

“First Comparison of the Environmental Performance of Rail Transport”

Pro-Rail Alliance

Examples of measures adopted by railway undertakings and the supply industry to improve the environmental impact of railway operations

The examples set out in the following table are taken from freely accessible publications or else have been sent to us by the companies concerned with a view to publication or were presented at meetings. They relate to railways from Germany and elsewhere. We have also included examples of underground railway and tram operations where the measures delineated are of relevance to railways or could be in future.

The examples enumerated are assigned to the impact categories of noise, energy consumption or pollutants as applicable. We have lent special priority to the issue of “Avoiding acoustic emissions” in the Pro-Rail Alliance’s “First Comparison of the Environmental Performance of Rail Transport”, and this explains why measures relating to noise are listed first. Measures to avoid pollutant emissions come next, followed by those to reduce energy consumption. Many measures act to avoid energy consumption and pollutant emissions simultaneously, sometimes even in addition to noise avoidance. Examples relating to both noise and other impact categories are to be found at the end of the pure noise avoidance measures. Examples relating to pollutant emissions and energy avoidance but not to noise avoidance have been included after measures on pollutant emissions. Where the lowering of pollutant emissions is primarily the outcome of lower fuel consumption, then the relevant measure is assigned to energy consumption only.

Rounding the list off are measures from the field of “general environmental standards”.

The bulk of examples collected concern vehicles worked by the railways in line with the concept underpinning the “First Comparison of the Environmental Performance of Rail Transport”. Trackside measures have only been covered in isolated instances (noise emissions, following “Innovation”).

The synopsis of measures was drawn up by SCI Verkehr GmbH in Cologne on behalf of the Pro-Rail Alliance.

Inclusion in this list does not mean we have conclusively appraised the quality, efficacy and operational practicability of the measures concerned. Some projects are still at the test stage. Our aim with the list is to demonstrate the wide variety of environmentally friendly measures that exist for rail operations and to spur railway undertakings at home and abroad to emulate the examples cited.

We will be glad to assist in conveying further information and contact details in respect of the measures listed.

We do not lay any claim to exhaustiveness. Supplementary input is welcome at any time at info@allianz-pro-schiene.de or by faxing +49 (0)30 27594560. Further information can be obtained at www.allianz-pro.schiene.de.

We plan to update this list at irregular intervals. The present version dates from 1 May 2006.

Serial No.	Impact category/ categories	Area(s) involved	Issue	Brief description	Source
1	Noise	General	ICE 3 test runs in the cause of uniform European noise standards	A wide range of acoustic measurements involving an ICE 3 have been carried out on the new-build line between Stendal and Wolfsburg as part of "Noemi", a European noise control project. Hard rubber pads with sound-damping properties had were placed between sleeper and rail on a test section 250 metres long near Gardelegen, specifically for the measuring runs, and tracks had been ground so as to minimise unevenness on the rail, which causes some of the traffic noise produced during wheel-rail contact. "Noemi" runs under the auspices of the European Association for Railway Interoperability (AEIF). The aim of the present measuring runs is partly to determine uniform European noise standards and partly to create uniform conditions for future European test tracks.	Eurailpress press release 26/08/03
2	Noise	General	Noise-based track access fee concept allows operators to be involved	Hitherto, there has been no immediate incentive for supply industry and the railways to use low-noise vehicles and track. In conjunction with other research institutes, TU Berlin has now developed a train-path pricing concept that factors in the noise emitted by a train. The concept involves a fixed price per train-kilometre plus a noise-based component that reflects the specific acoustic behaviour of the train in question. "Noise unit" ratings are determined for each wagon type, which are then used to calculate the number of noise units for the train, including the traction unit, as a whole.	Eisenbahn Revue International 05/04 p210ff
3	Noise	Procurement	FLIRT regional multiple unit	Stadler Rail of Bussnang in Switzerland developed the FLIRT multiple unit in 2002. The vehicle range was developed for regional, urban rapid transit and region-to-region traffic. It is characterised by low-floor entrances, a high accelerating capacity, a top speed of 160 km/h, damage-minimising crash behaviour and low acoustic emissions. The FLIRT range comprises three to six-car mainline multiple units involving electric or diesel-electric traction. FLIRT was subjected to acoustic testing as stipulated in prEN ISO 3095 and prEN ISO 3381 during the approval process. The readings taken meet Swiss, Austrian	Elektrische Bahnen 03/2005 p116ff; information from Stadler

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				and European requirements and are well within the relevant limit values. At a speed of 80km/h, for instance, a value of 74 dB(A) was recorded outside the vehicle whilst the reading inside was between 60 and 64 dB(A). In stationary state, FLIRT delivers 65 dB(A) with systems running. Requirements when moving off were also safely met with a reading of 75 dB(A).	
4	Noise	Procurement	Cutting noise on the CITADIS by Alstom	Measurements taken at the Wegberg-Wildenrath test centre for the CITADIS vehicle range yielded the following acoustic values. For the 2-system vehicle: interior noise at 100km/h 71dB(A) (mean value), exterior noise at 100km/h 85 dB(A), exterior noise when moving off 72 dB(A) (to 40km/h), interior noise when moving off 69 dB(A) (to 40km/h). With the hybrid vehicle, the same readings for interior and exterior noise at 100km/h and for interior noise when moving off (to 40km/h) were arrived at as for the 2-system vehicle. The only difference concerned the 78 dB(A) value measured for exterior noise when moving off (to 40km/h). Measurements were taken in conformity with the draft standards ISO 3095:2005 and ISO 3381:2005.	Paper entitled "Neue Wege auf alten Gleisen", proceedings of the 23 rd Horb Rail Conference 2005
5	Noise	Procurement	ICN operated by SBB with radial wheelset control	The ICN tilting-train stock operated by SBB (RABDe 500) features radial wheelset control to prevent "curve squeal" and reduce wear of the track. The noise values stipulated and achieved for this vehicle type are 92 dB(A) exterior noise level at 200 km/h measured at a distance of 7.5 m, 65 dB(A) compartment noise level at 200 km/h, 72 dB(A) vestibule noise level, 65 dB(A) exterior noise level in stationary state with systems running measured at a distance of 7.5 m and 55 dB(A) interior noise level in stationary state with the air conditioning running.	

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6	Noise	Procurement	Hercules quietest diesel locomotive of its class	The class 2016 diesel locomotive (Hercules) developed by Siemens for Austrian Federal Railways (ÖBB) was constructed to conform to the stringent noise control legislation in force in Austria and is accordingly (as at 2004) the quietest diesel locomotive in the 2MW class in the world. Some of the values prescribed were kept to by a considerable margin. The value for stationary locomotive noise is 65.5 dB(A), whereas the law merely demands a limit value of 80 dB(A). Most notably, it was possible to damp and absorb acoustic emissions from within the engine.	EI 06/04 p65ff
7	Noise	Procurement	UIC approval for low-noise K block	The UIC has permanently approved the composite brake block (K block) in European freight operations. The Board of Management of Deutsche Bahn AG had already made a decision two years previously to procure only freight wagons with K blocks in future. Fitting K blocks allows noise to be reduced directly at source relative to conventional cast-iron blocks. Adopting the new technology can reduce levels of subjectively perceived noise by up to 50 %. Deutsche Bahn played an instrumental part in its approval by the UIC by developing and trialling the new brake technology.	DB AG press release 15/10/03
8	Noise	Retrofit	DB Regio runs Class 203 stock with double acoustic insulation	Since mid-January, DB Regio's Central Franconia Unit has been working Class 203 locomotives modernised at Alstom's Stendal plant, and now boasting double acoustic insulation, at Nuremberg central station.	Nürnberger Zeitung of 15/01/2005, p28
9	Noise	Retrofit	Noise-attenuated freight wagons	In Switzerland, the noise emitted by rolling stock is being legally restricted through the entry into force of new noise control regulations. Any existing rolling stock that is to be retained, therefore, has to be rehabilitated. So as to be able to specify a limit value for rehabilitated freight wagons in the regulations, the Swiss Federal Environment Office has commissioned Prose AG of Winterthur to carry out noise measurements and propose a noise limit value for rehabilitated wagons. The test concept, findings and conclusions are set out in the article.	Eisenbahn-Revue International 02/05 p61ff.

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10	Noise	Retrofit	SNCF - reducing noise by taking action on wheels and brakes	SNCF is opting to lower noise emissions from rail traffic by taking action at the wheel/rail contact patch. Whereas new passenger stock is being almost exclusively fitted with “silent” disc brakes, noise levels on older, block-braked carriages and wagons are being reduced by switching from cast-iron brake blocks to models in composite and sinter materials. In the case of freight trains on trans-Alpine routes, however, there is a need to develop products capable of delivering the requisite brake performance.	zev rail 10/2004 p474ff.
11	Noise	Retrofit	TU Berlin developing acoustic fairings	Since autumn 2004, 1,000 leading-edge trains have been running on the Berlin urban rapid transit (URT) system (“S-Bahn”). Nonetheless, the Berlin Senate decreed in 2004 that starting and braking noise on these modern trains should be cut by five decibels. The task of achieving this went to Professor Markus Hecht. Once he had concluded his investigation, Professor Hecht was able to demonstrate that it is indeed possible to reduce URT-specific starting and braking noise. The source of noise emissions was discovered to be the motor bogies. These act like resonant bodies that amplify sound. The desired drop in noise levels was achieved by employing oscillation-damping materials and acoustic fairings coated with an acoustically insulating foam. Before fitting all vehicles with such soundproofing apparatus, there is a need to clarify questions of safety and, above all, of funding.	Internal TU document, No. 7-9, July 2005
12	Noise	Operation	DB Fernverkehr identifies wheel flats by means of stationary detectors	DB Fernverkehr has now installed a total of 20 stationary detectors to identify out-of-round wheels on ICE trains. There are plans to extend their use to all railway traffic. Though the primary purpose is not noise avoidance but enhanced safety and better maintenance planning, the measure nevertheless impacts positively on noise emissions.	FAZ, 18/01/2005, pT3

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13	Noise	Operation	Identification system reduces noise emissions	The Copenhagen URT system ("S-tog") has introduced an identification system for regular condition testing of every wheelset in operation. This has resulted in noise emissions and the cost of servicing URT vehicles being steadily reduced. In the USA, such systems are "mandatory for inter-state-used cars".	DSB press release 27/09/2004
14	Noise	Operation	Acoustic quality management for freight wagons	With the adoption of the TSI directive in November 2004 and its entry into force in mid-2005, the approval of conventional rolling stock is now subject to binding limit values for noise emissions. Acoustic quality management is intended to establish a procedure governing customer/maker relations on acoustics matters that will detect acoustic weak points on a vehicle at an early stage of development. The first step in cutting wagon noise involves lowering acoustic emissions from wheels by, for instance, fitting them with absorbers or replacing the brake system.	Güterbahnen 01/2005 p12ff.
15	Noise	Operation	Acoustic measuring site comes on stream near Adelaide	The Australian Rail Track Corporation (ARTC) has started a project to enable it to take noisy rolling stock out of service at the earliest possible opportunity. It goes by the name of Rail Squeal Acoustic Detection (RailSQAD) and aims to reduce noise nuisance levels.	International Railway Journal 11/2005 p48f.

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16	Noise	Innovation	Actively controlled pantograph cuts acoustic emissions	With the authorisation of Germany's Federal Railway Authority (EBA), the ASP pantograph (actively-controlled, single-arm pantograph) has been successfully tested at up to 230 km/h. The actively controlled pantograph was jointly devised by Bombardier and DB Systemtechnik and features two-stage control involving a pneumatic raising mechanism as the actuator in the first stage and pneumatic actuators (bellows) on torsion bars in the second. The control variable is the contact force between the contact wire and the pan head. Streamlined shrouding has been developed for particularly critical sources of noise. Wind noise can be reduced by up to 10 dB(A) with the new pantograph, causing acoustic emissions as perceived by the human ear to be halved.	Eisenbahnrevue International 10/03, p446f
17	Noise	Innovation	Noise cut on the ETR 500	FS, the Italian State Railway, has experimented with the wheel fairings and acoustically insulating materials on its ETR 500 high-speed train and in the process managed to lower noise by 4 dB(A). The materials have yet to be adapted to safety and transport standards, however.	Internationales Verkehrswesen, 6/2003, p297
18	Noise	Innovation	Quieter blowers for rolling stock	Voith Turbo of Heidenheim is developing a new range of blowers that, without forfeiting anything in terms of their aerodynamic properties, are significantly quieter than traditional designs. Evaluation of various options revealed a sickle-shaped blower blade to be a promising concept. Installed in roof-mounted cooling plant incorporating an electric fan motor and designed for use on a diesel-hydraulic railcar, the sickle blower improved noise output levels by 3 dB.	Nahverkehrspraxis, 07-08/2005 p6f

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19	Noise	Innovation	Freight-wagon bogies with rubber suspension	ContiTech and SKF have developed a new bogie suspension system for freight wagons that makes use of rubber elements. In particular, this is intended to significantly reduce noise generation. Benefits are also anticipated in terms of safe tracking, including at higher speeds, and of servicing costs.	Handelsblatt, 20/04/2006, p18
20	Noise	Innovation	Sound damping for rails	One way to reduce noise from rails is by insulating the rail webs. Rex Articoli Tecnici SA of Mendrisio in Switzerland has come up with rubber elements to this end that are fastened to the side of the web with spring clips. They effectively cut sound levels by five decibels (dB). The rubber elements can be fitted without any special tools or gadgets and do not need to be removed for track maintenance. They are supplied for S 54/BV 50 and UIC 60 rails, the types most commonly used on European main lines.	Eisenbahn Ingenieur 11/2005 p113
21	Noise	Innovation	Measuring station records “footprint” of rolling stock	A measuring station installed at Zevenhuizen in the Netherlands is to be used to record the “footprint” of railway vehicles and their environmental impact under a European research project entitled “Eureka Logchain Footprint”. A second measuring station has been set up by the A1 motorway at Lenzburg in Switzerland. Readings are being taken of dynamic load, the noise produced by vehicles, ground vibration as well as the temperature and degree of deformation and humidity of the various layers in the carriageway. The data are intended to give knowledge about the interaction between transport means and infrastructure and to serve as a basis for introducing a heavy traffic levy along the lines of the Swiss example.	Eisenbahn-Revue International 12/04 p570

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22	Noise	Innovation	Less noise through continuous rail bedding	Research is to be undertaken to develop and test further means of lessening the noise created by railways. The research activities described focus on ballasted track. Initial trials show that one means of tackling acoustic radiation is continuous rail bedding, which is structurally very well suited for use on slab track. However, a degree of system development supported by accompanying research is needed before it can be applied to ballasted track.	Eisenbahn Ingenieur 12/2005 p14ff. 10 figs
23	Noise	Infrastructure	New railway sleepers cut structure-borne sound	There are plans in Switzerland to use a new type of railway sleepers to reduce structure-borne emissions. Swiss Federal Railways (SBB) is conducting pilot tests to this end between the stations of Leuk and Salgesch. In the spring of 2006, the present sleepers on both tracks are being replaced over a distance of approx. 90 m in the portal area on the Leuk side of the 1,365-metre-long tunnel by a new type of sleeper with special padding that is designed to reduce structure-borne emissions. The tests will cost around €322,000.	Eisenbahn Technische Rundschau 01-02/2006 p4f.
24	Noise	Infrastructure	Sound damping for rails	One way to reduce noise from rails is by insulating the rail webs. Rex Articoli Tecnici SA of Mendrisio in Switzerland has come up with rubber elements to this end that are fastened to the side of the web with spring clips. They effectively cut sound levels by five decibels (dB). The rubber elements can be fitted without any special tools or gadgets and do not need to be removed for track maintenance. They are supplied for S 54/BV 50 and UIC 60 rails, the types most commonly used on European main lines.	Eisenbahn Ingenieur 11/2005 p113

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25	Noise	Infrastructure	Less noise through oscillatory grinding	The system of rail grinding for acoustic reasons practised by Schweerbau GmbH of Stadthagen combines reprofiling of the rail with oscillatory grinding, the latter giving rise to low levels of noise. Machined rails are conclusively identifiable by means of longitudinal grind marks and smooth contouring of their transverse profiles.	zev rail 08/2005 p324ff.
26	Noise	Infrastructure	Alpha Rail Team employs new rail milling train	On 15 May 2004, Austrian mechanical engineering company Linsinger handed its new SF03-FFS rail milling train over to the German firm Alpha Rail Team GmbH & Co. KG. Alpha Rail Team is a joint venture involving the two railway engineering specialists Sersa and Stahlberg Roensch. Benefits delivered by the new rail milling train include its working speed, its integrated instrumentation, the fact that it reprofiles and grinds in one operation, its high-fidelity restoration of the original rail profile, its ability to extend the service life of rails by up to 300 %, lower acoustic emissions when the track is negotiated and lower life-cycle costs (LCC).	Eisenbahn Ingenieur 06/03 p90 2 figs
27	Noise	Infrastructure	Lineside noise control	ÖBB Infrastruktur Bau AG is investing around €1.4 billion on noise control in 2005 and the following years. Contracts for relevant noise control measures are being concluded between ÖBB, federal states and municipalities on the basis of the Rail Traffic Noise Cadastre.	Nahverkehrs Nachrichten 12/11/2005
28	Noise	Infrastructure	Lineside noise abatement	Resources totalling €50.9 million have been earmarked in 2005 for the "Noise abatement along existing federal railway lines" scheme. More than 600 projects are running or planned under the scheme. In the sphere of active noise control, 34 acoustic barriers with a combined length of around 42 kilometres are set to be completed in 2005. Construction of a further 34 acoustic barriers measuring approx. 40 km in total is due to commence this year. The noise abatement scheme had made good progress by the end of 2004: since activities commenced six years previously, some 85,000 metres of acoustic walling had been erected and acoustically insulated windows fitted in 21,000 or so dwellings. In addition, some 13,000 fans had been fitted and over 1,500 roofs acoustically insulated.	Stadtverkehr 04/2005 p45; DB AG press release 07/03/2005

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29	Noise, pollutants, energy consumption	Procurement	HHA running new low-energy, recyclable underground trains	Improvements in lightweight construction techniques and adoption of efficient energy components allow an energy consumption value of 0.9 kWh per passenger-kilometre to be achieved with Hamburg's new DT 4.5 underground trains as compared with an international average of approx. 1.1 kWh/pkm. Moreover, the adoption of specialised wheel noise absorbers and fully encapsulated, water-cooled drive units has led to the noise produced when a train passes at 60 km/h being cut by 8 dB(A) compared to conventional vehicles. In addition, Alstom has drawn up a comprehensive recycling concept for DT 4.5 stock in conjunction with the operator HHA. Emphasis has been placed on employing recyclable parts and low-emission materials such as biofibre composites. It has been possible to raise the recycling ratio from 90.8 to 94.3 % over the predecessor vehicle.	EI 06/04 p65ff.
30	Noise, pollutants, energy consumption	Innovation	Knorr develops environmentally friendly brake systems	Knorr Bremse has developed a compressor specially geared towards the railway supply industry that generates the compressed air required for brake systems and other pneumatic apparatus with very little noise or vibration. The compressor requires less servicing and is up to 20 % more energy-efficient than conventional solutions. Adopting the new technology allows a 25% weight saving to be made. By dint of its specially coated pistons, furthermore, the compressor requires no oil lubrication, meaning that oil cooling and oil changes can be dispensed with altogether.	EI 06/04 p65ff.
31	Noise, pollutants, energy consumption	Retrofit	Diesel re-engining of Class 232 stock concluded	In early December 2003, the last of the 64 Class 233 diesel locomotives left DB's Cottbus workshops following a major overhaul that included re-engining. The refit programme began in May 2001. It was more than 30 years ago that this generation of diesel locomotives, built in what was then the Soviet Union, went into service with the former Deutsche Reichsbahn. The re-engined locomotive now meets contemporary environmental standards. The new engine, for example, is considerably less noisy and more economical in consumption. Emissions of soot particles are correspondingly lower.	Eurailpress press release 15/12/03

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32	Noise, energy consumption	Operation	Economising on energy by building a carriage shed and running an acoustically insulated shunting vehicle	Hohenzollersche Landesbahn AG (HzL) began building a new vehicle depot and carriage shed at Gammertingen in 2000. This obviates the need to heat railcars left out in the open in the winter months. The amount of engine noise emitted by the railcars outdoors is also reduced. For the purpose of marshalling stock into their sheds, HzL has procured a special-purpose, acoustically insulated shunting vehicle.	LOK Report 6/2000, p30f.
33	Noise, energy consumption	Innovation	LEILA bogie makes for quieter running as well as reducing rolling resistance and wear specifically through curves	A German-Swiss consortium with involvement by TU Berlin (specialist field: rolling stock) and Josef Meyer Waggon AG (Rheinfelden) is developing and trialling a "light, low-noise bogie" ("LEILA-DG"). Rolling noise is significantly lower than with traditional block-braked wagons due to the bogie's acoustic design, low-noise wheels, rubber suspension elements and the incorporation of disc brakes. Cross anchors enable axles to undergo radial adjustment through curves, causing noise emissions, energy consumption and wear to be cut during negotiation of curves. The energy consumed in propelling the individual vehicle forward against tractive resistance is reduced as a function of the layout of the line by between 3 and 25 % (no account being taken of air and gradient resistance in this computation). Additional economic and energy-related benefits accrue from the reduction in mass, which allows the payload to be raised. The scope for retrofitting the existing fleet with "LEILA-DG" was considered during design engineering.	Talk by Prof. Markus Hecht at the 4 th Viennese Railway Colloquium on 10 March 2006. (Further sources: consortium prospectuses for Innotrans 2004; ZEV Rail March 2004, p98ff.; Güterbahnen 2/2003, p18ff.; ETR 9/2003, p52ff.)
34	Pollutants	General	Substances emitted from railway premises and during railway operations	Environmentally harmful substances are released from various sources during railway operations, amongst them heavy metals and hydrocarbons. With a view to lastingly protecting water and soil against pollution, it is essential that railway companies be familiar with the sources and substances emitted and that they establish the whereabouts of such substances and their impact on the environment. The article reports on a study produced for Swiss Federal Railways (SBB) in which the principal sources for the entire SBB network are pinpointed and the relevant emissions recorded and qualitatively assessed.	Eisenbahn Ingenieur 12/2005 p18ff.

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35	Pollutants	Procurement	Gmeinder supplying diesel locos with particulate filters to Austrian narrow-gauge railways	ÖBB ("Krimmler Bahn" Zell am See-Krimml) and the Zillertalbahn railway have jointly ordered and procured several diesel locos with particulate filters from the Baden firm Gmeinder.	??? (to be added)
36	Pollutants	Procurement	SBB operating Vossloh diesel locomotives with particulate filters	<p>Swiss Federal Railways (SBB) is using a series of Class Am 843 diesel locomotives developed by Vossloh for shunting, engineering-train and freight-train duties. The locomotives are fitted with special silicon-carbide exhaust-gas filters that filter out approx. 99 % of soot particles of between 20 and 300 nanometres in size. Given a mean operating life of 30 years, that's equivalent to reducing emissions of this environmentally invasive fine particulate matter by a total of approx. 40 tonnes. The locomotives thus already meet stringent exhaust-gas standards that might not become binding for another five to ten years. Am 843 vehicles with particulate filters have likewise been procured by BLS Lötschbergbahn AG and track engineering company sersa AG.</p> <p>The filter-equipped Am 843 vehicles operated by SBB Cargo are also being scheduled to run in Germany (in the German-Swiss border region and the Saarland).</p> <p><i>[Cf. presentation by U. Winkler at the Pro-Rail Alliance Workshop on 7 Dec. 2005!]</i></p>	Güterbahnen 03/04; p32f.; Eisenbahn-Revue International 11/05, p520ff. and 1/06, p39

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37	Pollutants	Procurement	Trains with particulate filters	The first diesel multiple units fitted with soot-particle filters are to be worked on the Taunusbahn network in the Frankfurt area from the end of 2006 onwards. Rail systems manufacturer Alstom is building ten two-car Coradia Lint 41 regional trains in Salzgitter for just on €27 million that will be fitted with particulate filters and exhaust-gas optimised engines. In combination with the soot-particle filters, the engines meet the latest EU exhaust-gas standard 3a and additionally anticipate future more stringent provisions. <i>[Cf. presentation by G. Wogatzki at the Pro-Rail Alliance Workshop on 27 Oct. 2005!]</i>	Frankfurter Allgemeine Zeitung 20/09/2005 p2
38	Pollutants	Procurement	DB AG planning exclusive procurement of diesel locomotives with soot-particle filters	Deutsche Bahn AG will only be buying diesel locomotives fitted with soot-particle filters in future. The Federal Environment Ministry has been assured of this by DB's CEO Hartmut Mehdorn. It is also planned to retrofit existing locomotives with particulate filters. In cases in which this is precluded by the vehicle's layout, the locomotives will be retrofitted with environmentally sound engines. As Margareta Wolf reports, "Locomotive makers are planning a joint initiative under the working title 'Green Rail'. The Federal Environment Ministry is assessing whether to participate in this initiative."	Eurailpress press release 29/09/04
39	Pollutants	Procurement	Union Pacific buying 60 new locomotives	Railway undertaking Union Pacific Railroad is buying 60 locomotives from National Railway Equipment Co. These 2,100hp "generator set" diesel locomotives are particularly low-emission and will be deployed in the Los Angeles region. Union Pacific is taking possession of the first 30 locomotives in 2006, with the remaining 30 engines to follow the year after.	Union Pacific Press release 09/02/06
40	Pollutants	Procurement	Ports in Los Angeles using more environmentally friendly locomotives	The ports of Long Beach and Los Angeles have agreed a project to replace old traction units with Pacific Harbor Line (PHL). 18 locomotives with ageing diesel engines are to be replaced by new, more environmentally friendly ones for around €20 million. The agreement is part of a commitment by the companies to cut emissions over a ten-year period.	Railway Age 30/08/05

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41	Pollutants	Procurement	FEV Motorentechnik developing engine for US locomotives	FEV-Motorentechnik of Aachen has joined forces with US makers General Electric (GE) to develop a new engine that meets the environmental provisions of the Tier 2 environmental standard that will be in force as of January 2005. The compact diesel engine can be built as either a 12 or 16-cylinder model. The V12 variant weighs in at 19.5 t and delivers 3,660 kW. It performs as well as GE's previous 16-cylinder series engine and additionally meets the requisite environmental standards. The engine is currently fitted on 35 locomotives and fulfils the exacting requirements even under the most arduous of service conditions. The first engine in the new "GEVO" design series has accordingly been cleared for series production and is to be fitted on GE's "Evolution Series" locomotives in 2005.	VDI Nachrichten 19/11/2004
42	Pollutants	Procurement	Union Pacific buying 315 Tier 2 locomotives	GE and EMD have received an order from Union Pacific for 315 locomotives meeting the Tier 2 environmental standard applicable as of 1 January 2005. The new units have the same rating as their predecessors whilst their emissions have been cut by 40 %.	Railway Age 1/10/2004
43	Pollutants	Procurement	Green Goat® hybrid locomotives for Texas	RailPower Technologies is supplying Union Pacific with 10 Green Goat hybrid locomotives for use in Fort Worth and Houston. The locomotives are being financed under the Texas emissions reduction program.	Railway Gazette International 05/05 p248
44	Pollutants	Procurement	Green Goat® hybrid locomotives for Texas	TERP (Texas Emission Reduction Program) has responded to a request by eight transport undertakings by freeing up \$US24.39 million for the purchase of at least 25 RailPower Green Goat® hybrid locomotives.	Railway Age 30/07/2004
45	Pollutants	Procurement	Rail Power hybrid locomotives being built under licence in Sweden	Swedish Train Technologies (STT) intends producing locomotives incorporating "Green Goat" hybrid technology by Canadian firm RailPower Technologies under licence. An initial hybrid shunting locomotive is already being manufactured at STT's Vetlanda works and should be completed by the end of 2005.	International Railway Journal 09/2005 p14

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46	Pollutants	Retrofit	Uwe Adam TOC using diesel locos with particulate filters	Since 2005, Uwe Adam Eisenbahnverkehrsunternehmen GmbH has been using several classes of former Reichsbahn diesel locomotives for engineering works duties that have been retrofitted with particulate filters. The exhaust-gas limit values demanded by the client ("significantly better than EURO 4") are adhered to with quite a bit to spare. Operational experience gained has been very positive. The retrofit of further vehicles is being considered. Particulate filters have been fitted to diesel engines made by a variety of firms and having a range of output categories.	Information provided by Uwe Adam Eisenbahnverkehrsunternehmen GmbH in March 2006
47	Pollutants	Retrofit	SBB Infrastructure opts for soot-particle filters	The Infrastructure Division at Swiss Federal Railways SBB is planning to fit particulate filters to all diesel vehicles with a lengthy remaining service life by the end of 2008. Over 100 shunting locomotives, light rail motor tractors and self-propelled service vehicles had already been retrofitted with particulate filters by 1 Oct. 2005. A further 145 are to follow by year-end 2008. As well as being responsible for track upkeep, the Infrastructure Division also performs shunting duties at marshalling yards.	Eisenbahn- Revue International 11/2005, p520ff.
48	Pollutants	Retrofit	V60D retrofitted with particulate filters	Some years ago, a GDR-produced V60D shunter (alias Em 4/4 22) was retrofitted with a particulate filter for duties in the hall of a Swiss canning factory. The same locomotive is now successfully working the Oensingen-Balsthal-Bahn line (OeBB) in the Swiss Jura region.	Lok Report 8/05, p49

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49	Pollutants	Retrofit	WHE modernises diesel locomotive	In April 2001, Wanne-Herner Eisenbahn received a completely modernised and re-engined MaK G1600BB diesel locomotive from Westfälische Lokomotivfabrik Reuschling (WLH). Partly on grounds of environmental protection, the cooling plant was upgraded to dual-cycle in the process, whilst both the hydrostatic equipment for the radiator and compressor and the exhaust-gas apparatus were renewed. The new MTU 12 V 4000 R 20 engine was fitted. WHE expects the modernised locomotive to significantly raise availability levels and cut emission values.	Lok Report 09/01 p41; Eisenbahn Ingenieur 52 (2001) 8, p80, 1 fig; Eisenbahn-technische Rundschau 50 (2001) 7-8, p382f.
50	Pollutants	Retrofit	Railion freight loco modernised at Cottbus workshops	The first re-engined Class 298 vehicle with a Caterpillar engine was released for service from Cottbus on 19 August 2005.	Eurailpress 22/08/2005
51	Pollutants	Retrofit	WLH builds liquefied-gas light rail motor tractor for Krämer	Eisenbau Krämer, a tube makers from Hilchenbach, has had a Deutz designed light rail motor tractor (KHD Class KG 230 B diesel loco) converted from diesel to gas propulsion. Under current environmental standards, Krämer would have had to erect a new filling station specifically for the diesel locomotive as well as installing expensive exhaust-air extractors in the workshop halls. The re-engining exercise by Westfälische Lokomotivfabrik Reuschling (WLH) involved fitting a fuel-gas tank complete with pipework and vaporiser as well as altering the engine bed and cowling, completely redesigning the cooling plant and fitting a new exhaust silencer.	Lok Report 09/01 p41f
52	Pollutants	Innovation	World's first biogas train	The world's first biogas train entered service in Sweden in June 2005. Svensk Biogas invested the equivalent of over a million euro on converting a conventional Fiat railcar so as to enable passenger trains to likewise run on the environmentally friendly fuel. Two gas engines by Volvo replace the old diesel engine. There are eleven flasks of biogas on board the Swedish train. That's enough for a run of around 600 kilometres. The train boasts more than 54 seats. Top speed is quoted as being 130 km/h.	AFP 18/06/2005; Railway Gazette International 07/05 p390

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53	Pollutants	Innovation	RZD intends converting diesel locos to gas propulsion	OAO Russian Railways (OAO RZD) aims to have converted 250 diesel locomotives to gas propulsion by 2010. Work on the project is beginning in 2004. According to the President of RZD, Gennady Fadeev, top priority will be given to locomotives with gas propulsion in the future procurement of rolling stock. The Sverdlovsk railway (a division of RZD) plans to convert all its diesel locomotives to gas traction by 2007. The first locomotive is set to take up service in 2006.	Gudok 24/05/04; Railway Gazette International 08/05 p467
54	Pollutants	Innovation	First natural-gas conversion at the Peruvian Central Railway	The Peruvian Central Railway has had a freight and passenger train converted from diesel to gas propulsion. The train was converted by General Electric and now works the 4,800-metre-high Andes line between Lima and the Huancayo region. Reasons cited for the conversion were cleaner combustion and the significantly lower cost of gas.	Reuters 17/06/05, International Railway Journal 08/05 p4; Lineas del Tren 325
55	Pollutants	Innovation	Pilot project for natural gas traction in DB's shunting operations	Deutsche Bahn AG has placed the first Class 360 diesel-hydraulic locomotive converted to run on liquefied natural gas (LNG) into service. It platforms complete passenger trains at Munich Central Station on a daily basis. The pilot project being run by DB's Munich Research and Technology Centre primarily seeks to investigate the machine's energy consumption, range, fuel provision, emissions of both noxious substances and noise, and life-cycle costs. The gas engine delivers 472 kW and is a D 3508 Caterpillar diesel engine converted to gas propulsion and spark ignition. The tank system by Linde carries max. 872 litres of liquefied natural gas at a pressure of around four bar and a temperature of minus 138° C. Before the gas is fed to the engine at 2.5 bar, the heat exchanger warms it up to +20° C.	BahnTech 01/2001, p17; zev 4/01, p148

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56	Pollutants	Innovation	X 73500 multiple units with natural gas engines	A study is to be conducted to assess the feasibility of converting the drive systems on SNCF's Class X 73500 TER diesel railcars to gas engines, which would allow pollutant emissions to be considerably reduced. As at year-end 2005, the project is not being further pursued. <i>[Cf. the presentation by T. Gehrman at the Pro-Rail Alliance Workshop on 7 Dec 2005!]</i>	RG, 8/1999 p490 and 496
57	Pollutants	Innovation	Diesel particulate filters and emission optimisation within the engine make railway vehicles with MTU drive systems even cleaner	Emission limit values for diesel vehicles are being steadily tightened up. In the case of locomotives and drive systems for traction units, MTU is working on developing methods of reducing soot emissions by means of measures taken outside the engine. At present, ceramics (silicon-carbide) or sinter metal are used in particulate filters. The exhaust gas is able to flow through these porous materials. In the process, the soot is precipitated and adheres to the filter material, making for separation rates of 95-99 per cent. Emission optimisation does not, however, commence with the diesel particulate filter but with measures inside the engine. Worthy of note is the emission-optimised version of the 8V 4000 R41, where it was possible to reduce emissions of nitrogen oxides to below eight grams per kilowatt-hour under ISO 8178-4 cycle F. With railcars, significance attaches to the PowerPack, which already meets Stage 3A limit values.	MTU heute 02/05 p28f, MTU Report 02/05 p29f
58	Pollutants	Innovation	Filter for diesel locos	Sommer Verfahrenstechnik of Saalfeld performs development work in the field of filter materials for soot-particle filters. In future, ceramic materials are to be used that are capable of releasing oxygen for post-combustion from the filter material. Burn-off of soot deposits is assured without any elaborate regulation or the use of external energy. The choice of filters for diesel locomotives ought to be made by the experts at the respective system suppliers.	Fahrgast 03/05 p17f.
59	Pollutants	Innovation	Shunting locomotive with hydrogen propulsion	Trenitalia Cargo plans to develop a prototype locomotive with hydrogen propulsion. The D143.3027 unit currently stabled in Livorno is to be used for the purpose.	TuttoTreno 12.2004 p4

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60	Pollutants	Innovation	Fuel cells for railway vehicles	Vehicle Projects and Nuvera intend developing an 150kW fuel cell for railway vehicles. The “advanced rail vehicle” is intended to reduce infrastructure expenditure and cut out exhaust gases. Other projects by Vehicle Projects are a sub-surface locomotive with fuel-cell propulsion and a 1.2MW shunting locomotive for commercial and military applications.	International Railway Journal 10/05 p6
61	Pollutants	Innovation	Biodegradable flange and points lubrication at DB AG	Two of the most crucial areas of application for rapidly biodegradable lubricants are flange and points lubrication, which both have a vital bearing on safe railway operations. The article sets out DB AG’s current requirements with regard to rapidly biodegradable flange and points lubricants together with the principal test methods and their findings.	Eisenbahn Technische Rundschau 10/2005 p619ff.
62	Energy consumption	Procurement	Renfe demanding better energy values for locomotives tendered for	Spanish operator Red Nacional de Ferrocarriles Españoles (Renfe) is demanding improved technical features in a tendering exercise for 50 new locomotives for freight operations. The new vehicles are to have lower energy consumption and to be significantly cheaper to maintain.	Cinco dias, 03/08/2005
63	Energy consumption	Procurement	ÖBB demanding energy-consumption data from makers and drawing up verification test procedures	When procuring new electric multiple units (Class 4023/4024) for local services, Austrian Federal Railways (ÖBB) demanded binding energy consumption figures from the makers. The details furnished were corroborated in measuring runs, with “individual running cycles” being stipulated and tested. These “running cycles” had been enumerated in the call for competition and correspond to typical areas of application for multiple units. The readings taken were used to underpin development of a forecasting model for further “running cycles”. Further measurements revealed the forecasting model to be very consistent with actual energy consumption. The entity supplying the vehicles and co-operating in the subsequent measurements was a consortium comprising Bombardier Transportation and Elin EBG Traction. One of the reasons for ÖBB proceeding in this way was to enable it to calculate energy costs when competing for regional	Presentation by Ing. Martin Turk (ÖBB Traction) at the 4 th Viennese Railway Colloquium, 10 March 2006

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				passenger transport contracts. <i>[Cf. the presentation by M. Turk at the Pro-Rail Alliance Workshop on 13 June 2006!]</i>	
64	Energy consumption	Procurement	Siemens developing energy life-cycle assessment for metro trains	Siemens Transportation Systems has analysed the energy consumed by a newly developed series of metro trains for Oslo over their entire life-cycle. The brunt is shown to fall on energy for traction and auxiliaries (95 % given a 30-year service life) as well as on sourcing and providing raw materials for manufacture (4.46 %). By using 50 % secondary aluminium, it is possible to significantly cut energy consumption at the manufacturing stage to just above that for high-grade steel. High-grade steel is heavier but a better means of thermal insulation. For the rest, savings on weight and enhancements of drive systems are the most efficacious measures. The systematic study revealed further scope for progress. <i>[Cf. the presentation by A. Stribersky at the Pro-Rail Alliance Workshop on 19 Sept 2006!]</i>	Presentation by Dr Anton Stribersky at the 4 th Viennese Railway Colloquium, 9 March 2006
65	Energy consumption	Procurement	Lightweight aluminium design of FLIRT cuts energy consumption	The aluminium based design of FLIRT by Stadler cuts energy consumption on the lightweight regional railcar. The body consists of extruded aluminium sections. The drive equipment comprises four traction chains operating with water-cooled IGBT rectifiers.	Maker's information FLIRT Stadler
66	Energy consumption	Procurement	EuroRunner / An environmentally friendly locomotive	Great importance was accorded to achieving environmental protection goals when developing the EuroRunner locomotive, which for instance ÖBB operates as Class 2016 (Hercules). The design engineers laid particular emphasis on low fuel consumption as well as on minimising exhaust-gas and acoustic emissions. Three-phase power transmission delivers a high degree of efficiency over the entire speed and tractive force range, as well as providing the electric energy for the train line with little extra input.	ETR, 1-2/2003, p48

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67	Energy consumption	Procurement	ICE 3 with low energy consumption	When designing the multiple unit, the preconditions for fuel-efficient operation were established by means of its lightweight aluminium construction, optimised aerodynamics and scope for recuperating power when braking over a higher number of axles than on ICE 1/2 stock. Given 40% seat utilisation, the ICE 3 consumes just 2 litres of fuel per 100 km and person.	EI 06/04 p65ff
68	Energy consumption	Procurement	KNORR Bremse developing lighter, higher-output brake assemblies	KNORR Bremse has made progress in recent years in adopting new brake linings and design principles for disc brakes. Smaller brake units or fewer brake discs are possible despite the same or enhanced braking capacity being delivered. The situation is similar as regards magnetic track brakes. Friction properties are improved, moreover, by using sinter instead of steel for the brake magnets. This reduces the problem of unwanted welding-on layers whilst also making for more reliable provision of braking power, hence allowing the size or number of brake magnets to be reduced. The reduction in vehicle mass facilitated by the new-style brake assemblies provides scope for modest though nevertheless important savings in traction energy.	Presentation by Dr.-Ing. Henry Lehmann (KNORR-Bremse GmbH) at the 4 th Viennese Railway Colloquium on 10 March 2006
69	Energy consumption	Procurement	New ICE livery saves weight	Deutsche Bahn AG has ordered 28 new seven-car ICE T tilting-body trains from a manufacturing consortium made up of Alstom, Siemens and Bombardier. In a departure from the initial series, on ICE T2 vehicles ribbon glazing is merely imitated by the livery. This saves weight and accordingly has a positive impact on energy consumption.	Bahnzeit Nov. 03, p12
70	Energy consumption	Operation	Union Pacific rewards engine drivers for saving energy	The first results have been announced in a contest on the most energy-efficient way of driving launched in 2004. The competition enabled Union Pacific to save more than 60 million litres of diesel or around €26 million in 2005.	http://www.theau.tochannel.com/news/2006/02/22/211378.html

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71	Energy consumption	Operation	Driver training at DB AG focused on saving energy	Deutsche Bahn is running its Energy Saving project with the aim of cutting the energy consumed by its passenger trains by ten per cent. 14,000 engine drivers have undergone a triple-tier training course. Following study of theoretical principles, drivers were able to put what they had learned to effect in practical tests at locomotive simulators and on the line. In a parallel move, all ICE trains and passenger locomotives were fitted with electricity meters, whilst diesel meters and energy consumption displays were developed for cabs. The first successes have already been recorded. Energy consumption on passenger trains has fallen by four per cent in 2003.	DB AG press release 17/10/03
72	Energy consumption	Operation	Anticipatory resolution of pathing conflicts helps save energy	DB Netz AG is seeking to help save energy in train running by means of anticipatory analysis and resolution of pathing conflicts. It is intended in particular to prevent trains coming to a halt ahead of crossings or junctions, since a comparatively large amount of energy is consumed during braking and acceleration. The aim is to introduce software that detects imminent pathing conflicts in good time and automatically sends the driver appropriate driving recommendations (drive more slowly or try to reduce timing).	Presentation by Dr.-Ing. Eberhard Jansch at the 4 th Viennese Railway Colloquium, 9 March 2006
73	Energy consumption	Operation	LZB-based economical driving on the Viennese underground	WIENER LINIEN has introduced LZB-based automatic driving on some of its underground lines. Comparing a train's actual position with its nominal status allows rates of acceleration to be prescribed that are conducive both to on-time running and to economical driving. Drivers are left with a purely supervisory role for the most part. On the U 6 line, where automatic driving has not been adopted, drivers are given signal-based instructions for economical driving. It has been possible to cut traction energy consumption on the Viennese underground by around 5 % with the new system. <i>[LZB = German version of continuous train control system]</i>	Presentation by Dipl.-Ing. Hans Richter at the 4 th Viennese Railway Colloquium, 9 March 2006

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74	Energy consumption	Operation	System for energy efficient driving	The U1 and U2 lines on the Nuremberg underground are fitted with a signal system that uses speed signalling to indicate to each train the optimum speed for proceeding to the next station, thus reducing the number of acceleration and braking events.	Elektrische Bahnen, (98) 11-12/2000 p469
75	Energy consumption	Operation	Environmentally benign long-distance passenger services at DB	DB AG operates its fast long-distance trains almost exclusively with electric traction, which produces no pollutant emissions of note at track level and requires the equivalent of just 2.8l of petrol per person and 100km to do so assuming mean ridership levels. Top of the table by dint of a 50% patronage factor is the ICE service between Hamburg and Berlin with a specific equivalence value of 2.65l for a 1.5h timing at an average of 190km/h. Rail has left the competition standing here, since the motor car requires twice as long for the journey and, at the equivalent of 9,2l of petrol, three and a half times as much energy.	Elektrische Bahnen 103 (2005) Vol 7, p363
76	Energy consumption	Operation	AVE Madrid-Seville cuts energy costs by 9.5 %	The Spanish railway company Renfe has managed to cut energy costs on its Madrid-Seville high-speed line by 9.5 % through the use of kinetic energy. The savings equate to a reduction of carbon dioxide emissions by approx. 4,111 t. In addition, savings amounting to €650,000 per year have been achieved. The pilot project was launched in 2003 and implemented in February 2004	El Pais 03/05/2005
77	Energy consumption	Operation	Action taken by Ostmecklenburgische Eisenbahngesellschaft mbH (OME)	OME is pursuing several means of economising on fuel. Alongside the time-controlled preheating of multiple units, energy-saving magnets are being used on injector pipes and oil-change periodicities extended by using higher-grade oils.	OME release, 14/06/2005

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78	Energy consumption	Innovation	“e-transformer” by Alstom reduces energy consumption	Rail systems manufacturer Alstom has developed a novel power supply system for electric railcars. Instead of a conventional transformer, high-output electronic chips on cooling plates are used. For one thing, this allows the total weight of the power supply system to be halved, from twelve to six tonnes. The premiere of the “e-transformer” is planned for June 2004 on the LIREX hybrid railcar in Saxony-Anhalt. For the refit, one of the four diesel engines is being replaced by the “e-transformer”.	InnoTrans Report 09/03 p6
79	Energy consumption	Innovation	Mannheim tram operator uses modern “MITRAC” energy store	Bombardier has been working with MVV Verkehr AG for over two years to trial the new “MITRAC Energy Saver”, which operates with double-layer capacitors. The system is capable of storing energy on light rail transit vehicles and trams that would otherwise be dissipated during braking and to return it upon the vehicle moving off again. In trial operations, it was possible to reduce the energy consumed by the LRT vehicle by about 30 %. The additional weight brought about by the storage device is already reflected in this figure. It is possible, furthermore, to reduce the peak load to be supplied via the overhead contact system by up to 50 %, thus allowing new catenary to be erected with less cost input and better use to be made of existing equipment. The energy store also enables non-electrified sections to be bridged, thus yielding further service benefits. <i>[Cf. the presentation by Chr. Kehl at the Pro-Rail Alliance Workshop on 19 Sept 2006!]</i>	Talk by Dipl.-Ing. Markus Klohr (Bombardier) at the 4 th Viennese Railway Colloquium on 10 March 2006 (further reading: EI 06/04 p65ff; ERI 11/03 p488)

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80	Energy consumption	Innovation	FICAS technology by Bombardier cuts axle loads and energy consumption	With its FICAS technology (Fully Integrated Carbody Assembly System), Bombardier Transportation has revolutionised carbody construction. FICAS stands for a highly innovative modular sandwich construction technique in which high-grade steel plates are bonded together with a foam core between. Hitherto, use has generally been made of extruded aluminium profiles or prefabricated wagon sections in steel for carbody construction. The new sandwich principle means side walls can be up to 120 mm thinner, which creates significantly more utilisable space as well as lopping several tonnes off a vehicle's weight and hence impacting positively on energy consumption and axle loads. The modern FICAS solution for rolling stock draws on design-engineering processes that have long found successful application in shipbuilding and aircraft construction.	Bombardier press release September 2004
81	Energy consumption	Innovation	Modular system for rail vehicle doors by Fahrzeugtechnik Dessau AG	Fahrzeugtechnik Dessau AG is championing environmental compatibility in its new modular-design door range for light rail transit as well as regional and high-speed vehicles. Electricity is used as the operating medium instead of compressed air, the generation of which requires a high energy input. The number of individual parts has been reduced to a minimum, which, as well as being good news in energy terms, also acts to reduce input. Emissions are lower than hitherto due to welded subassemblies being replaced by special-purpose aluminium bar sections and castings.	EI 06/04 p65ff
82	Energy consumption, pollutants	Procurement	Lightweight brake disc by Knorr lowers energy consumption	A lightweight brake disc in an aluminium/ceramic composite material allows significant weight advantages to be achieved over conventional cast-iron brake discs that translate into savings on traction energy. It is possible in this way to save 350 kWh per year for each brake disc. Developed by Knorr, the technology will first be fitted on Munich's new underground vehicles. Further benefits of the aluminium brake disc are its long service life as well as reduced wear on linings, which in turn reduces abrasion.	EI 06/04 p65ff

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83	Energy consumption, pollutants	Retrofit	1,000 DB AG diesel locomotives fitted with preheaters	Deutsche Bahn AG has fitted more than 1,000 of its 1,700-strong diesel locomotive fleet with preheaters. The energy-saving and in some instances fully automatic preheater and heat-retention devices ensure optimum operating temperatures for engines prior to starting when outside temperatures are low. With its new system, DB saves up to 20 per cent in diesel fuel during the warm-up phase for diesel locomotives, with particulate emissions simultaneously being reduced. Most units operate fully automatically and can be programmed in advance by staff. Units are being installed at DB's Cottbus and Bremen workshops. Project co-ordinator is the company's division DB Systemtechnik.	Eurailpress press release 26/11/04
84	Energy consumption, pollutants	Retrofit	HGK procures new diesel engines with lower exhaust-gas values	Häfen- und Güterverkehr Köln AG (HGK) has commissioned MTU Friedrichshafen to manufacture 16 Type 12 V 4000 engines (1,320 kW) as well as a same-design spare engine. The equipment is to be used to re-engine the same number of DE1002 diesel-electric industrial locomotives operated by HGK. Factors crucial to the order being placed were low fuel consumption, optimum exhaust-gas values and long servicing periodicities.	EI 49 (1998) 4, p114 f., 1 fig ETR 47 (1998) 5, p319
85	Energy consumption, pollutants	Innovation	Energy store on capacitor basis cuts fuel consumption and pollutant emissions at "hot-spots"	The MITRAC Energy Saver by Bombardier, currently being trialled on a Mannheim LRT vehicle (see above), is also to be adopted for diesel railcars in future with a view to harnessing braking energy. The developers anticipate fuel savings in the order of 25-40 %. The energy store is intended to allow the diesel engine to be switched off in tunnels and at stations and in this way avoid high pollutant concentrations in these areas. Noise nuisance levels can also be reduced in this way.	Talk by Dipl.-Ing. Markus Klohr (Bombardier) at the 4 th Viennese Railway Colloquium on 10 March 2006
86	Energy consumption, pollutants	Innovation	Trenitalia trialling use of solar panels as means of supplying rolling stock with power	As part of the EU's PVTRAIN project, Trenitalia is installing solar panels on five passenger carriages, two locomotives and a number of freight wagons. They supply power for services such as air conditioning, lighting, pantograph raising and electric locking. Trials will run until October 2004. The E636.385 electric locomotive was on a test run near Alessandria at the end of September 2004.	Ansa press release 15/03/2004

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87	Energy consumption, pollutants	Innovation	“Else” railcar runs on solar energy	The four-axle narrow-gauge railcar (600 mm gauge) known as Else, the German acronym for “electric solar railway”, runs on solar energy. The vehicle can seat from six to eight people and has so far operated on a park railway. It can travel 60 km and serve 80 stops without any contact with the grid. Further railcars are to be built on the same principle as Else.	www.solarbahn.de
88	General environmental standards	General environmental standards	ICE 3 with environmentally friendly concepts	The ICE 3 high-speed train is setting new standards in the environmental friendliness of rolling stock. Extensive use has been made of natural materials such as timber and stone for its interior design. Toilets are no longer cleaned chemically but rather by means of a closed-circulation aqueous compound system. The air conditioning operates with air as opposed to environmentally harmful coolants.	EI 06/04 p65ff
89	General environmental standards	General	Waste separation on trains	In the disposal sphere, OME has introduced refuse sorting facilities on some of its vehicles. Refuse sorting is regularly offered in any new local rail passenger service projects OME becomes involved in.	OME release, 14/06/2005
90	General environmental standards	General	Waste separation on trains	DB Fernverkehr AG is opting for refuse sorting on its ICE trains	