing seasons there will of course be a very different need for heating and cooling between summer and winter. To some extent the control units of the current HVAC's takes this into account. This should be further investigated before the potential can be assessed with higher precision.

8.3.6. Annexes to the Øresund calculation report

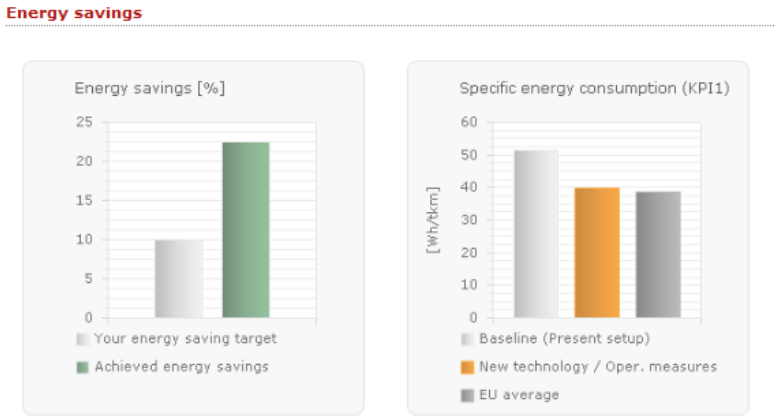
8.3.6.1. Energy saving potentials

The following figures are screen prints from the Railenergy Calculator.

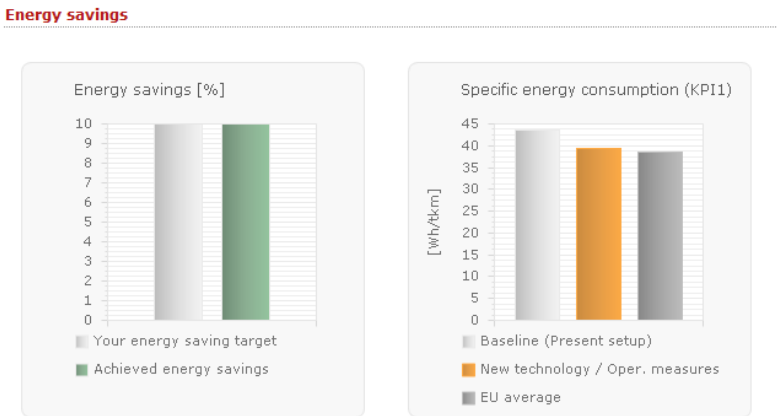
ER (high scenario):



ER (low scenario):



ET:



8.3.6.2. CO2 saving potentials

Current energy mix

Country specific mix of primary energy carriers

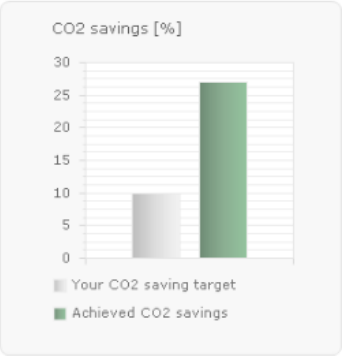
Denmark

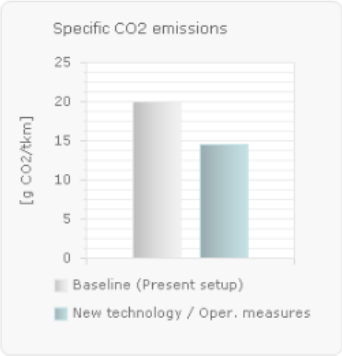
Solid fuels	Oil	Gas	Nuclear	Renewables	Other
49,4 %	2,7 %	17,5 %	0,0 %	26,0 %	4,4 %

Current CO2 emissions at source: 390 g CO2/kWh

ER (high scenario):

CO_2 savings



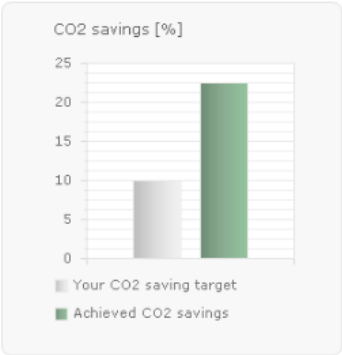


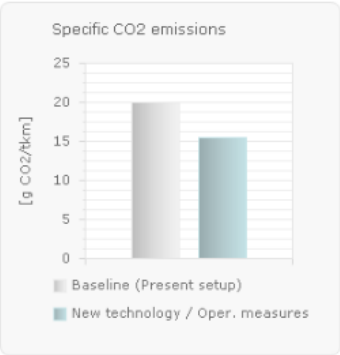
CO_2 saving figures

Total annual CO2 savings in this inquiry	**1.314 tons**
Technology and operational measures	1.314 tons
Change in energy mix	0 tons
Specific CO_2 emissions	9,66 g CO2/seat-km
CO_2 savings in percent	27 %
Your CO_2 target	10 %

ER (low scenario):

CO_2 savings



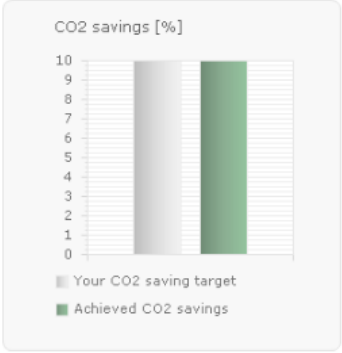


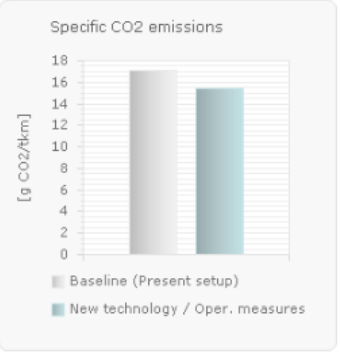
CO_2 saving figures

Total annual CO2 savings in this inquiry	**1.093 tons**
Technology and operational measures	1.093 tons
Change in energy mix	0 tons
Specific CO_2 emissions	10,27 g CO2/seat-km
CO_2 savings in percent	22 %
Your CO_2 target	10 %

ET:

CO_2 savings





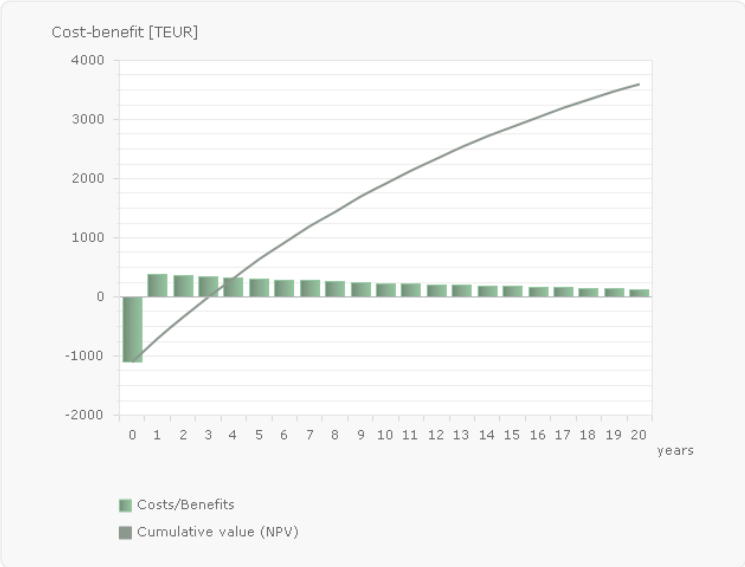
CO_2 saving figures

Total annual CO2 savings in this inquiry	**1.601 tons**
Technology and operational measures	1.601 tons
Change in energy mix	0 tons
Specific CO_2 emissions	10,17 g CO2/seat-km
CO_2 savings in percent	10 %
Your CO_2 target	10 %

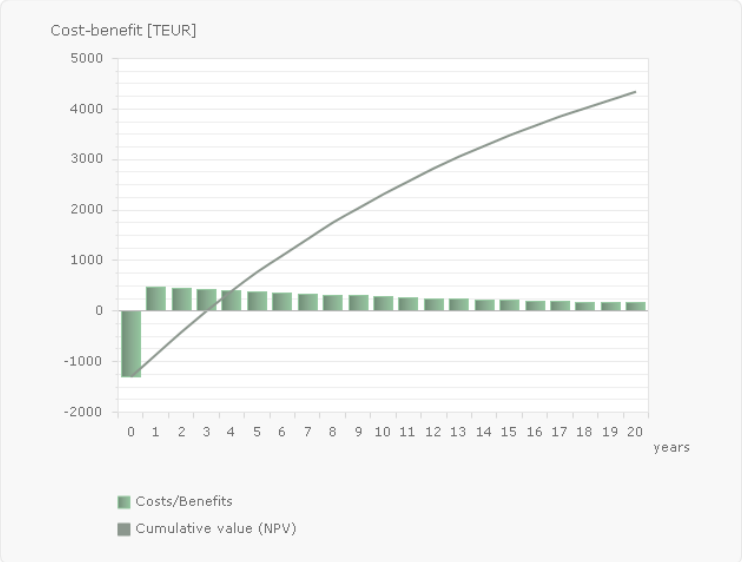
8.3.6.3. Cost benefit results

The following illustrations show the cost benefit curve using a fixed payback time of 3 years.

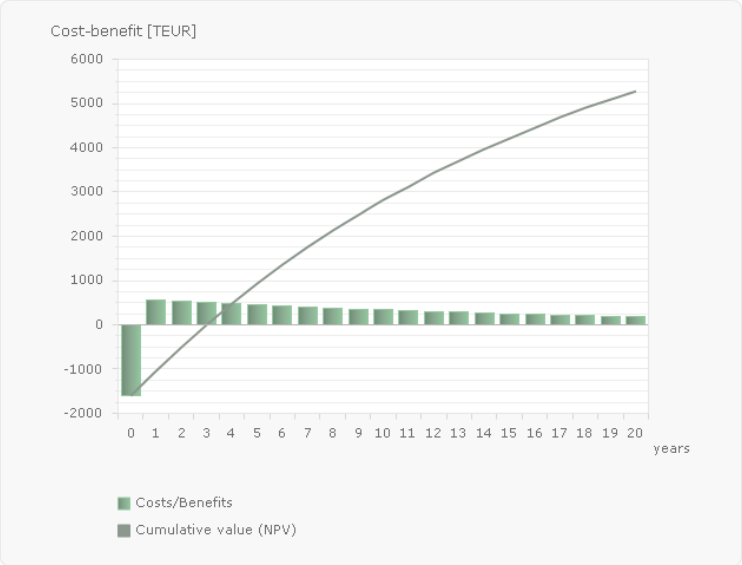
ER "Low parking" scenario



ER "High parking" scenario



ET


Cost-benefit [TEUR]
6000
5000
4000
3000
2000
1000
0
-1000
-2000
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
years
Costs/Benefits
Cumulative value (NPV)

8.4. Timişoara site: Specifications for the Procurement of 10 DMUs and 10 EMUs[4]

The present awarding procedure is based on the new concepts elaborated under the ECORailS project within IEE programme, according to the EU directives and strategies referring to sustainable transports development.

According to the new procedure, the main conditions and targets required by the end user shall be specified, the tenderer being free to offer the technical concepts and solutions for best meeting them.

Based on these procedures, there will be certain mandatory (or minimal) technical conditions, while for the others, the tenderer may propose one or several variants / subvariants provided they are accounted for by the descriptions provided and the forms filled in as required (as compared to the version proposed in the Specifications, or to a standard version) according to the following criteria:

a. Difference in terms of energy consumption in service [kWh, kWh/S, kWh/pkm]
b. Differences in terms of emissions [Emissions: g CO_2-pkm, g NO_x-/pkm, Noise etc.]
c. Life Cycle Costs (LCC) – in the present documentation, a 30 years' life cycle is considered
d. Technical- or utilization advantages (and the way in which they influence the values above, too)
e. Advantages related to fiability and reliability in service
f. The difference in price (*if any*) an optional version (equipment / technology etc.) is likely to induce in the total purchase price as compared to the tenderer's standard version.

With a view to facilitating drafting, any mention of the above in the awarding documentation shall be referred to as: ***ECORailS Criteria.***

The ECORailS Criteria shall play an important role in offer evaluation, aiming at stimulating the Tenderer's application of the most competitive technical solutions, technologies and equipment in order to reduce energy consumptions, emissions and operation costs.

Far from being a dogmatic document, the present awarding documentation is rather an example of drafting and a guide to explaining and assisting with the elaboration of such documentations according to the new ECORailS concepts. The Notes (written in Italics font) inserted in the Specifications include extra comments or recommendations.

This documentation refers particularly to the modality of drafting the requirements aimed at enhancing the products in terms of the ECORailS criteria. For this reason, a series of requirements or details related to the user's preferences are not mentioned at all, or mentioned only very briefly. They are to be completed by those drawing up the awarding documentation, but, for a good documentation, we recommend that everything related with DMU utilization in its specific operation conditions, should be required, wihtout specifying the technical solutions.

The present Specifications refer to the procurement of multiple-unit trains, but many of the modalities proposed, as well as the related explanations, or the foot notes can be applied to

[4] Author: Integral Consulting R&D, Bucharest (Romania).

other types of procurements aimed at reducing energy consumptions, emissions and operating costs.

8.4.1. Offer documents

For the offer to be eligible and competitive, it should provide explicit and well grounded answers, on an item-to-item basis, to each requirement in the Specifications, its attached forms and the Awarding Sheet.

All the statements shall be enlarged upon, backed up by attached documentations including explanatory notes, calculations / experiments etc., and verifiable through documents, the fabrication- and acceptance tests and, during current operation, throughout the service life.

The tenderer shall submit a detailed description of the rail car, of the technical concepts and solutions applied, of all the equipment, with reference and related provisions on cutting edge technology in the latest standards and norms in the line (UIC, EN, ISO, TSI - Technical Specifications for Interoperability, etc.), EU directives and recommendations etc., by specifying the level of the respective provisions and the modality of having it complied with.

The offer shall include the drawings, technical data sheets, diagrams, calculations, references to standards and norms as well as other documents required in order to explain and substantiate the detailed description and the statements referring to the compliance with various technical parameters or conditions.

Additionally, the Technical Data Sheets on the forms attached to these Specifications shall be also filled in.

Basically, the offer documentation shall include as follows:

- Data sheets of general technical characteristics for the DMU and for each equipment item. They shall include all the technical parameters, including weights, efficiency, noise level, emissions etc. for various operation regimes and conditions. The technical characteristics shall comply with and refer to the latest standards or specific recommendations.
- Operating diagrams
- Outline – and mounting drawings
- LCC sheet – according to the form in the awarding documentation
- Reference documents – homologations, agreements, references to similar applications, references from end-users
- Explanatory note referring to the modality in which ECORailS criteria are complied with
- List of the documents to be submitted (Operation- and Maintenance Instructions, Driver's Manual, Service Manual, Test bulletins, diagnosis- and maintenance software, List of consumables and wearing parts, Spare Parts Catalogue etc.)
- Further documents or documentations which may contribute to a better evaluation of the offer.

The modality in which the technical data sheets are filled in, the descriptions and the attached documentations for the DMU and for each of the proposed equipment items / solutions / technologies shall constitute an important factor in the evaluation of each offer. Basically, they shall meet the following criteria:

- they shall clearly meet, on an item-to-item basis, all the requirements in the awarding documentation and the ECORailS criteria;
- they shall be drafted in a concise manner, with a reference to rigurously defined technical data, to standards / norms – directives etc.;
- all the data shall have to be proven against documents, tests etc.

The tenderer shall bear the whole responsibility if the data specified in the offer are not proven by the acceptance tests or during operation.

The basic documentation required by the awarding documents shall be in Romanian.

The additional attached documentation shall be in Romanian or English.

8.4.2. Object of the awarding procedure: Procurement of 10 DMUs and 10 EMU [5]

The choice of the rolling stock type results mainly from the must of having rail passenger transport – in our case, the short- and medium distance one – best customized. It should, therefore, provide optimum solutions to the users' basic specific requirements, namely: frequent runs, short travel times, comfort and safety conditiions, low fares.

Locomotives operation is not economical, as locomotives are heavy units with a high consumption, fit for heavy trains featuring a fixed formation and a high degree of loading, therefore, particularly for long routes and freight trains.

The rolling stock type ideal to regional passenger transport is represented by Multiple Units (MU) – namely Electrical Multiple Units (EMU) for electrified routes, Diesel Multiple Units (DMU) for non-electrified routes, or mixed diesel – electric traction vehicles, for highly circulated routes including both electrified and non-electrified sections.

Main advantages of MUs: variable configurations according to the traffic requirements, low axle load, low energy consumption and low emissions, higher accelerations at start-up / braking, higher fiability etc.

8.4.3. Composition of a multiple-unit train[6]

Diesel electric multiple train unit can be configured, for instance, in the following versions:

- Version 1.
  A multiple-unit train shall be made up of 3 cars: (M = motor car; R= trailer car).
  The cars can be double-decked, with integral circulation at the upper deck.
  The train shall be able to operate in various configurations (MRM, MRR, MR, MM, M) easy to achieve.
- Version 2.
  A multiple-unit train shall be made up of 5 cars: (M= motor car; R= trailer car).
  The train shall be able to operate in various configurations (MRRRM, MRR, MR, M) easy to achieve.

[5] Rail transport can be effected by means of a large variety of rolling stock. As a rule, prior to a tender, studies are conducted and development strategies are elaborated, so as, based on the local specific conditions, to set the medium- /short- term objectives and the means through which they can be reached

6 : The Specifications for a real tender shall include more references concerning the user's options (number of seats per class, required indoors facilities, facilities for low mobility people, luggage, bicycles, walkways in between cars etc.).
We have not gone into such details in the present Specifications, as these issues are not within the scope of ECORailS project's main objectives

The trailer cars (or some of them) shall be also equipped with control post (at one end), so that the trains may be driven from either end, irrespective of their configuration.

The multiple control shall allow for the control and monitoring of up to 4 traction units.

The tenderer may propose any other configuration- and equipping versions (M/R, single- or double-deck cars, or a different number of control posts etc.) provided he accounts for the version proposed (as compared to the above versions), based on ECORailS Criteria / performance Indicators, the number of seats, the facilities in the train configuration, the driving modality etc.

Train configuration in various versions shall be easy to achieve; time duration for modifying the configuration shall be also specified. (approximately 3 minutes).

There shall be a minimum number of control posts; however, they should allow for achieving the proposed configurations, so that the train may run forward – in reverse direction only by changing the driving post).

The electric multiple train unit (EMU) can be configured similar to the diesel multiple train unit (DMU), and the choice of equipment (pantographs, traction motors brake asynchronous recovery, control system, etc.) will remain at the bidder choice.

Irrespective of the version proposed, the multiple-unit train shall feature a suitable performance in service under the specified operation conditions, and meet the technical conditions as stipulated (eligibility conditions).

The offers meeting the eligibility conditions shall be scored according to the indicators showing the compliance with ECORailS criteria, and, first of all, to the indicator of energy consumption expressed in kWh/loc*km for each of the train configuration versions. The basic indicator shall be for those cars providing the maximum number of seats. This indicator is to be filled in the offer for standard conditions, as well as for a test track, as defined in the annexes. This last indicator shall be test proven according to a test in keeping with the description in the annex.

Both the operation- and the testing conditions are given in the present documentation.

However, the tenderers are recommended to check these conditions on the site, in order to complete them according to their own observations, or to request extra data.

The lack of certain data in the awarding documentation, or the misinterpretation / a different interpretation of these data shall not account for the failure to reach the indicators as specified in the offer, during the tests.

The failure to reach the indicators specified in the offer may lead to its losing score points and further on to penalties which may end up in contract cancellation out of the Tenderer's fault.

Standardized service life: minimum 40 years.

8.4.4. Operation conditions

8.4.4.1. Climatic- and general conditions (shocks, vibrations etc.)

(according to UIC, as well as to certain extra difficulties engendered by the infrastructure condition)

The ambient- operation- transport- and storage requirements related to the multiple-unit trains adapted for service on the Romanian Railways, according to SR EN 50125-1:2003 are the following:

- ambient temperature outside the vehicle — min. -25° C, max. + 40° C
- temperature inside the vehicle cars — min. -25° C, max. + 50° C
- temperature inside the instrument units — min. -25° C, max. + 70° C
- annual average humidity level — ≤ 80%
- maximum absolute humidity (in tunnels) — 30 g/m^3
- altitude — max. 1200 m
- maximum / exceptional wind — 35 m/s / 50 m/s
- rain water — 6 mm/min
- solar radiation, maximum level (maximum exposure duration: 8 hours) — 1120 W/m^2

Track characteristics – to be specified in the Annex according to the Standard Service Profile (SFF). The Standard Service Profile (SSP) corresponding to regional passenger traffic, as it is defined in TecRec - „Specification and verification of energy consumption for railway rolling stock" elaborated under Railenergy project, approved of and published by UIC and UNIFE.

- Conditions referring to overall dimensions, manoeuvrability, stabling, maximum axle load, maximum length etc.
- Overall dimensions: STAS 4392-1984; UIC 505-1 -2006
- Track gauge: 1435 mm
- Minimum curve radius on current track: 150 m
- Maximum axle load of the multiple-unit train without passengers, with all the reservoirs and circuits as supplied 15 tons
- Overall length over buffers or the automatic front coupling: max. 85 000 mm

8.4.4.2. General conditions-1

The offer shall confirm its compliance with the provisions in the latest normative / recommendations referring to the passengers' actual requirements (comfort, design, ergonomics etc.), ECORailS criteria, the operation prescriptions, the commercial objectives of CFR Călători (Passengers Transport), traffic safety, fire prevention regulations, interoperability, utilization of allowed materials, ecologic and ergonomic design, conditions referring to disadvantaged / disabled / low mobility people etc., and shall describe the modality in which these requirements have been met according to cutting edge technology.

8.4.4.3. General conditions-2

The technical data in the offer shall be proven through stand tests, acceptance tests, and a running test under service conditions. The test track characteristics shall be specified in the Annex in keeping with the Standard Service Profile (SSP) corresponding to regional passenger traffic as it is defined in TecRec – „Specification and verification of energy consumption for railway rolling stock" elaborated under Railenergy project, approved of and published by UIC and UNIFE

8.4.4.4. General conditions-3

The multiple-unit trains shall be agreed upon / homologated with AFER.

8.4.5. General technical conditions

a. Number of seats: no. of seats per complete train: 300

b. The number of seats shall be specified for each car type (1st class, 2nd class, ground floor / upper deck)

c. Number of standees: .... (maximum 4 passengers. / m^2)

d. Maximum speed in service with train complete (maximum) configuration: 160 km/h + 10% (in alignment, on elevated plane and with the seats occupied)

e. Maximum speed in operation M+R: approx. 140 km/h

f. Maximum speed in operation in M+R+R configuration: ..... km/h

g. Maximum acceleration at start-up: approx. 0,6 m/s^2

h. Maximum deceleration at braking: approx. 1,4 m/s^2

i. High speed at curves: ..... (according to the user's data)

j. Autonomy: minimum 1000 km

k. High capacity passengers' access / exit: the quality of door- and staircase systems operation shall be determined consequently; total and easy circulation at the upper deck; accessible entries for people with low mobility – the doors for disabled people's access shall be provided with a servo-control mobile platform in compliance with EN 14752:2006.

8.4.6. Power pack

The power pack shall be located under the floor and it shall basically include the diesel engine, the electric transmission, the auxiliaries power supply and the necessary related systems (intake, filtration, exhaust, lubrication, cooling, control-protections-diagnosis, compressor, air conditioning etc.).

The diesel engine and the other power pack component parts shall be dimensioned so as to ensure that the general technical conditions, the fiability- and reliability conditions, as well as ECORailS criteria are best met under the above mentioned operation conditions.

The elements shall be located so as to be protected against shocks / vibrations / blows, while featuring at the same time a modular design able to allow for easy access with a view to carrying out any necessary supply, lubrication, checks, spares- and faulty components replacement.

The power pack / diesel engine offer shall include all the related component parts, accessories and installations.

The power pack shall be delivered with any possible special tools and devices necessary for operation and maintenance.

The tendering documentation shall meet the requirements under paragraph 1 that shall constitute offer evaluation criteria.

8.4.7. Diesel engine

The offer documentation shall account for the diesel engine choice so as to best meet the state of art technical- and fiability requirements, as well as the lowest values for:

- Fuel- and oil consumption
- Emissions according to stage IIIB as per the EU Directive 2004/26/EC – NRMM (transposed in the Government Decision 133/2008), EU Directive 2010/26/EU, UIC 330, UIC 345, UIC 624.
- Noise level – according to EU Directive EU Directive 2002/49/EC on ambient noise evaluation and monitoring (transposed in Government Decision no. 674/2007), Commission Decision 2004/446/CE – TSI,
- Life Cycle Costs (LCC)

The following shall be also examined and scored in the offer evaluation process:

- Capacity of start-up at low temperatures
- High fiability indicators, as resulted from similar applications

The engine- specific documentation shall include the technical characteristics (proven through the type- and investigation tests), optimum consumption diagrams, list of the documents to be provided (Engine Instruction Book, Operation- and Maintenance Manual, Service Manual, Test Bulletins, diagnosis- and maintenance software, List of consumables and wearing parts, Spare Parts Catalogue, references from on-site applications etc.) as well as any other documents or documentations which may contribute to a better offer evaluation, and to a better and more efficient operation and maintenance, respectively.

In addition to the above, the tenderer shall also fill in:

a. Annex W42-03-02- FT 02 - EE and EF Characteristics of DMU Diesel Engine

b. Annex W42-03-09- FT 09 - Overall Costs for DMU life cycle – LCC

The offer documentation shall be in keeping with the requirements under paragraph 1.

8.4.8. Electrical transmission[7]

The electrical transmission shall be of a.c. – a.c. type.

The tenderer shall describe the solutions he proposes, namely the component equipment items (generator, inverters, traction motors, ventilation systems, control- and diagnosis system, wheel slip - -skid control and further protections, interaction / adjustment with other DMU equipment – diesel engine, protections, computer- aided on-board system / diagnosis- and maintenance data base etc.).

Technical data shall be specified for: transmission efficiency, consumption for equipment forced ventilation, noise level, LCC, service life, fiability.

The tendering documentation shall comply with the requirements under paragraph 1.

[7] : In the present Specifications, we have decided on electrical transmission as a basic option.
DMU suppliers may offer other variants as well (mechanical- hydro mechanical- hydraulic transmission).
In these variants, regenerative braking is not possible, therefore the suppliers of DMU provided with other transmission types shall be required to describe and quantify (through fuel- and costs savings) the advantages which may make up for the lack of energy regeneration means.

8.4.9. Electric power sources

The tenderer shall describe the solutions he proposes, namely the component equipment (storage batteries, charging source (on the DMU and external), energy regeneration / -storing system, intelligent systems for energy consumption optimization etc.).

For the optional versions (energy regeneration systems), the following issues shall enlarged upon: the solutions adopted, their efficiency (the savings achieved), the additional investment costs and LCC as compared to the basic version. The decision on whether each of the optional versions shall be contracted or not shall be made based on the comparison between the savings it provides and its costs level. If optional versions are agreed on, the suppliers having offered these solutions will be scored extra points according to the data provided in their offer documents and the Technical Data Sheets filled in for the respective versions.

The offer documentation shall meet the requirements under paragraph 1 and the other provisions in the awarding documentation.

8.4.10. Bogies

The tenderer shall describe the solutions he proposes, namely the component equipment, the solutions referring to braking, protection, reduced wears and noise abatement (particularly at curve negotiation), materials used etc.

The offer documentation shall meet the requirements under paragraph 1.

8.4.11. Compressor

The compressor shall provide the necessary air volume and flow. The compressor shall feature a high fiability and reliability in service under the given operation conditions, require low maintenance (lubrication- free etc.), and have a low noise level.

The offer documentation shall meet the requirements under paragraph 1.

8.4.12. Air system

The offer documentation shall meet the requirements under paragraph 1.

8.4.13. DMU Braking

The offer documentation shall meet the requirements under paragraph 1 and ts shall be filled in, namely the Annexes W42-03-04- FT 04 - DMU air system and braking and W42-03-09- FT 09 Overall costs for DMU life cycle - LCC.

The compliance with the prescriptions on passenger trains braking as per UIC norms 540, UIC 546, the modality in which the brake tests were performed and the parameters obtained shall be also specified.

The tendering documentation shall refer to all the brake types foreseen for DMU, according to the tenderer's experience and studies conducted. In the main, the offer shall (also) meet the following requirements:

a. Electro-pneumatic braking – It shall ensure the proper deceleration level necessary for stopping under safe conditions, without excess heating, blockings and wheel tyre excess wear. It shall be specified the performing modality and the emergency braking conditions. Technical solutions shall be described. Further options (combination with an electromagnetic brake etc.) may also be included.
   The braking parameters (maximum deceleration, braking distance from maximum speed

to stop, at maximum load), as well as the technical solutions aimed at reducing wears, blockings, braking noise, the brake diagnosis, overall costs LCC and to ensure brake diagnosis.

b. Parking brake – It shall be electrically controlled and shall ensure DMU braking under safety conditions, at maximum load and for the most difficult operation conditions (maximum declivity, runway condition etc.). The data in the technical data sheet shall be proven by the acceptance tests.

c. Electro-dynamic braking – It shall ensure DMU braking at maximum load down a maximum declivity grade. The technical parameters and the condition of efficient long-time service without excess heating shall be specified in the offer. The data in the technical data sheet shall be proven by the acceptance tests.[8]

d. Regenerative braking and regenerated energy using for supplying the auxiliaries: The tenderer shall specify whether this optional requirement is met, and, if so, the design solutions, the degree of energy regeneration to be reached (in % and in kWh, respectively), as well as the modality in which the regenerated energy may be used. The data in the technical data sheet shall be proven by the acceptance tests.[9]

e. Storage of the energy regenerated at braking and its utilization at the next DMU start up: The energy shall be stored in supercapacitors fitted on top of the DMU.
If this optional feature is offered, the following shall be specified: design solutions, regeneration degree to be reached (in % and kWh, respectively) and the modality in which the regenerated energy can be used. The characteristics of the storing devices (volume, weight, location, efficiency, additional operations and costs – procurement costs, maintenance costs, LCC – etc.) shall be specified. The data in the technical data sheet shall be proven by the acceptance tests.[10]

8.4.14. Electric system

The offer documentation shall meet the requirements under paragraph 1.

[8] Actual operation conditions shall be specified. If the DMUs are operated on a straight track and over short braking distances, brake dimensions may be smaller than for the electro-dynamical braking to be applied down a high-declivity gradient over long distances. Two dimensioning versions may be possibly provided, by specifying the differences between them (maximum power, length of operation, dimensions, extra costs, whether there are any differences as to delivery deadlines etc.). Electro-dynamic braking is useful in order to reduce the wears occurring with air braking. It is very advantageous at downhill driving. It can be provided by most suppliers. It can be required as an extra option (to analyse the extra investment costs), or as compulsory equipment.

[9] Based on the specific mentions required in the Specifications and in the Annexes W42-03-04- FT 04 DMU air system and braking and W42-03-09- FT 09 Overall costs for DMU life cycle – LCC, respectively, the offers, as well as the investments-to-maintenance costs ratio and the advantages as to reducing consumptions, emissions etc. can be compared among them.
Based on this comparison, this option shall be included or not upon the contract concluding.
The technology is already proven and supplied by several suppliers, therefore we can estimate that there will not be high extra costs, the delivery deadline will be the same, and there will be no impediments as to operation and maintenance. We therefore recommend that electro-dynamic braking should be accompanied by the energy regeneration option. In the case of electro-dynamic braking, we recommend the energy regeneration option as well.

[10] Based on the specific mentions required in the Specifications and in the Annexes W42-03-04- FT 04 DMU air system and braking and W42-03-09- FT 09 Overall costs for DMU life cycle – LCC, respectively, the offers, as well as the investments-to-maintenance costs ratio and the advantages as to reducing consumptions, emissions etc. can be compared among them.
Based on this comparison, this option shall be included or not upon the contract concluding.
It is a new technology which may have certain disadvantages concerning the extra procurement costs, the delivery deadline, the volume of the super-capacitors, the technical solutions involving diesel traction. In exchange, it brings a remarkable energy saving (possibly up to 35%), an enhanced behaviour in operation as compared to battery- based service (length of service 10 – 12 years, good efficiency, low maintenance, low toxicity etc.).
We recommend that the decision should be made after analysing the data in the offers.

8.4.15. Train Control and Management System - TCMS

DMU shall be provided with a TCMS system with dynamic self-configuration according to the (variable) train configuration in order to allow for the train coupling / uncoupling and multiple control.

The offer documentation shall meet the requirements under paragraph 1 and the other provisions under paragraph 14 and in the rest of the awarding documentation.

The IT system shall be manufactured by a supplier specialized in equipment and software for application on rolling stock, in strict compliance with the safety- and interoperability norms imposed by the directives and normative in force.

The tenderer shall specify the compliance with the interoperability provisions as per the Commission's Decision 2006/679/CE and with the other technical requirements, as per UIC 612 and other specific norms.

In this chapter we will refer to the basic TCMS requirements from the point of view of the whole DMU, considering the technical- specific- and detail requirements for various equipment and functions as met.

The TCMS will also handle the interface to the driver, crew, and service personnel. The buttons, switches, indicators and other gear on the driver's desk will be connected to the TCMS. The TCMS will have to translate the operator's actions into control signals to the various systems and report back to the operator via the indicators.

The requirements referring to the TCMS information system may be classified into several categories according to the objectives it reaches, namely:

8.4.15.1. Passenger information system and external displays

It includes:

a. Visual- (inside- and outside displays) and sound information system providing the necessary or required information on the route (stations, running times, departure – arrival time, connections with other trains – means of transport, delays etc.), information – warning announcements, bilateral driver / train crew – passengers information or communications (emergency, panic, special situations etc.), various information, advertisements, music etc.

b. Cab-to-Cab communication/internal communication, which shall make it possible for onboard personnel to speak with each other between the crew cabin and other service areas.

c. Emergency speech unit located in each vestibule, which shall make it possible for the passengers to speak with the driver in case of an emergency.

d. Video monitoring (accident prevention, special situations, anti-terrorism etc.) and communications

e. Communication with the central TCMS system.

There will have to be two types of electronic information displays:

- Exterior Information Displays – placed outside the train, over the exterior doors. (4 pcs/ intermediate car, 2 pcs/ end car)
- Interior Information Displays – placed inside the trains. (2 pcs/car)

Handsets will have to be provided in each driver's cab, each crew cabin, and also "service handsets" throughout the train. It has to be possible to make a public announcement in the train (in case of multiple coupled trains: in all MUs) from all handsets. Also, via the handsets it has to be possible to place an intercommunication call to any other handset present in the multiple unit, or multiple coupled MUs.

In each crew cabin there has to be one gooseneck microphone, which makes it possible to make announcements in the train (in case of multiple coupled trains: in all MUs).

8.4.15.2. Driving information system

It shall perform the following functions:

a. It shall communicate with the other computers in the configuration of various equipment (diesel engine, electrical transmission, fuel consumption measuring- and recording system etc.) in order to take over and monitor various information.

b. Based on the information under paragraph „a" and on the other information received from various transducers / sensors and will allow for carrying out the commands under optimum efficiency- and safety conditions.

c. With multiple control, it shall control and monitor both its own unit, and the other units it controls.

d. In case of emergency or abnormal operation, it shall operate in real time in order to command the protections and the necessary measures to be taken, under a running regime adequate to the new conditions. It shall also control the display of the information on the fault, the protections and the new running regime. If necessary, or on demand, further instructions may be displayed as well.

e. All the protections controlled (wheel slip /-skid control) shall operate so as to allow for the travel to be continued at the best possible parameters considering the situation arisen.

f. It shall control the display of all the information necessary for the drive of the own- and the control unit, as well as for conveying the messages referring to failures, on the display in the driving post, also allowing for the check up of certain parameters, on demand.

g. One or two displays shall be mounted on the desk. In his offer, the supplier shall make proposals as to display location and organization. The information displayed shall be visible, meet the requirements under paragraph f, be synthetic, suggestive, and of as much as possible help to the driver with his driving and decision making, yet without providing unimportant information which may divert his attention.

h. It shall provide helpful instructions for an optimum driving in terms of fuel / energy consumption.

i. It shall store all the data characteristic of a running „session" (as defined by the user), inclusively correlated with the data from the DMU driver and the related necessary ones (date, time, train configuration, temperatures, route, occupancy level, location etc.). These data shall necessarily include the recording of all the consumptions (fuel, energy etc.).

In the main, the stored data are recorded on a working storage, a long-duration memory and an event memory (this last one records cyclically (automatically deleting the previous data) a large number of data characteristic of safe driving.

The recorded data serve as documents if an accident / event is to be analysed, therefore they cannot be deleted / modified, shall to be complete and feature the degree of accuracy required for all the values measured.

8.4.15.3. Equipment operation- and safety optimization and control systems

- train safety systems (Dead man, Indusi, ATP, ETCS, ERTMS, APC etc.). The train safety and control system shall be required according to CFR- and EU strategy referring to the safety and interoperability conditions, as defined in Directive 2008/57/EC, and transposed in the national legislation through the Government Decision no. 877/2010, Law no. 55/2006 on rail safety, UIC 612-1 etc.);
- equipment control systems (auxiliaries, door controls, lavatories, batteries, lighting, ventilation, air conditioning, smoke- and fire detection etc.).

Some reasons / requirements are set forth under different chapters in the Specifications, others are described in the normative etc. In the main, the user shall specify only the compliance with the specific normative and requirements according to different specific conditions.

ECORailS specific requirements: the system shall monitor all the consumption- related functions so that they may be controlled and optimized for minimum consumptions, in keeping with the actual (technical and / or comfort) requirements.

- Traction motor- and other technological ventilation systems: solutions involving natural ventilation shall be utilized as much as possible (self-ventilated traction motors, power electronics on optimized copper radiators, centralized / joint ventilations etc.). Forced ventilation shall be controlled and adjusted gradually according to heating, their gradient and various requirements (air draughts and their evolution in operation etc.).
- Air conditioning, heating, ventilation in the cab and passenger salon (see chapter 15) – adjustments correlated with the temperature outside and inside, the natural air exchange, the number of passengers related to the ambient volume etc.
- Lighting (see chapter 16)
- Door controls (see chapter 20) – adjustments correlated with running requirements / optimizations, automatic closing, signalling / passengers information / passengers counselling systems etc.

8.4.15.4. Optimized driving assistance

Optimized driving is a very important resource for fuel / energy savings.

The TCMS shall also include a software able to offer the driver adequate assistance with a view to an economically optimized driving, while also observing the safety conditions and the running times. The supplier shall recommend as economical and efficient as possible a system (or variants) in order to meet this requirement.

We appreciate that the requirements below should be basically met. At the same time, any supplier's optimization proposals are also welcome.

- On the display on the control desk – or on one of the 2 displays (see para 14.2 – f, g, h), the optimum required rotational speed and the +/- difference as to the optimum consumption (for instance an indicator with a variation on the vertical, having 0 = optimum consumption in its centre, the plus signed percentage deviation upwards, and the minus signed percentage deviation downwards) may be displayed. Rotational

speed may be similarly displayed. The information will have to be constantly updated based on actual position, track information, speed and time compared to timetable.

- The optimum consumption shall be calculated according to the route (track conditions, speed limits, running times, train configuration and loading). We consider that one of the solutions may be to make an estimate calculation, and the actual driving modality is to be subsequently analyzed by storing the differences in the case of a better consumption and consequently adapting the software.
- For each travel, the system shall store the consumption, by calculating the deviations as to the optimum consumption; the penalties or the bonuses achieved can be calculated and even displayed (based on the user's coefficients / prescriptions). At the end of the travel, the important driving errors may be also displayed.

8.4.15.5. Fuel consumption measuring- and recording system

The system shall allow for total fuel consumption measuring. The data shall be recorded as correlated with the date and the time of consumption, as well as with other related parameters (diesel engine speed, locomotive speed, auxiliary consumptions (besides traction ones), signalling of exaggerated or accidental consumptions etc.

The system shall be achieved according to the provisions under EN 50483-2 clause 2, homologated, metrologically certified.

The system shall be designed as anti-vandalism and so that it may not get disadjusted.

The system shall be able to communicate with the centralized TCMS system in order to allow for data collecting and display, as well as for optimized driving assistance.[11]

8.4.15.6. Maintenance Software

a. The data stored from the TCMS central system shall be taken over or sent to the depot, where they will be taken over through the maintenance software.

b. On demand, or as an optional solution, the on-board controller shall send all the required data to a control centre in real time. In this case, the same communication system can be also used for the communication among a DMU units for multiple control.

c. The maintenance software will be fitted in the user's PC network, make up a data base taken over from each on-board controller (paragraph h) and process all these data in order to:

- Provide the diagnosis data and statistics (failures, operating times and –conditions, wear condition, failure to operate within the prescribed parameters etc.) for the multiple unit train and the main equipment in its units. The software shall also provide the necessary related prescriptions (checks, remedies, adjustments, parts- and consumables replacement etc.).
- Provide data and statistics related to the driving modality and to consumptions (for traction and the other consumptions, respectively), operation regimes etc.
- The statistics shall include all the data base for all the DMUs in service; however, statistics selected according to various criteria (over a time period, a certain route, comparisons between DMUs and equipment items of the same type, or between

[11] The supplier shall be able to configure the TCMS system in the version he considers optimum, so as to apply, through the communication system, the specific functions developed by the suppliers of certain equipment (diesel engine, transmission, air conditioning, door closing etc.), while also providing the data base necessary to its functions, to the displays and to the maintenance software (according to the basic requirements in the Specifications and to the equipment- and functions specific technical requirements as per the normative).

consumptions (according to time periods, drivers, routes etc.), information aimed at the operation or maintenance etc. can be also provided.

- The statistics can be automatically sent, or interconnected to other data bases, at various levels: to inform the managing board, to decide on the necessary maintenance measures, to reward / penalize the drivers according to the compliance with the economic- and safety criteria, to record costs, diagnosis data etc.

The maintenance software is a modern requirement compulsory in order to allow for optimized efficient operation and maintenance, with tremendously important economic effects in terms of reliability in service.

Considering this software complexity and the must of having it best correlated with the specific operation modality, it can be made by a manufacturer specialized in such software types.

In this case, this software will not be required in the Specifications (or, it will be required optionally), yet the DMU supplier shall have to necessarily ensure as follows:

- The recording of all the required data by the on-board informatic system, and their providing, as agreed on (on-line, or at agreed on intervals) in a protocol as agreed on, which may allow for the data provided to be read and interpreted.
- The tenderer shall meet the above requirements, as well as fill in a standardized Technical Data Sheet, by providing an item-to-item detailed description of the system he offers, in keeping with each of the specified requirements.
- The tenderer shall specify his availability to correlate / adapt the software offered with / to the user's- and the maintenance software requirements.
- The tenderer shall specify the facilities offered: licence, documentation, training, parameters – the sections for which the user may make certain modifications / adjustments etc.

The tenderer shall fill in the Annex W42-03-05 - EE and EF Characteristics of the Train Control and Management System.

8.4.16. HVAC (Heating, Ventilation, Air Conditioning)

The offer documentation shall meet the requirements under paragraph 1 and the prescriptions in all the specific normative in force regulating comfort conditions, UIC 553 – 2003 and EN 13129-1:2004.

The tenderer shall make sure to provide optimum heat insulation (of the passenger coaches and the driver's cab, respectively), so that the consumptions necessary for air conditioning, heating and ventilation, may be minimum.

There shall also be intelligent monitoring- and optimizing systems, both to provide the necessary comfort (according to the regulations above), and to optimize the consumptions according to the outdoor temperature, indoor temperature, air draughts, humidity, air quality, cars / compartments without passengers etc.

Each multiple-unit train coach shall be provided with an adequately dimensioned heating which makes use of the heat supplied by a liquid agent, heated either by the diesel engine residual heat, or by a self-sufficient heating unit.

All the heating units shall be provided with thermostat devices, thus allowing for the operation in automatic regime, and shall be protected when the heating agent reaches the minimum level. A system shall be provided for temperature control in the compartments of the multiple-unit train coaches, as well as for pre-heating programming.

The heating units shall ensure the comfort parameters both at running and at standstill.

The ventilation of confined spaces will not be made according to the seating capacity, but based on the actual demand (number of passengers). The ventilation equipment has to allow for power variation according to an occupancy indicator and (the level of) indoor air quality (IAQ). (for eg. demand-operated ventilation based on CO2 sensors).

The tenderer shall fill in Annex W42-03-06 – FT 06 - EE and EF Characteristics of HVAC System.

8.4.17. Lighting

The offer documentation shall meet the requirements under paragraph 1 and the provisions of all the specific normative in force regulating the general- and local lighting conditions, mainly UIC 555 and SR EN 13272:2001.

The tenderer shall use the most efficient lighting systems in terms of efficiency, sight protection conditions, fiabilty and service life.

Interior materials shall also be selected so as to enhance lighting quality and its necessary consumption, through their quality, colour, index- and modality of refraction.

The location and material of the windows shall be selected so as to provide optimum lighting volume and quality.

There shall also be provided intelligent monitoring- and optimization systems, in order both to ensure the necessary comfort, and to optimize the consumptions according to natural lighting, the necessity of general and local lighting according to the presence and the number of passengers etc.

The lighting systems shall meet the provisions imposed by the necessity of preserving the environment quality.

The tenderer shall fill in the Annex W42-03-07 – FT 07 - EE and EF Characteristics of the lighting system and the offer documentation as per paragraph 1.

8.4.18. Control cab

A control cab shall be located at either end of the DMU, irrespective of the configuration offered (see paragraph 3).

The train formation- and cab location versions, respectively, shall be analysed in terms of the lowest delivery price, while without any prejudice to the optimum configuration possibilities according to the number of passengers.

The offer documentation shall meet the requirements under paragraph 1 and the provisions under all the specific normative in force, mainly UIC 651 – 2002.

The conditions the tenderer shall best meet in compliance with all the specific normative basically refer to:

- Visibility outside (heated rear-view mirrors or video cameras to capture the outside image) and inside (display, instruments, handles etc.), irrespective of the conditions (night time, rain, snow, frost, fog, curves, sunlight etc.)
- Ergonomic conditions for outside visibility (windows heated by an electrical wire - the maximum admitted heat output is of 7 W/dm2, provided with windscreens, front window washing system, sun shade and demisting system). The front window has to be designed so as to resist to impact from different objects.
- Comfortable ride conditions (air-conditioning / heating, thermal- / sound insulation, vibrations, ergonomic seat, low noise level etc.)
- Communication conditions (with the dispatcher, the passengers, the information system, control desk, mike etc.)
- Pleasant, relaxing design etc.
- Safety under normal traffic conditions or at the occurrence of certain events (derailment, collision etc.)
- In order to reach the Driver's cab from the passenger compartment, a key shall be required to open the door. From the inside of the cab, it has to be possible to open the door by a handle to give a quick evacuation in case of an emergency.
- All parts of the front window have to be well integrated and easy exchangeable for maintenance and repair. The side windows will have to be designed and placed so as to accentuate direction and dynamics.

8.4.19. Passenger coach

The offer documentation shall meet the requirements under paragraph 1 and the provisions under all the specific normative in force, particularly of UIC 567 – 2004.

The conditions the tenderer shall best meet in compliance with all the specific normative basically refer to:

- Comfortable ride conditions (air-conditioning, thermal- / sound insulation, vibrations, ergonomic upholstered seats / , seats, circulation, low noise level etc.).
- The interior arrangements shall provide the passengers' comfortable ride, as well as a modern ambient surrounding with a pleasant and relaxing design.
- Safety under normal traffic conditions or at the occurrence of certain events (derailment, collision, etc.).
- There shall be provided luggage racks, small tables between the seats, heating system guards in the passengers' salon, boxes for food wastes, minimum two toilets equipped with vacuum WC system with retention basin and fresh water tank.
- Fire extinguishers shall be provided as for SNTFC normative.
- There shall be provided access areas and facilities for disabled people, lifting device for disabled people in wheel chairs, according to the Commission Decision 2008/164/CE and with UIC 565-3. Folding chairs can be located in free available spaces.

8.4.20. Engine cooling – ventilation control

The tenderer shall apply the most efficient technologies / systems allowing for a continuous demand control of the motor ventilation, so as to permit the controlling of the ventilation power according to the actual cooling demand of the motor.

8.4.21. Door actuation control

On either side of the multiple-unit train there shall be provided sliding access doors providing a safe and tight closing. For passengers' access, the coaches may have at least one double-leaf door on either side, one single-leaf and one double-leaf door on either side, or two double-leaf doors on either side. The doors shall have easily accessible opening handles inside and outside, or actuation buttons. The door opening / closing control system shall secure the automatic door closing at the multiple-unit train start, after a 5 km / h speed has been reached; before the multiple-unit train stops, when the 5 km/h speed is reached again, the doors are prepared for opening. The multiple-unit train doors shall be selectively closed / opened – on either side of the train – as controlled by the driver from the driving cab. The door opened / closed state shall be signalled in the driving post. An emergency actuation shall be provided above or on the side of the doors. When closed, the doors shall totally cover the stairs.

8.4.22. Smart stabling

The offer shall also include a solution to monitor and optimize the consumptions for the train at standstill. Basically, it shall ensure that the train at standstill should be supplied at optimum consumptions, according to the requirements (actual temperature at the parching place, local temperatures, light conditions etc.):

a. Diesel engine heating – only if diesel engine pre-heating is foreseen before starting at temperatures below a minimum preset value, and if there is a freezing risk (cooling agent without antifreeze solution).

b. Heating of train at standstill – to be controlled only at a temperature below the minimum admitted limits (required by certain equipment, or by the conditions necessary for the cleaning / maintenance operations)

Minimum operation times and local heatings (where necessary) shall be provided).

a. Train pre-heating before travel – to be foreseen with a minimum time before passengers' boarding – only if necessary in order to provide the prescribed conditions.

b. Lighting of train at standstill – to be foreseen only if necessary, for the necessary time and area.

The system shall ensure the optimum consumptions according to the prescriptions and the sensors- provided values.

The system shall allow for the adjustment of certain temperature parameters which can be regulated according to the user's prescriptions.

The supplier shall provide the necessary instructions and instruments for an easy and operative maintenance of the trains at standstill.

The system shall register the consumptions, according to consumer types, as well as the operating times, thus allowing the user to monitor and optimize certain services / consumptions.

The supplier shall specify the potential of the energy saving for trains at standstill, achieved through constructive measures (e.g. diesel engine with antifreeze solution and cold starts-up that reduce the situations / times requiring consumptions at standstill and / or through the optimized consumption control system (inclusively by filling in Annex W42-03-08 – FT 08 - EE and EF Characteristics of Smart stabling).

8.4.23. Life Cycle Costs

The tenderer shall fill in the Annex W42-03-09- FT 09 - Overall Costs for DMU life cycle – LCC

LCC value shall be an important criterion in offer evaluation.

Consequently, the values in the Annex W42-03-09- FT 09 - Overall Costs for DMU life cycle – LCC

shall be proven in current service, of course, provided the user observes the supplier's operation- and maintenance prescriptions.

During the guarantee period and during the service, respectively – as determined in the delivery contract, the supplier shall be liable for the compliance with the values specified in the Annex W42-03-09- FT 09 - Overall Costs for DMU life cycle – LCC.

The data base elaborated according to the prescriptions under paragraph 14 and to the operation- and maintenance procedures recommended in the supplier's documentation shall allow for the analysis of the causes having determined the respective deviations.

If the supplier is to blame for these deviations, then he will bear direct responsibility, according to the provisions stipulated in the awarding contract.

The supplier may also provide the management / monitoring of maintenance during service over a certain time period, so that the version of Annex W42-03-09- FT 09 - Overall Costs for DMU life cycle – LCC (with all the costs included) should be optimum.

8.4.24. Related effects

The tenderer shall provide data referring to the related effects identified following offering a product with high performances in terms of reducing energy consumptions and chemical emissions. The data shall have in view references referring to: life quality, social impact, comfort, degree of safety a.s.o.

As far as possible, the indicators measuring these effects shall be quantified.

8.4.25. Reference Documents

1) Directive 2002/49/EC relating to the assessment and management of environmental noise – transposed into Government Decision no. 674/2007)
2) Directive 2004/26/CE to Directive 2004/26/EC of the European Parliament and of the Council of 21 April 2004 amending Directive 97/68/EC on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery
3) Directive 2008/57/CE on the interoperability of the rail system within the Community
4) Directive 2010/26/EU amending Directive 97/68/EC of the European Parliament and of the Council on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery
5) Commission Decision of 29 April 2004 specifying the basic parameters of the 'Noise', 'Freight Wagons' and 'Telematic applications for freight' Technical Specifications for Interoperability referred to in Directive 2001/16/EC (2004/446/CE)

6) Commission Decision of 23 december 2005 concerning the technical specification for interoperability relating to the subsystem 'rolling stock — noise' of the trans-European conventional rail system (2006/66/EC)
7) Commission Decision of 28 March 2006 concerning the technical specification for interoperability relating to the control-command and signalling subsystem of the trans-European conventional rail system (2006/679/CE)
8) Commission Decision concerning the technical specification of interoperability relating to persons with reduced mobility in the trans-European conventional and high-speed rail system (2008/164/CE)

9) UIC 176 Specifications for passenger information displayed electronically in trains
10) UIC 330 Railway specific environmental performance indicators
11) UIC 345 Environmental specifications for new rolling stock
12) UIC 410 Composition and calculation of the weight and braking of passenger trains
13) UIC 440 Sonorization of RIC passenger coaches
14) UIC 505-1 Railway transport stock - Rolling stock construction gauge
15) UIC 518 Testing And Approval Of Railway Vehicles From The Point Of View Of Their Dynamic Behaviour - Safety - Track Fatigue - Ride Quality
16) UIC 540 Brakes - Air Brakes for freight trains and passenger trains
17) UIC 542 Brake parts - Interchangeability
18) UIC 544 Brakes - Braking power
19) UIC 546 Brakes - High power brakes for passenger trains
20) UIC 547 Brakes - Air brake - Standard programme of tests
21) UIC 553 Heating, ventilation and air-conditioning in coaches
22) UIC 555 Electric lighting in passenger rolling stock
23) UIC 560 Doors, footboards, windows, steps, handles and handrails of coaches and luggage vans
24) UIC 564-1 Coaches - Windows made from safety glass
25) UIC 565-3 Indications for the layout of coaches suitable for conveying disabled passengers in their wheelchairs
26) UIC 567 General provisions for coaches
27) UIC 576 Wagon doors and securing devices (Interchangeability)
28) UIC 612-1 Rolling stock configurations and main activated functions for EMU/DMU, locomotives and driving coaches
29) UIC 617-5 Special safety regulations for drivers' cabs of tractive units
30) UIC 624 Exhaust emission tests for diesel traction engines
31) UIC 625-2 Fitting of front windows, side windows and other windows installed in drivers' cabs of motive power units with internal combustion engines, and in driving trailers (with a view to ensuring protection for the staff)

32) UIC 651 Layout of driver's cabs in locomotives, railcars, multiple-unit trains and driving trailers

33) STAS 4392 Standard railways. Track gauges

34) SR EN ISO 3095:2006 “Railway applications - Acoustics - Measurement of noise emitted by rail bound vehicles”,

35) SR EN ISO 3381:2006 “Acoustics – Measurement of noise inside railbound vehicles”,

36) SR EN 13129-1:2004 Railway applications — Air conditioning for main line rolling stock — Part 1: Comfort parameters

37) SR EN 13272:2001 Railway applications — Electrical lighting for rolling stock in public transport systems

38) SR EN 13452:2004 Railway applications – Braking; Mass transit brake systems

39) SR EN 14813-1:2006 Railway applications. Air conditioning for driving cabs. Comfort parameters

40) SR EN 15020:2007 Railway applications. Rescue coupler. Performance requirements, specific interface geometry and test methods

41) SR EN 15152:2007 Railway applications. Front windscreens for train cabs

42) SR EN 50121-2:2007 Railway applications. Electromagnetic compatibility. Emissions of the whole railway system to the outside world

43) SR EN 50125-1:2003 Railway applications - Environmental conditions for equipment - Part 1: Equipment on board rolling stock

44) SR EN 50126:2003 Railway applications. The specification and demonstration of reliability, availability, maintainability and safety (RAMS).

45) SR EN 50128:2003 Railway applications - Communications, signalling and processing systems - Software for railway control and protection systems.

46) SR EN 61377:2003/2006 Railway applications. Rolling stock. Combined testing of inverter-fed alternating current motors and their control system.

47) Law no. 55/2006 referring to railway safety

48) H.G. 1395/2007 amending HG 850/2003 and HG 1533/2003 on rail transport system interoperability.

49) H.G. 1563/2006 amending HG 850/2003 and HG 1533/2003 on rail transport system interoperability.

50) Technical norm of 19 January 2010 – “Rail vehicles intended for passenger transport. Sonorization systems. General technical requirements."

51) NTF 56-002/2010 - "Rail vehicles intended for passenger transport. Electrically-pneumatically- and electro pneumatically actuated external- and internal doors. Design requirements."

8.4.26. List of Forms in the Specifications – Technical Data Sheets

Crt. No	Technical Data Sheet	Designation	Page no.	Code ECORailS_WP4_W42-03-BD
1	FT 01	DMU EE and EF Characteristics	1	W42-03-01
2	FT 02	DMU Diesel engine EE and EF Characteristics	1	W42-03-02
3	FT 03	Electrical transmission EE and EF Characteristics	1	W42-03-03
4	FT 04	DMU air system and braking EE and EF Characteristics	1	W42-03-04
5	FT 05	Train Control and Management System EE and EF Characteristics	1	W42-03-05
6	FT 06	HVAC System EE and EF Characteristics	1	W42-03-06
7	FT 07	Lighting EE and EF Characteristics	1	W42-03-07
8	FT 08	Smart stabling EE and EF Characteristics	1	W42-03-08
9	FT 09	DMU Overall Life Cycle Costs - LCC	1	W42-03-09
10	FT 10	LCC technologies	1	W42-03-10

8.4.26.1. ECORailS Tests - Timisoara Site Annex W42-03-01 -FT-01-EE and Env features of DMU_110208_V.1.0

Tenderer: .....

TECHNICAL SHEET no. 01 - EE and Env features of DMU

No.	Denomination	MU	**Empty DMU -**to be filled-in for the versions of train configuration offered					**Loaded DMU** -to be filled-in for the versions of train configuration offered					**Reductions obtained through innovative constructive measures, technologies, with recovery potential etc.**		**Reference norms**
			MTTM	MTM	MTT	MT	M	MTTM	MTM	MTT	MT	M	%	Description	
1	**Weight of DMU**	kg													
2	**Maximum speed**	km/h													
3	**Installed power - total**	kW													
4	**Traction power**	kW													
5	**Power for traction auxiliary services**	kW													
6	**Installed power - train heating**	kW													
7	**Installed power - train air conditioning**	kW													
8	**Installed power - lighting**	kW													
9	**Parked train consumption - for diesel m**	kWh													
10	**Parked train consumption -interior tem**	kWh													
11	**Number of seats**														

No.	Denomination	MU	**Empty DMU -**to be filled-in for the versions of train configuration offered					**Loaded DMU** -to be filled-in for the versions of train configuration offered					**Reductions obtained through innovative constructive measures, technologies, with recovery potential etc.**		**Reference norms**
12	**Maximum acceleration at start-up**	m/s2													
13	**Maximum deceleration at breaking**	m/s2													
14	**Energy consumption at field test without auxiliary consumers**	l /pkm													
15	**Energy consumption at field test with all auxiliary consumers**	l /pkm													
16	**Duration** (without consumers)	s													
17	**CO2 emissions**	g CO2 / S km													UIC345, UIC330,
18	**Exhaust emissions**	g NOx / S km													UIC345, UIC330,
19	**Interior noise, V=0**	dB													UIC345, UIC330,
20	**Exterior noise** (7,5 m), **V=0**	dB													UIC345, UIC330,
21	**Exterior noise** (7,5 m), **at start-up**	dB													UIC345, UIC330,
22	**Exterior noise** (7,5 m), **V=Vmax.**	dB													UIC345, UIC330,

Notes:

All values are to be filled-in by each tenderer, referring to the requirement from the technical specification and respectively to a field test that is going to take place on a line detaining the characteristics defined through the technical specification. The tenderers shall respect the format of the technical sheet. Possible supplementary details ca be provided in an informative annex, with explicative role, but which can not justify the divergence from the values from the table. The tenderer can offer a standard version and optional versions, respectively versions for different design, equipment, technologies, etc. In this case the tenderer will fill-in FT01-standard and FT01-a, b, c for different versions. The versions will be explained through descriptive annexes, the possible price difference from the standard variant being indicated. For each version, all the other Technical Sheet that suffer modifications form the standard one, are to be completed.

8.4.26.2. ECORailS Tests - Timisoara Site Annex W42-03-02-FT-02-EE and Env features of Diesel Engine for DMU_110208_V.1.0.

Tenderer: .....

TECHNICAL SHEET no. 02 - EE and Env features of Diesel Engine for DMU

No.	Denomination	MU	Values	Description, comments, EE and Env advantages	Norms
1	**Diesel Engine type, producer**				
	Production year				
2	**Dimensions**	mm			
	Volum	m3			
3	**Weight**	kg			
4	**Specific fuel consumption**	g /kW-h			
	Nominal power	kW			
5	**Maximum speed**	rpm			
6	**Traction power at n max.**	kW			
7	**Fuel consumption at n max.**	l / h			
8	**CO2 emissions at nominal power**	g CO2 /h			
9	**Exhaust emissions at nominal power**	g Nox /h			
10	**Noise at n max.**	dB			
11	**Idle speed**	rpm			
12	**Power at n min**	kW			
13	**Fuel consumption at n min.**	l / h			
14	**Fuel consumption** (UIC 623 cycle)	l / h			
15	**Injection electronic control**				
16	**Oil consumption**	l / h			
17	**Minim temperature for start-up**	° C			
	Nominal power for heating and AC	kW			
18	**Consumption for pre-heating and heat conservation** (if necessary)	l / h kW /h			
19	**Recording of fuel consumption**				
20	**Diagnosis system, visual display, recording**				
21	**Computer assisted**				

No.	Denomination	MU	Values	Description, comments, EE and Env advantages	Norms
	maintenance				
22	**Communication with on-board computer**				
23	**Possibility to unload the diagnosis and maintenance data**				
24	**Reliability - availability - safety**				
25	**Life cycle**	years			

8.4.26.3. ECORailS tests - Timisoara site Annex W42-03-03-FT-03- EE and Env features of electrical transmission_110208_V.1.0.

Tenderer: .....

TECHNICAL SHEET no. 03- EE and Env features of Electrical Transmission

No.	Denomination	MU	Values	Description, comments, EE and Env advantages	Norms
0	**Type, producer**				
0.1	**Effective power**				
0.2	**Reliability, availability**				
0.3	**Life cycle duration**	years			
1	**Traction generator, type**				
1.1	Weight	kg			
1.2	Power at maximum speed	kVA			
1.3	Effective power at maximum speed				
1.4	Noise at maximum speed	dB			
1.5	Protections				
2	**Traction engine, type**				
2.1	Weight	kg			
2.2	Number of traction engines / DMU				
2.3	Power at maximum speed	kVA			
2.4	Effective power at maximum speed				
2.5	Noise	dB			
2.6	Protections				
3	**Commend system, adjustment protection**				
3.1	Weight	kg			
3.2	Number of blocks				
3.3	Effective power	kVA			
3.4	Ventilation maximum power				
3.5	Noise	dB			
3.6	Protections				
3.7	Adherence coefficient at start-up				
3.8	Adherence coefficient at braking				

Notes:

- All values are filled-in by each tenderer, referring to the requirements from the Technical Specification
- The tenderers shall respect the format of the technical sheet. Possible supplementary details ca be provided in an informative annex, with explicative role, but which can not justify the divergence from the values from the table.
- The tenderer can offer a standard version and optional versions, respectively versions for different design, equipment, technologies, etc. In this case the tenderer will fill-in FT03-standard and FT03-a, b, c for different versions. The versions will be explained through descriptive annexes, the possible price difference from the standard variant being indicated. For each version, all the other Technical Sheet that suffer

8.4.26.4. ECORailS tests - Timisoara site Annex W42-03-04-FT-04- EE and Env features of pneumatic installation and of braking for DMU_110208_V.1.0.

Tenderer: .....

TECHNICAL SHEET 04 Pneumatic installation and braking for DMU

No.	Denomination	MU	Values	Description, comments, EE and Env advantages	Norms, annexes, doc.	Obs.
1.	**Equipment for the production of compressed air**					
1.1	Type compressor (without greasing)					
1.2	Power	kW				
1.3	Filtration, air drainage					
1.4	Duration for the complete filling of the installation	min.				
1.5	Noise maximum level	dB				
2.	**DMU braking**					
2.1	Composition, description of electro-pneumatic braking					
2.2	Composition, description of electro-magnetic braking					
2.3	Anti-skid control					
2.4	Emergency brake					
2.5	Filling time					
2.6	Way length for normal braking - loaded DMU	m				
2.7	Way length for emergency braking - loaded DMU	m				
2.8	Maximum deceleration	m /s2				

No.	Denomination	MU	Values	Description, comments, EE and Env advantages	Norms, annexes, doc.	Obs.
3.	**Parking brake**					
3.1	Description					
3.2	Indicators, signals, protections					
3.3	Pinning test, DMU at maximum load	35‰				
4.	**Electro-dynamic brake**					
4.1	Sizing power	kW				versions
4.2	Braking test - loaded DMU, from Vmax.	25‰				
4.3	Way length for braking - loaded DMU V max.- 10km/h	m				on the test line
4.4	Verification of heating, protections, signaling					
5.	**Energy recovery braking**					optional
5.1	Design solutions, recovery mode					
5.2	Maximum recovery power	kW,%				field test
5.3						
6.	**Energy storage braking**					optional
6.1	Design solutions, storage mode, recovery					
6.2	Additional weight	kg				
6.3	Maximum recovery power	kW,%				field test
6.4	Euration of energy storage					
7.	**Annex documentations**					annex documentations are to be specified

Notes:

- All values are to be filled-in by each tenderer, referring to the requirement from the technical specification and respectively to a field test that is going to take place on a line detaining the characteristics defined through the technical specification.
- Possible supplementary details can be provided in an informative annex, with explicative role, but which can not justify the divergence from the values from the table.
- The tenderer can offer a standard version and optional versions, respectively versions for different design, equipment, technologies, etc. In this case the tenderer will fill-in FT01-standard and FT01-a, b, c for different versions. The versions will be explained through descriptive annexes, the possible price difference from the standard variant being indicated. For each version, all the other Technical Sheet that suffer modifications form the standard one, are to be completed.
- In the technical sheet FT_09-LCC and in the annexed sheets, the optional versions (for points 4,5,6) are to be filled-in separately, specifying the possible savings and also if there are any supplementary costs or late deliveries compared to the standard version.

8.4.26.5. ECORailS Tests - Timisoara site Annex W42-03-09-FT-09-Life cycle costs for DMU - LCC_110208_V.1.0.

Tenderer: .....

FT-09-Life cycle costs for DMU

No.	System name	Procurement costs	Energy consumption & costs / year			Spare parts	Wear parts, consumables	Planned maintenance	Repairs	General / capital overhauls			Total costs (€) after:					Total LCC	Obs.
		€	Consumption /year	MU	€	€	€	€	€	type	months	€	1 year	5 years	10 years	15 years	30 years (LCC)	%	
1	Car body																		
2	Bogies and undercarriage																		
3	Diesel engine			l															
4	Generator principal			kWh															
5	Traction control and adjustment																		
6	Traction engines			kWh															
7	Ventilation systems for cooling			kWh															
8	Energy source for auxiliaries			kWh															
9	Accumulator batteries																		

No.	System name	Procurement costs	Energy consumption & costs / year		Spare parts	Wear parts, consumables	Planned maintenance	Repairs	General / capital overhauls			Total costs (€) after:					Total LCC	Obs.
10	Compressor			kWh														
11	Pneumatic installation																	
12	Braking *																	separately for all types of braking offered
	for all types according to TS point 12 a,b,d,e																	
13	Electric installation																	
14	Computer system																	
15	Air conditioning			kWh														
16	Heating			kWh														
17	Lighting			kWh														
18	Communication and information system																	
19	Information system																	
20	Interiors			kWh														
21	parked trains			kWh														
22	Doors' actuating																	
23	Train control optimization system																	
	TOTAL (€)																100	total, without opt. vers.
	TOTAL (%)															100		

Notes:

- A period of service of 5000 hours / year, or 200.000 km shall be considered. Out of that, 1400 hours are considered at low temperatures (requiring train heating) and 1000 hours at high temperatures (over 28°C.)

- Parking shall be considered for 3500 hours / year, out of which 2000 hours at night, 800 hours at temperatures below 0 °C and 400 hours below -10°C.
- In the acquisition costs column, there shall be filled in only the possible extra costs of certain optional versions, as well as the total value (without extra optional costs) of the standard version submitted (the yellow cell).
- Under energy consumptions, there shall be filled in only the costs for the consumption from sources external to the train (fuel, exterior electrical energy). The other consumptions shall be given for the comparative analysis related to other offers and the percentage value of the total.
- For certain component parts (diesel engine, or optional versions, for instance), it is recommended to provide separate LCC sheets, and to fill in only the global data in the present sheet.
- For regenerative braking versions, the values for the regenerated consumptions shall be signed minus.
- The tenderers shall comply with the technical data sheet format. Any further explanations or details shall be given in an explanatory annex to the technical data sheet. Specifications shall be made - with references to the technical documentation referring to train equipping with devices for consumptions measuring and recording, as correlated with the on-site conditions. The format of the present Technical Data Sheet is according to the European Standard EN 60300-3-3 : 2005.
- The tenderer may offer a standard version and optional ones, namely referring to the design, equipping, technologies etc. In this case, FT05 (standard) and FT 05 - a, b, c (for the various versions) shall be filled in. The versions shall be explained in descriptive annexes, by also specifying the possible differences in prices as compared to the standard version. For each version, there shall be filled in the other Technical Data Sheets, too, which will be modified as to the standard version.
- RK at 60 months is given for information purpose, as an example of how to fill in the document. The RG, RK overhaul schedules shall be filled in by the tenderer.
- When evaluating the offers, a comparative analysis shall be made between the total acquisition value and the total LCC value (the yellow cells), values which do not include the costs in the lines related to the versions required as optional versions.
- The optional versions shall be analyzed according to the data in the table, by comparison with the other offers. The optional versions can be contracted accordingly, and in this case, all the offers shall be scored according to the data provided.

8.4.26.6. ECORailS Tests - Timisoara site Annex Annex W42-01-02-21-Operation and testing conditions for rolling stock

TECHNICAL SHEET no. 11 - Operation and testing conditions for rolling stock

1. Standard parameters defining the operation conditions for the rolling stock

ID	Parameter	M.U.	Values	Definition
I	**Infrastructure characteristics**			
I 01	Route length	km		Total distance of selected route or reference track from selected origin station to selected destination station
I 02	Altitude profile (height)	m		The total height profile in meters above sea level along the selected route or reference track
I 03	Altitude profile (gradient)	‰		The gradient profile (slope) along the selected route or reference track
I 04	Track speed profile	km/h		The maximum speed profile at every location along the selected route or reference track
I 05	Curve radius	m		The exact locations and radii of all curves along the selected route or reference track
I 06	Tunnel profile (length)	km		The exact locations and lengths of all tunnels along the selected route or reference track
I 07	Tunnel profile (cross section area)	m^2		The exact locations and cross section areas of all tunnels along the selected route or reference track
E	**Electric supply**			**System characteristics**
E01	Nominal voltage	Volts		Choice of the different standard electrification systems (750 V DC, 1.5 kV DC, 3 kV DC, 15 kV AC, 1x25 kV AC,2x25 kV AC)
E02	Nominal frequency	Hz		Choice of the different standard electrification systems (DC, 16.7 Hz, 50 Hz)
E03	Mean voltage at pantograph	Volts		Mean voltage measured at pantograph during operation of the train according to existing standard measurement protocol (EN 50163)
E04	Neutral sections	m		The exact locations and lengths of all neutral/phase separation sections along the selected route or reference track
S	**In-service operation mode**			
S01	Stops/stations	Integer		Number and exact location of stations with planned stops (except departure and arrival station)
S02	Stand still time on the route	hh:mm:ss		The total time elapsed for stopping time at stations (wheels not in motion)
S03	Journey duration	hh:mm:ss		Total time elapsed (from wheels rolling at departure station to wheels stopped at arrival station) e.g. from time table

S04	Load conditions in passenger service (multiple units)	tons		Total pay load of passengers e.g. average or all seats occupied (total weight of persons, average weight per person per service type)
S05	Load conditions in service (locomotives)	tons		Total pay load (total weight hauled by locomotive): weight of wagons in service plus passengers according to S08
S06	Passenger load conditions - occupancy according to number of seats (or standing capacity if applicable)	%		Total passenger occupancy rate e.g. average or all seats occupied
S07	Comfort function duration in-service operation	hh:mm:ss	Summer: Winter:	Duration for the total package of comfort functions in service operation: Heating, ventilation, Air-condition, lighting, entertainment and info panels (during summer and winter) per 24 hours
S08	Comfort function profile for in-service operation (load)	%	Summer: Winter:	Cumulated load profile for the total package of comfort functions in service operation: Heating, ventilation, Air-condition, lighting, entertainment and info panels (during summer and winter) per 24 hours
P	**Out of service mode (parking)**			
P01	Pre-heating and pre-cooling duration	hh:mm:ss		Total average duration of the pre-heating or pre-cooling period before each "in service" period begins per 24 hours
P02	Pre-heating and pre-cooling load profile	%		Load profile for pre-heating or pre-cooling before each "in service" period
P03	Cleaning period duration	hh:mm:ss		Total average duration of the "cleaning mode" period per 24 hours
P04	Cleaning period load profile	%		Load profile for "cleaning mode" period
P05	Parking period duration (hibernating)	hh:mm:ss		Total average duration of the "parking mode" per 24 hours
P06	Parking period load profile (hibernating)	%		Load profile for "parking mode" period
A	**Ambient conditions**			**with seasonal changes**
A01	Temperature	° Celsius	10.6	All year round average temperature
A02	Humidity	%	78	All year round average humidity
A03	Sunlight	W/m^2	736	Intensity of sunlight
A04	Head wind	m/s	2.2	Average head wind conditions in service operation
*A05 **	Ambient air pressure	hPa	1005	International standard atmosphere
*A06 **	Minimum temperature (winter conditions)	° Celsius	-35,3	Winter minimum temperature
*A07 **	Humidity at winter conditions	%	85	Winter mean humidity
*A08 **	Maximum temperature (summer conditions)	° Celsius	40,0	Summer maximum temperature
*A09 **	Humidity at summer conditions	%	72	Summer mean humidity

* Optional parameters.

2. Defining the standard profile for the test track for verifying the rolling stock's consumption and parameters.

Station	km	Altitude [m]	Speed restriction [km / h]	Arrival time	Stopping time	Departure time	Travel time / interstation	Comments
Station A	0,000		40		3:00	0:00:00		
	1,000		80					
	3,000		120					
Station B	15,000		120	0:11:00	2:00	13:00:00	11:00	
	25,000		90					
	27,000		140					
Station C	40,000		160	0:28:00	2:00	30:00:00	15:00	
Station D								

Notes:

The tables above are in keeping with the **UIC Standard / UNIFE TecRec 100_001 /11.03.2010** annexes:

- Annex A - in which the parameters required in order to describe the rolling stock operations conditions (paragraph 1) are identified and defined
- Annex B, in which the standard values are defined for the profile of a test line on which the vehicle consumptions and other parameters (accelerations, decelerations, noise level etc.) are to be measured according to the requirements in the Specifications

The data in the table of paragraph 2, are given merely by way of example.

In order to use the forms under paragraphs 1 and 2, it is necessary to refer to the recommendations in the standard "TecRec 100_001 / 2010" regarding the parameters definition and the modality of conducting the check tests for the rolling stock energy- / fuel consumption etc.

In order to have all the parameters required under the technical data sheets proven, several tests shall be performed, such as:

a) by observing the running times specified under paragraph 2;

b) route covering in a minimum time (by checking maximum start-up acceleration and maximum braking deceleration);

c) optimized driving in order to get minimum consumption (with and without regenerative braking options, respectively);

d) in DMU configuration for 100% passengers and DMU configuration for approx. 60% and 20% passengers (for instance).

According to the requirements, tests may be performed along two or several test lines, in order to check under the most severe operation conditions (for instance, in order to check maximum speed, traction / braking on maximum declivity ramp-gradient, curve negotiation, protection operation or consumption optimization controls etc.

For each test line, all the data shall be defined according to the table, paragraph 2, possibly through additional attached documentations referring to the track constructive profile and characteristics (curves, superelevation of rails, declivities, points, restrictions, etc.).

All the conditions of each type of test shall be clearly defined in the Specifications.

Based on the above (possibly on the remarks to be made on site), the tenderers shall have the necessary data in order to calculate and simulate the technical data they will fill in the technical data sheets, inclusively in the data sheet referring to the costs throughout the service life.

8.5. Timişoara site: estimate of system-wide energy efficiency by 2020[12]

In order estimate system wide energy reductions until 2020 we need to take into account several factors that can influence the energy consumption of rolling stock. The main factors that influence energy consumption in the railway sector are the evolution of the volume of activity in Romania and the evolution of the railway transport market share. Both of these indicators may lead to decreasing energy consumption levels compared to the potential energy reduction when energy efficient measures are applied. For example the simple facts that railway increases its market share compared to the road transport market share will lead to a reduction in the overall energy consumption and CO2 emissions.

If however railway transport will increase its market share and simultaneously apply energy efficiency principles, the effects are much greater.

The first stage of our estimation will begin from the Timişoara tests results i.e. 15,85% energy efficiency compared to the current rolling stock and 10,90% energy efficiency compared to the current awarding (see WP5 – Deliverable 17 Validation Report, paragraph 3.1 First Level performance indicators).

Within this first step we will show how energy efficiency will evolve during 2010-2020 without influence from any external factors. In order to obtain reduced energy consumptions new trains have to be acquired or modernized and in order to do that we must know and average capacity increase as new trains are acquired and old trains are being taken out of service.

According to the "Program of restructuring and economic-financial stabilization of the Romanian railway for passenger transport „CFR Călători" – SA" (October 2010), the acquisitions plan for the period 2010-2020 is shown below.

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
DMU	***0***	***10***	***20***	***20***	***20***	***20***	***20***	***10***	***0***	***0***
EMU	***0***	***10***	***20***	***20***	***20***	***20***	***20***	***10***	***0***	***0***

TABLE 1. PLANNED ACQUISITION FOR THE PERIOD 2011-2020

According to the same document the number of coaches needed for service during 2010 – 2020 should be decreased as shown below.

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
number of coaches	2152	2082	1942	1802	1662	1522	1382	1328	*1328	*1328

TABLE 2. NECESSARY NUMBER OF COACHES FOR THE PERIOD 2011-2020

* estimated values

We consider the average number of seats on coaches to be 80 seats and for EMUs/DMUs to be 100 seats. Also, considering the starting capacity of 2011 of being the number of needed coaches (2152) times the average capacity of a coach (80 seats) we can determine how much average capacity in added with each acquisition compared to the year 2011. This is relevant due to the fact that with each new acquisition in which the ECORailS principles are included a 5% increase in energy efficiency is expected compared to the previous awarding. This means that, for example, in 2014 the 20 EMUs and DMUs that are being acquired,

[12] Author: Integral Consulting R&D, Bucharest (Romania).

should be 5% more energy efficient than the EMUs and DMUs acquired in 2013, (5%x5%+5%) more energy efficient than the ones bought in 2012 and so on.

In table 3 shows the percentages of capacity added in each year compared to 2011.

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Capacity	-	3,66%	7,32%	7,32%	7,32%	7,32%	7,32%	3,66%	0,00%	0,00%

TABLE 3: CAPACITY ADDED IN EACH YEAR COMPARED TO 2011.

As stated above, each new acquisition will not only be 15,85% more efficient than the existing rolling stock but also 10,91% more that the previous one. This will lead alone to an increase of the initial 15,85% potential for energy efficiency to reach a maximum potential of 30,98% energy efficiency until 2020 simply due to the acquisitions program of the railway company.

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Energy efficiency	15,85%	16,43%	18,80%	20,85%	23,13%	25,65%	28,45%	30,98%	30,98%	30,98%

TABLE 4. ENERGY EFFICIENCY POTENTIAL IN ECORAILS CONDITIONS WITHOUT INFLUENCING FACTORS

However there are several factors which can further contribute to the system wide energy efficiency potential in Romania.

The first such factor is the increase in the volume of activity. According to the “Program of restructuring and economic-financial stabilization of the Romanian railway for passenger transport „CFR Călători” – SA” an increase is planned in the volume of activity measured in (thou train-km) as seen below.

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Volume of activity (train*km)	55000	57000	60000	63000	65000	67000	71000	75000	80000	*82480
Volume increase compared to 2011	0,0%	3,6%	9,1%	14,5%	18,2%	21,8%	29,1%	36,4%	45,5%	49,96%
Energy efficiency due to increased volume in ECORailS conditions	15,9%	16,4%	17,3%	18,2%	18,7%	19,3%	20,5%	21,6%	23,1%	23,8%

TABLE 5: VOLUME OF ACTIVITY OF THE ROMANIAN RAILWAY COMPANY FOR THE PERIOD 2011-2020

* estimated value

Due to the 15,85% energy efficiency potential identified for 2011 and a 50% increase in volume of activity an increase to 23,8% in energy efficiency potential is expected in 2020.

Another factor that can potentially lead to an increase in the system wide energy efficiency is the increase in capacity. As seen above in the “Program of restructuring and economic-financial stabilization of the Romanian railway for passenger transport „CFR Călători” – SA”, the national railway company planes to acquire until 2020 120 EMUs and 120 DMU while simultaneously reducing the number of coaches. This will result on average as seen in table

6 an increase in the total capacity (measured in number of seats) compared to the year 2011.

In 2020 a 5,62% average increase in capacity is expected, which will lead to an increase in energy efficiency provided ECORailS criteria are being used, to 16,74%.

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Overall capacity increase (no. seats)	-	700	2100	3500	4900	6300	7700	9680	9680	9680
Capacity increase compared to 2011	-	0,41%	1,22%	2,03%	2,85%	3,66%	4,47%	5,62%	5,62%	5,62%
Energy efficiency compared to 2011 as a result of increased capacity in ECORailS conditions	15,85 %	15,91 %	16,04 %	16,17 %	16,30%	16,43%	16,56 %	16,74 %	16,74 %	16,74 %

TABLE 6. CAPACITY INCREASE AND ENERGY EFFICIENCY DUE TO INCREASED CAPACITY DURING 2011-2020

A final influencing factor for the increase in energy efficiency is the increase of passenger railway transport market share.

According to statistics of the Ministry of Transports and Infrastructure, the present market share of passenger railway transport is 20,84%. According to the targets imposed by Romania's Sustainable Strategy, the market share for railway passenger transport should reach 26% by 2020 which signifies an 5,16% increase in market share. Considering that gained market share for railway transport is lost by the road transport we show in table 8 data for energy consumption and emissions generated by "EcoPassenger" for the route Timisoara – Jimbolia (one of our test routes).

	Thousand passengers	Thousand passengers	Market Share	Thousand passengers	Market Share	Thousand passengers	Market Share
Year	2007	2008	2008	2009	2009	2010	2010
Railway	88263	78252	20,70%	70332	20,57%	48848	20,84%
Road	231077	296954	78,40%	262311	76,72%	177684	75,82%
Waterborne	211	194	0,10%	161	0,05%	83	0,04%
Air	3144	3541	0,90%	9093	2,66%	7750	3,31%

TABLE7: MARKET SHARE OF PASSENGER TRANSPORT MODES IN ROMANIA.

According to our calculations based on "EcoPassenger" data railway transport is 57% more energy efficient than road transport and generates 49% fewer CO2 emissions. Considering the planned 5,61% increase in railway transport market share by 2020 this would lead to an overall reduced energy consumption by 2,90%.

*Indicator	*MU	*Rail	*Road	**Efficiency Rail vs Road	** Efficiency Rail vs Road in a 5,61% increase in rail market share
CO2	Kg	2,4	4,9	49%	2,50%
Energy consumption	L	1,3	2,3	57%	2,90%
Particulate matters	g	0,91	1,4	65%	3,40%
NO	g	2,9	23,2	13%	0,60%
NMHCs	g	0,26	2,5	10%	0,50%

TABLE 8. ENERGY CONSUMPTION AND EMISSIONS OF RAILWAY VERSUS ROAD TRANSPORT.

* provided by EcoPasenger
** calculated

In order to determine the overall increase in the system wide energy efficiency by 2020 we must now take into account all potential energy efficiencies generated by all factors.

We firstly take into account the 15,85% potential for energy efficiency according to the ECORailS criteria, then we add the 7,92% (the resulting 23,8% minus the initial 15,85%) increase in energy efficiency generated by an increase in transported volume, adding then 0,89% increase in energy efficiency due to the increased capacity and lastly adding the 2,90% increase in energy efficiency due to increased market share. By summing up all potentials, the total maximum potential for system wide energy efficiency in 2020 would reach 42,69%.

The figure below shows the evolution until 2020 of all energy efficiency potentials until 2020 considering a 15,85% energy efficiency potential compared to the current rolling stock and the remaining energy efficiency potentials generated by various factors.

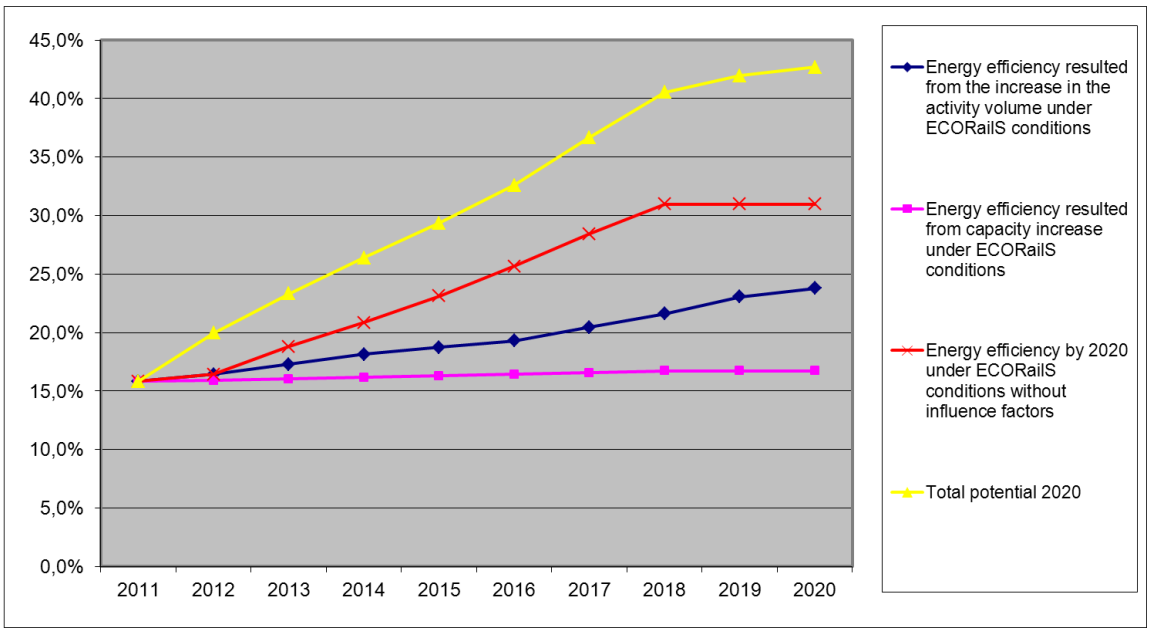


FIGURE 1. MAXIMUM SYSTEM WIDE ENERGY EFFICIENCY POTENTIALS DURING 2011-2020

However due to the fact that for the future ten years we have technological restrictions that will not allow to obtain on a yearly basis a 10,91% increase in energy efficiency compared to the previous offer, a realistic scenario for the Timisoara region would only take into consideration system wide increase in energy efficiency generated due to increased capacity, volume and market share.

This probable scenario would result in a system wide energy efficiency of **27,56 %**.

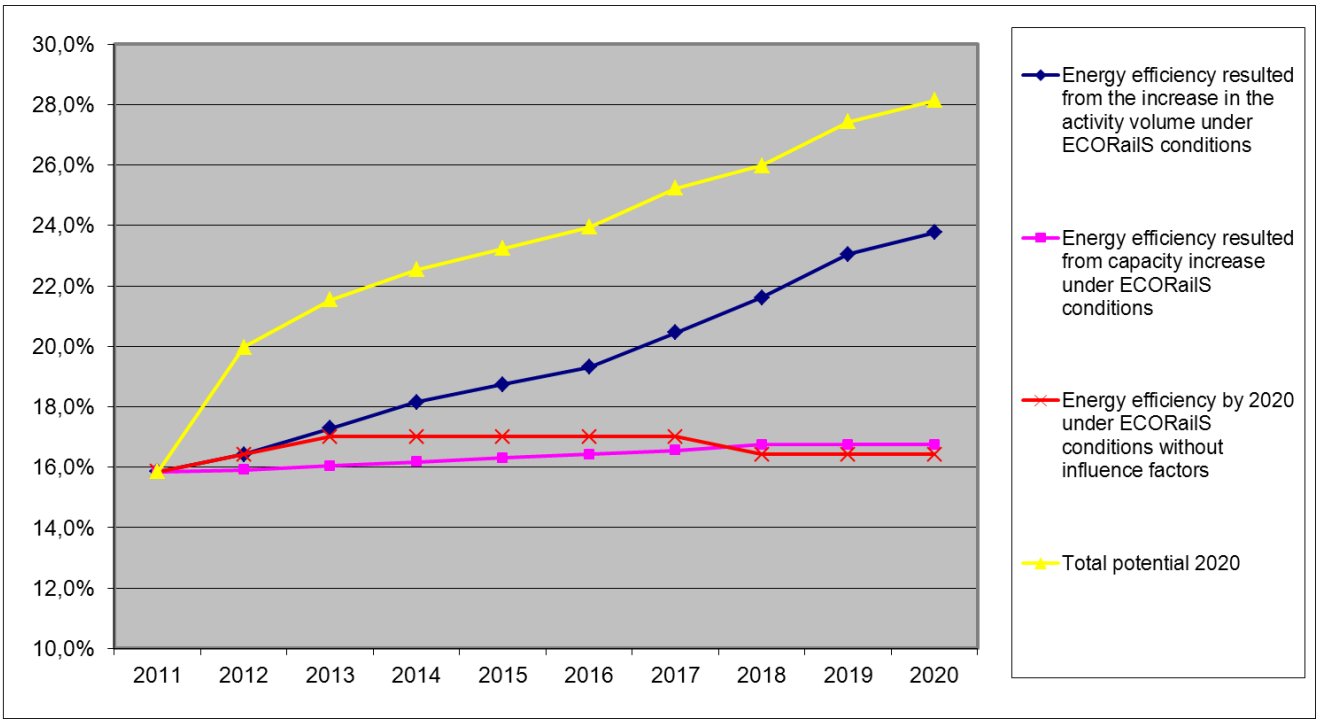


FIGURE 2. PROBABLE SYSTEM WIDE ENERGY EFFICIENCY POTENTIALS DURING 2011-2020.