					Relative Cost						Emissions				Service & bottlenecks				
Category	ID	Cat.	Technology Name	Transport Mode	% cost saving compared with the baseline	identification of the baseline (reference technology)	% fuel saving compared with the baseline	identification of the baseline (reference technology)	% resources saving compared with the baseline	identification of the baseline (reference technology)	% CO2 saving compared with the baseline	identification of the baseline (reference technology)	% SOx saving compared with the baseline	identification of the baseline (reference technology)	% operational or infrastructural delays reduction	% of frequency of service *potential* improvement due to delays & bottlenecks reduction	% of reliability improvement due to delays & bottlenecks reduction	Do the tech influence some problems and/or bottlenecks? If YES put the % of mitigation	Identification of problems and/or bottlenecks
Engines and propulsion systems	EN02	A	Directly driven propeller	Maritime	This technology is already widely in use and should be the reference technology	Directly driven propeller (applied in majority of ocean going vessels)	0	Directly driven propeller	0	Directly driven propeller	0	Directly driven propeller	0	Directly driven propeller	0	0	0	No	None, proven technology
	EN03	A	Mechanically connected propeller	Maritime	This technology is already widely in use and should be the reference technology	Same as Technology Name, standard technology for both ocean going and coastal shipping	0	Mechanically connected propeller	0	Mechanically connected propeller	0	Mechanically connected propeller	0	Mechanically connected propeller	0	0	0	No	None, proven technology
	EN07	A	Diesel-mechanic propulsion with high speed engine	Maritime	This technology is already widely in use and should be the reference technology	Same as Technology Name, applied mostly in smaller coastal vessels	0	Diesel-mechanic propulsion with high speed engine	0	Diesel-mechanic propulsion with high speed engine	0	Diesel-mechanic propulsion with high speed engine	0	Diesel-mechanic propulsion with high speed engine	0	0	0	No	None, proven technology
	EN11	B	Diesel-Electric propulsion with dual fuel engine	Maritime															
	EN16	A	Full/parallel hybrid	Road	ref comments in mail	diesel engines	0-35%	diesel engines	depending on assumptions	diesel engines	0-35%	diesel engines	0-35%	diesel engines	0	0	0	NO	NO
	EN18	B	Fuel cell technology	Road	the efficiency of the fuel cell system will reduce drastically the energy bill (in the case of a mass production of fuel cells).						50%	fossil fuel	100%	fossil fuel					
	EN21	A	Exhaust Abatment System	Inland Waterways		Already applied		Already applied		Already applied	From 0 to +2 %	Already applied	From 0 to +2 %	Already applied					
	EN24	B	Improved Gas Engine	Road															
	EN06	B	Mechanical azimuthing thrusters	Maritime	Higher Capex, potential lower Opex	Mechanically connected propeller by reduction gear to the propeller shaft, thruster assisted	0-20%	Mechanically connected propeller by reduction gear to the propeller shaft, thruster assisted	0	Mechanically connected propeller by reduction gear to the propeller shaft, thruster assisted	0-20%	Mechanically connected propeller by reduction gear to the propeller shaft, thruster assisted	0-20%	Mechanically connected propeller by reduction gear to the propeller shaft, thruster assisted	0	0	0	0	None, proven technology
	EN39	A	Gas engines	Inland Waterways	negative impact	traditional gasoline engines		traditional gasoline engines		traditional gasoline engines	positive +	traditional gasoline engines	positive +	traditional gasoline engines					
	EN48	B	CCNR III Engine	Inland Waterways		CCNR II Engine		CCNR II Engine		CCNR II Engine	positive +	CCNR II Engine	0	CCNR II Engine					
	EN51	B	CCNR IV Engine	Inland Waterways	data not available	CCNR III Engine	data not available	CCNR III Engine	data not available	CCNR III Engine	positive +	CCNR III Engine	0	CCNR III Engine					
Fuels and energy sources	FU02	A	Ethanol and bio-diesel	Maritime	cost increase up to 100%	Conventional diesel engines	Unchanged in energy use per kilometer	conventional diesel engines	0	Conventional diesel engines	Same as below	Conventional diesel	slightly reduced	10 ppm diesel	Availability of biofuels varies hugely between regions, there have been some early issues with biofuels, especially in cold weather, but shere good access, performance should be similar to conventional fuels	unchanged	unchanged	no	availability and cost
				Road	cost increase up to 100%	Conventional diesel engines	Unchanged in energy use per kilometer	conventional diesel engines			Bioethanol: 70%, biodiesel 45%, but ref remarks in accompaning mail.	Conventional diesel	slightly reduced	10 ppm diesel	Availability of biofuels varies hugely between regions, there have been some early issues with biofuels, especially in cold weather, but shere good access, performance should be similar to conventional fuels	unchanged	unchanged	no	availability and cost
	FU03	A	CGN (compressed natural gas)	Multimodal	positive +	ULSD	100%	ULSD	100% petroleum	ULSD	0	ULSD	0	ULSD					Problems of transport. LNG is often used for transporting natural gas over large distances, in ships, trains or pipelines, and the gas is then converted into CNG before distribution to the end user.
	FU08	A	LNG	Multimodal	positive +	ULSD	100%	ULSD	100% petroleum	ULSD	0	ULSD	0	ULSD					
	FU18	A	Biogas	Multimodal	0	ULSD	100%	ULSD	100% petroleum	ULSD	80-90% less than liquid fossil fuels	ULSD	0	ULSD					Needs upgrading and purification process to eliminate the H2S produced during the digestion of raw biogas
	FU05	B	Alternative maritime power (AMP)	Maritime	Non profit measure. Main goal is to reduce local emission	Ship based power generation in harbour	100% when in harbour/port	Ship based power generation in harbour	100% when in harbour/port	Ship based power generation in harbour	100% when in harbour/port	Ship based power generation in harbour	100% when in harbour/port	Ship based power generation in harbour	0	0	0	Reduces noice and local emissions at from vessels when in port.	Hard to specify amount of reduction in noise and emission as this depends on vessel type. Yet, for every kWh of electricity about 200grams of bunker fuel is consumed.
	FU06	B	Wind energy	Maritime															
				Inland Waterways	0	ULSD	100%	ULSD	100% petroleum	ULSD	zero emissiones	ULSD	10%	ULSD					Intermittency and the non-dispatchable nature of the wind energy production can raise costs for regulation, incremental operating reserve.
	FU13	B	Electricity	Road	varies	diesel engines	around 50% in energy content for heavy vehicles on highways, higher for smaller vehicles and urban use	diesel engines	data not available	diesel engines	35% with double efficiency compared to diesel and emissions assumptions as in mail	diesel	similar	diesel	various charging facilities needed (fast and normal charging)	0	0	0	0
				Railway															
	FU25	A	Sky sails system	Maritime	5-20% on Opex	None-Skysails	5-20%	None-Skysails	0	None-Skysails	5-20%	None-skysails	5-20%	None- sky sails	0	0	0	0	Wheather dependent,
	FU26	B	Waste heat recovery system	Maritime	Higher CapEx, reduced Opex by 4-8%	Vessels without steam driven turbine generator (ocean going vessels with installed power exceeding 20 MW)	4-8%	Vessels without steam driven turbine generator (ocean going vessels with installed power exceeding 20 MW)	0	Vessels without steam driven turbine generator (ocean going vessels with installed power exceeding 20 MW)	4-8%	Vessels without steam driven turbine generator (ocean going vessels with installed power exceeding 20 MW)	4-8%		0	0	0	0	none
Cargo handling and Transfert	HT01	A	Diesel to electric power convertor (RTGs)	Multimodal															
	HT03	A	Hybrid hydraulic drive Terminal tractors	Maritime	Increased CapEx, lower opex	None-braking energy recovery systems	up to 50-60%	None-braking energy recovery systems		None-braking energy recovery systems	up to 50-60%	None-braking energy recovery systems	up to 50-60%	None-braking energy recovery systems	0	0	0	0	More information is needed about this technoilogy before it can be benchmarked. Also, this is a multimodal techn. However, benchmarking is done based on general infomration. Benchmarking made on following source: http://www.kalmarind.co.uk/pages/hybrid-drives.php
	HT07	A	Low emission engines	Multimodal	positive impact	Euro II	5%	Euro II		Euro II	positive impact	Euro II		Euro II					
	HT08	B	ZF transmission systems	Multimodal															
	HT09	B	Green schemes to improve RTGs emissions and noise	Multimodal															
	HT10	A	Horizontal container (un)loading	Multimodal	positive impact	Traditional containers cargo handling	positive impact	Traditional containers cargo handling		Traditional containers cargo handling		Traditional containers cargo handling		Traditional containers cargo handling			92,6% reliability		
	HT06	B	MP-RTGs	Multimodal	negative impact	Traditional gantry cranes		Traditional gantry cranes	reduces equipment	Traditional gantry cranes	positive impact	Traditional gantry cranes	positive impact	Traditional gantry cranes					
	HT11	B	Cargo Cassette and Translifter	Maritime	positive + (based on the assumption that techn. will lead to increased cargo through put)	Traditional container cargo handling	0	positive + (based on the assumption that techn. will lead to increased cargo through put)	0	positive impact (based on the assumption that techn. will lead to increased cargo through put)	0		0		Potential for faster ship turn around due to increased efficiency during loading and unloading operations	Possible to increase frequency, but highly dependent on operational conditions	difficult to quantify, but has a potential positive effect	May contribute to alleviate vessel waiting time outside port	
	HT20	B	BEX	Inland Waterways	positive impact	0		0		0		0		0			positive impact		
	HT28	B	Automatic RoRo cargo unit handling	Multimodal															
	HT36	B	FlexiWaggon	Railway							strong decrease of the CO2 emissions (see the chart on the web site) because the transport is by rail and not by truck (the truck is on the train)								
				Multimodal	data not available	Traditional boxcars		Traditional boxcars		Traditional boxcars	positive impact	Traditional boxcars	positive impact	Traditional boxcars			positive impact		
				Road	No inputs														
				Inland Waterways	data not available	Traditional boxcars		Traditional boxcars		Traditional boxcars	positive impact	Traditional boxcars	positive impact	Traditional boxcars			positive impact		
				Maritime	Possible to have Schenker elaborate on this technology? MARINTEK has no formel competence to answer this.	Traditional boxcars		Traditional boxcars		Traditional boxcars									

Category	ID	Cat.	Technology Name	Transport Mode	Relative Cost						Emissions				Service & bottlenecks				
					% cost saving compared with the baseline	identification of the baseline (reference technology)	% fuel saving compared with the baseline	identification of the baseline (reference technology)	% resources saving compared with the baseline	identification of the baseline (reference technology)	% CO2 saving compared with the baseline	identification of the baseline (reference technology)	% SOx saving compared with the baseline	identification of the baseline (reference technology)	% operational or infrastructural delays reduction	% of frequency of service *potential* improvement due to delays & bottlenecks reduction	% of reliability improvement due to delays & bottlenecks reduction	Do the tech influence some problems and/or bottlenecks? If YES put the % of mitigation	Identification of problems and/or bottlenecks
Heating and cooling technologies	HC02	B	Intelligent temprature unit	Railway		Benefits include improved customer service, arising from knowing where equipment is and providing tailored service, and reduced operating costs obtained through better utilisation of equipment, reduction of mistakes and automation. The return on investment is quick, although many users of RFID do not discuss these issues.Creating cost efficiency with GPS A 2006 paper entitled Satellite Navigation technology Applications for Intelligent Transport Systems, compiled by the University of Leeds Institute for Transport Studies professor Dr Paul E. Firmin, suggests that the ETCS could also be utilised to significantly reduce costs associated with train control and fleet management. Firmin suggests that satellite navigation technologies could compliment existing, ground-based systems in order to monitor individual wagons for cargo control and train signaling, which could, in turn, reduce the necessary time distance between trains and increase train frequencies													Tags do not have batteries or any other material harmful to the environment. The radio power from a reader is comparable to a handheld cell phone. The railroads are acquainted with the use of radios so RFID adds little burden. Society is becoming more concerned with privacy issues, but there are no privacy issues with tracking rail cars. RFID integrates nicely with GPS to further enhance the tracking capability. Failure and disappointment often occur when a technology is applied to an application for which it is ill-suited. Although many RFID systems appear the same, and the implementation looks straightforward, this is not the case. As a result, some potential users of RFID technology have had bad experiences and are left with a bad taste. There are always things that crop up, even for well-designed equipment. Technology always evolves. Unexpected things happen that sometimes require engineering and updates.
	HC03	B	Temperature control units	Road															
	HC04	B	RFID tag antenna with temperature alarm sensor	Multimodal															
Innovative units and treatment	LU13	B	Braking energy recovery	Railway			10%	In a conventional train engine, energy is dissipated as heat and lost to the atmosphere. But using the dynamic braking system developed by GE, that energy can capture and store This could mean 10% less CO2 emissions and 10% less diesel fuel than a standard locomotive in North America			10%	In a conventional train engine, energy is dissipated as heat and lost to the atmosphere. But using the dynamic braking system developed by GE, that energy can capture and store This could mean 10% less CO2 emissions and 10% less diesel fuel than a standard locomotive in North America			A contribution to operational or infrastructural delays is not foreseen	A contribution to frequency of service potential improvement is not foreseen	A contribution to reliability improvement is not foreseen	No	
	LU14	B	Onboard energy storage systems	Railway			25-30%	Up to 30% energy saving are measured in a prototype Bombardier's light rail vehicle			%25-30	Up to 30% C02 emission reduction are measured in a prototype Bombardier's light rail vehicle			A contribution to operational or infrastructural delays is not foreseen	A contribution to frequency of service potential improvement is not foreseen	A contribution to reliability improvement is not foreseen	No	
Vehicles	VE02	A	Electric Locomotive	Railway	~ 50	NS 999 is an entirely electric locomotive that uses a lead-acid energy storage system comprised of 1,080 12-volt batteries to operate in railroad switching applications without the use of a diesel engine and with zero exhaust emissions.	~ 40-50	The project's goal was to demonstrate the feasibility of a plug-in battery powered locomotive that would eliminate direct rail yard emissions and save up to 50,000 gallons of diesel fuel per year.			100	The project's goal was to demonstrate the feasibility of a plug-in battery powered locomotive that would eliminate direct rail yard emissions and save up to 50,000 gallons of diesel fuel per year.	100	The project's goal was to demonstrate the feasibility of a plug-in battery powered locomotive that would eliminate direct rail yard emissions and save up to 50,000 gallons of diesel fuel per year.	A positive contribution to operational delays or infrastructure is not foreseen	A positive contribution to service potential improvement is not foreseen	A positive contribution to reliability improvement is not foreseen	No	
	VE03	A	Hybrid Truck	Road			60-80%	fuel/diesel truck			80%	fuel/diesel truck							
	VE09	A	Electric vehicles	Road	the battery cost is very high and also the physically dimensions		100%	fuel/diesel truck			100%	fuel/diesel truck							
	VE10	A	Euro VI vehicles	Road	more expensive	Euro IV	increase of 2-3%	Euro IV		Euro IV	increase of 2-3%	Euro IV	Sox-emissions are fuel - not technolgy dependant	Euro IV	0	0	0	0	0
	VE01	B	Hybrid Locomotive	Railway	~ 15-20	GE's Evolution Hybrid Locomotive is being developed with technology to capture and store braking energy for later use, increasing power while reducing fuel use and emissions. The energy dissipated in braking a 207-ton locomotive during the course of a year is enough to power over 9,100 average U.S. households over the same time period.	15	Hybrid diesel-electric locomotive will capture the energy dissipated during braking and store it in a series of sophisticated batteries. That stored energy can be used by the crew on demand—reducing fuel consumption by as much as 15 percent and emissions by as much as 50 percent compared to most of the freight locomotives in use today. In addition to environmental advantages, a hybrid will operate more efficiently in higher altitudes and up steep inclines			50	GE's hybrid locomotive is being designed to reduce carbon dioxide emissions over its lifetime as much as taking 2,600 cars off the road for a year.			A positive contribution to operational delays or infrastructure is not foreseen	A positive contribution to service potential improvement is not foreseen	A positive contribution to reliability improvement is not foreseen	No	
	VE22	B	Road-rail cargo interchange	Railway															
	VE25	B	Brake energy recovery system	Railway	There is not enough outcome		There is not enough outcome		There is not enough outcome										
	VE29	B	Aerodynamic drag improvements	Road	depending on operational patterns	"conventional trucks"	10-26%	conventional trucks		conventional trucks	10-26%	conventional trucks	10-26%	conventional trucks	0	0	0	0	0
	VE35	B	Electrification ofTrucks on Highways	Road	The eHighway system involves both vehicles and infrastruture. Operating costs (and thus the potential saving compared with baseline) correlate strongly with the differential of diesel price and kWh price of electricity. The total system will be economically feasible. Analysis for the German Ministry of Environment (BMU) show a **cost reduction** for logistic companies, even when including the costs of the infrastructure.	Ordinary truck operation - using dieselfuel on motorway.	-76.5% (Assuming that on average each truck travel 85% of the yearly distance on highway, of which 90% would be electrified)	100% Diesel-powered trucks	fossil fuel (see F)	see G	Depending on the country's power mix: up to 77% in case of electricity originated from renewable energy sources	100% Diesel	77%	100% Diesel	The eHighway system would allow for increased efficiency in operations, but this has not yet been quantified.			Not necessarily (during change period maybe some flexibility reduction)	Technical concept already proven at test track outside of Berlin. System ready for first pilot and to demonstrate economic and environmental benefits under real transport conditions Key problem is the initial investment which can only be made by a concerted (EU) action
Navigation technologies	NA02	A	Automatic Identification System (AIS)	Maritime	0	Baseline is Technology, already in use covering all vessel traffic (above 300gross tonn) up to 20-30 nautical miles from AIS base station (coast line)	0		0		0		0		Improves ability to coordinate and plan utilisation of port resources, depending on vessel arrival	Possibility to improve efficiency of (un)loading vessel and reducing waiting time outside port. Imprved service frequency	Possibility to improve efficiency of (un)loading vessel and reducing waiting time outside port. Imprved service reliability	Difficult to quantify as it depends on a number of parameters	None, proven and existing technology
	NA15	B	WiMax	Maritime	Potential cost saving through increased efficiency of document handling between ship-shore	Non-internet access	0	None-internett Access	0	None-internett Access	0	None-internett access	0		Reduced probaility of delays due to more efficient ship reporting/ document handling	Potential for increased vessel turn around time	Potential for increased vessel turn around time	Potential for reduced vessel waiting time outside port	None particular
				Road	depending on operational patterns														
				Railway	There is not enough outcome		There is not enough outcome		There is not enough outcome		0		0		There is not enough outcome	There is not enough outcome	There is not enough outcome	There is not enough outcome	There is not enough outcome
	NA01	B	Train Control System	Railway	There is not enough outcome		There is not enough outcome		There is not enough outcome		0		0		There is not enough outcome	There is not enough outcome	There is not enough outcome	There is not enough outcome	There is not enough outcome
	NA05	B	ECDIS	Maritime	Increased CapEx	Paper nautical charts	0	Paper nautical charts	0	Paper nautical charts	0	Paper nautical charts	0	Paper nautical charts	0	0	0		Is this a relevant technology to evaluate? Major impact of ECDIS is removal of human error by only navigating on charts, also giving each vessel real time information of operational situation along route. I.e. safety at sea and in port!
	NA12	B	GEO satellites	Maritime	Increase Capex and Opex	None- GEO satellites	0	None- GEO satellites	0	None- GEO satellites	0	None- GEO satellites	0	None- GEO satellites	Enables early warnings in terms of route changes, ship-shore reporting at sea. Difficult to quantify	0	0		In terms of benchmarking, GEO, LEO and Inmarsat can be combined. Although representing different types of com tech sys, all share the same objective of extending communication outside VHF/ WiMax coverage
	NA13	B	LEO satellites	Maritime	See above	See above													
	NA14	B	Inmarsat	Maritime	See above	See above													
	NA07	A	Global Navigation Satellite Systems or GNSS	Maritime	This technology is already widely in use and should be the reference technology														
				Railway	There is not enough outcome		There is not enough outcome		There is not enough outcome		0		0		There is not enough outcome	There is not enough outcome	There is not enough outcome	There is not enough outcome	There is not enough outcome
				Road	This technology is already widely in use and should be the reference technology														
	NA16	B	Route optimisation system (scheduling)	Inland Waterways	positive +	0	positive impact	0	0	0	emissions -7%	0	emissions -7%	0	positive impact		positive impact		
	NA17	B	River Information Services (RIS)	Inland Waterways	positive +	0	5%	0	0	0	positive impact	0	positive impact	0	positive impact		positive impact		
	NA18	B	Predictive cruise control (PCC)	Road	depending on operational patterns														

					Relative Cost						Emissions				Service & bottlenecks				
Category	ID	Cat.	Technology Name	Transport Mode	% cost saving compared with the baseline	identification of the baseline (reference technology)	% fuel saving compared with the baseline	identification of the baseline (reference technology)	% resources saving compared with the baseline	identification of the baseline (reference technology)	% CO2 saving compared with the baseline	identification of the baseline (reference technology)	% SOx saving compared with the baseline	identification of the baseline (reference technology)	% operational or infrastructural delays reduction	% of frequency of service *potential* improvement due to delays & bottlenecks reduction	% of reliability improvement due to delays & bottlenecks reduction	Do the tech influence some problems and/or bottlenecks? If YES put the % of mitigation	Identification of problems and/or bottlenecks
Best practices of technologies integration	BP04	A	Traffic Flow Management	Railway	5%	A reduction of the total consumption by about 5% seems to be realistic in the medium future in Switzerland	20%	Focus on high network capacity at lowest energy consumption • Reduced network dimensions (for development) • Real train data • Demonstration software based on MATLAB • Core is a very fast train run simulation for speed and energy consumption versus location / time			5%	Focus on high network capacity at lowest energy consumption • Reduced network dimensions (for development) • Real train data • Demonstration software based on MATLAB • Core is a very fast train run simulation for speed and energy consumption versus location / time			A contribution to operational or infrastructural delays is not foreseen	A contribution to frequency of service potential improvement is not foreseen	A contribution to reliability improvement is not foreseen	No	
	BP07	A	Carbon-free rail freight transport	Railway	16%	DB Schenker Rail UK has outlined plans to introduce carbon free rail freight services for customers using trains hauled by electric locomotives, further improving the environmental credibility of rail freight.	20%	The energy generated by the turbines would be enough to power a 'green fleet' of DB Schenker Rail UK's Class 92 electric locomotives. The electricity would be sold to Network Rail for use in the overhead power cables and in doing so, DB Schenker Rail UK will be able to offer customers 'carbon free' rail freight services in the UK by the end of the year.	20%			The energy generated by the turbines would be enough to power a 'green fleet' of DB Schenker Rail UK's Class 92 electric locomotives. The electricity would be sold to Network Rail for use in the overhead power cables and in doing so, DB Schenker Rail UK will be able to offer customers 'carbon free' rail freight services in the UK by the end of the year.			A contribution to operational or infrastructural delays is not foreseen	A contribution to frequency of service potential improvement is not foreseen	A contribution to reliability improvement is not foreseen	No	
	BP02	B	TDS	Railway	20%			The basic idea of the train control system (TCS) is to leave the operational principle as it is, but the entire operation gets computer aided support by adding a radio data system for communication between trains and central train controller				The basic idea of the train control system (TCS) is to leave the operational principle as it is, but the entire operation gets computer aided support by adding a radio data system for communication between trains and central train controller			A contribution to operational or infrastructural delays is not foreseen	A contribution to frequency of service potential improvement is not foreseen	A contribution to reliability improvement is not foreseen	No	
	BP03	B	GEKKO	Railway	10%	DSB (Danish State Railways) and SNCF (France) have trialled the device	0%	GEKKO is a device that tells drivers if they are running in the correct schedule pathway.A GEKKO server contains all the necessary information about timetables, route and train characteristics. The driver carries a portable PDA device into which he enters the train number. The PDA then requests the timetable and route information from the server	10%		15%	GEKKO is a device that tells drivers if they are running in the correct schedule pathway.A GEKKO server contains all the necessary information about timetables, route and train characteristics. The driver carries a portable PDA device into which he enters the train number. The PDA then requests the timetable and route information from the server			A contribution to operational or infrastructural delays is not foreseen	A contribution to frequency of service potential improvement is not foreseen	A contribution to reliability improvement is not foreseen	No	
	BP08	B	Integrated shortsea transport	Maritime	This is only on a conceptual stage, difficult to determine its impact on greening of corridors. Limited information availbale.	Short sea shipping/ feedering services													
	BP13	A	EREX (ERESS)	Railway							savings: up to 30% of the energy consuption with a consequent 30%savings in CO2	no application of the Best Practice							