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platform for the implementation of NAIADES

STRATEGIC RESEARCH AGENDA I FOR INLAND WATERWAY TRANSPORT

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Content

1 OBJECTIVE

Europe and its citizens need an efficient economy. Among others, effective traffic systems are an important precondition for this. This includes all transport modes with their specific system characteristics and strengths.

Despite of the presently reduced transport volumes further strong boosts are expected for the future[1]. Boundaries of the traffic systems are more often reached and exceeded, leading to increasing emissions, accident numbers and congestion as well as declining reliability and punctuality.

However, possibilities to expand infrastructure in general are limited due to lack of funding and missing public acceptance. In this light the best possible support of strengths of all transport modes is needed. The target should be to cope with the rising transport tasks in a way that is as sustainable and environmentally sound as possible. IWT can make a considerable contribution to this, since it is long known as the most environment-friendly and safest surface transport mode with favourable energy efficiency[2]. In addition, inland navigation has considerable free capacity for increased exploitation, thus being able to prevent that congestion in traffic might also impede or even limit economic developments within Europe.

The European Commission therefore claims to strengthen inland navigation: „In the context of a liberalised inland navigation market, the European Commission aims at promoting and strengthening the competitive position of inland waterway transport, in particular by enhancing its integration into multi-modal supply-chains"[3]

Against this background, the NAIADES-Action Programme initiates concrete measures to promote inland navigation; last not least the Platform for the Implementation of NAIADES (PLATINA) results from this programme. As a part of PLATINA, task 2.2.3 deals with the development of a Strategic Research Agenda (SRA) for the Inland Waterway Transport mode: Research and development is supposed to decisively contribute to the promotion and strengthening of inland waterway transport. This document describes the need for future research activities and the direction they are heading for within inland navigation.

Hence, it is the intention of this SRA, to indicate and determine major research areas and priorities, thereby supporting policy, e.g. in terms of possible input for future research programmes such as the framework programmes of the European Commission. It is not the intention of this SRA, to determine or identify research demand on project level.

Finally, research for inland navigation should be arranged in such a way that its targets, content and promotion comply with the envisaged future significance of this mode.

1 Due to the economic crisis transport volumes have decreased; nevertheless, on medium and long term horizon a continuation of the previous growth paths (and its impacts respectively) is expected from most experts.

2 Planco Consulting GmbH: Comparison of traffic modes (Verkehrswirtschaftlicher und ökologischer Vergleich der Verkehrsträger Straße, Bahn und Wasserstraße), Essen 2007

3 European Commission: "Integrated European Action Programme for Inland Water Transport, NAIADES"

2 CHARACTERISTICS AND PERFORMANCE FEATURES

Strengths

Apart from the aforementioned advantages energy efficiency and safety, inland navigation is characterized by a high transport performance as to bulk cargo and high cost efficiency. Within the today's EU and its complete network of 43,000 km, traffic performance amounts to 141 bn tkm[4].

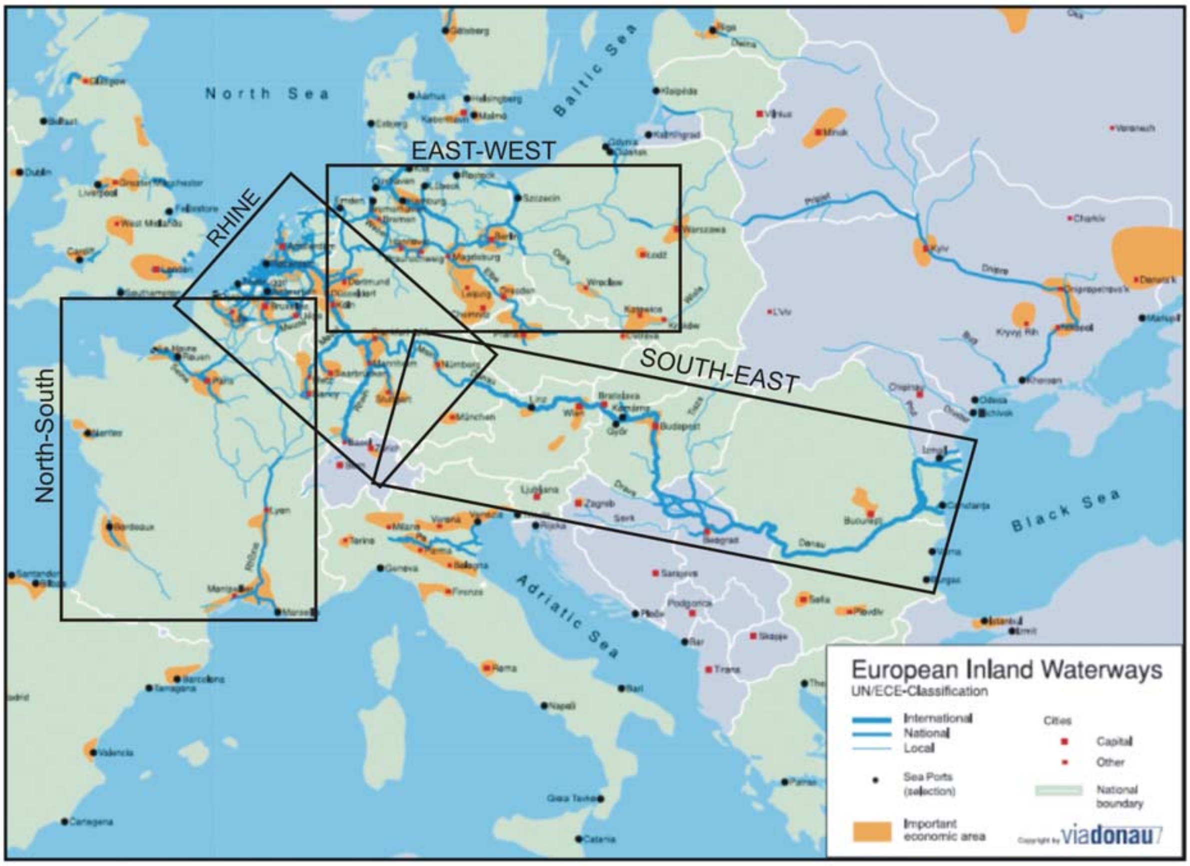

Figure 1 Overview on European inland waterways. Source: via donau

Mainly within the Rhine corridor, the performance of IWT is comparably high, resulting from a rather good waterway infrastructure and a corresponding high demand. IWT generates just under 116 bn tkm within the Netherlands, Belgium and Germany. This reflects 82 % of the EU-total figure and corresponds to a modal split within the respective countries of 44, 14 and 13 %. Thereby, inland navigation already today contributes to the relief of road and rail.

4 Source: European Commission, DG for Energy and Transport, EU Energy and Transport in Figures, Statistical Pocketbook

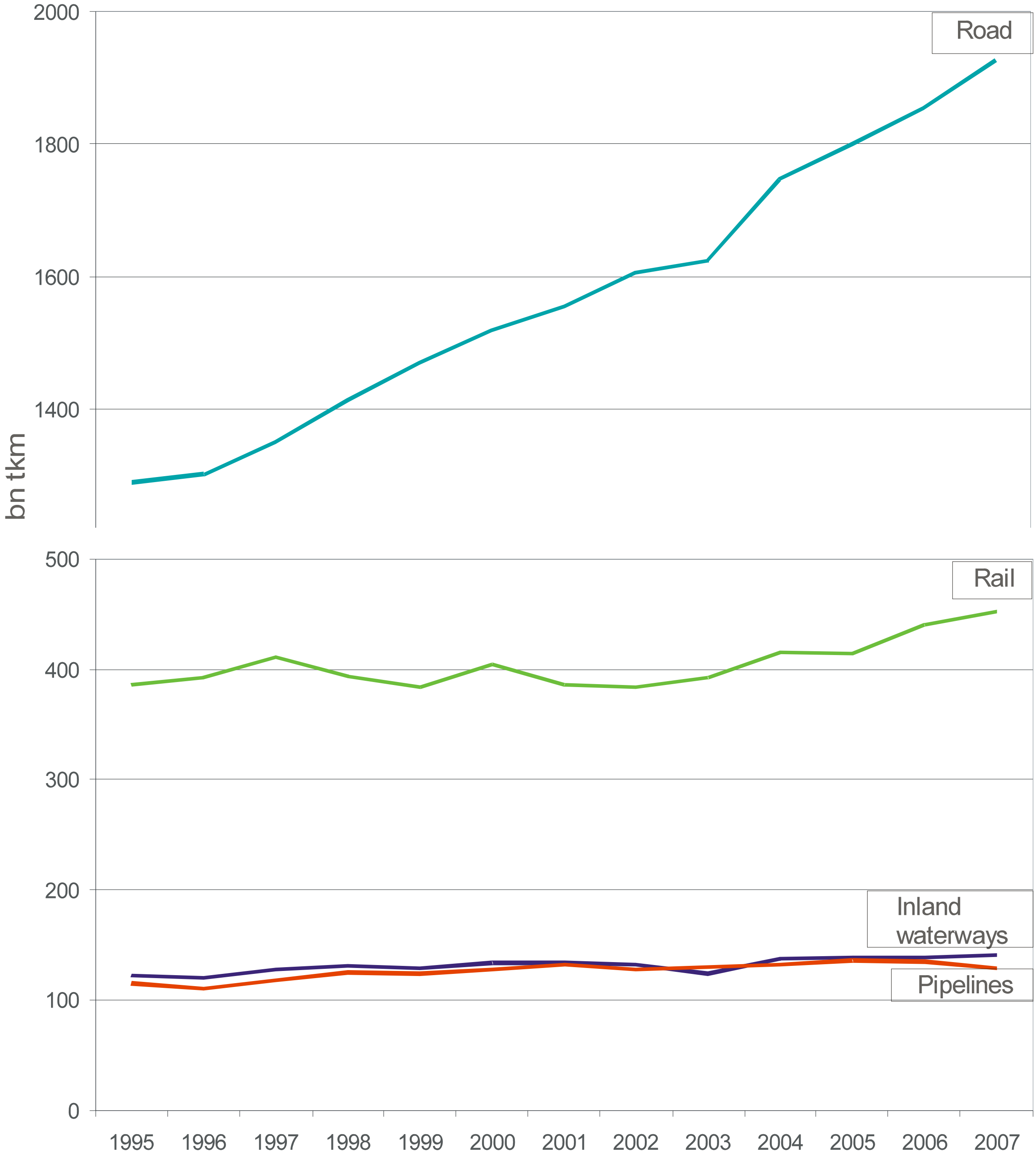

Figure 2 EU-27 - Development of freight transport performance by mode (Source: European Commission, DG for Energy and Transport, EU Energy and Transport in Figures, Statistical Pocketbook 2009)

Also within the EU accessing countries of Central and Eastern Europe inland navigation makes for traffic with lower environmental impact. It does not only support the connection of these countries to the EC core region, but also releases the traffic modes road and rail.

The infrastructure of both modes does not yet comply with the EU-standards in many of the new countries so that it is already overloaded today. With about 16 bn tkm, traffic performance of inland navigation within the accessing countries falls clearly short of the considerable potential mainly within the Danube corridor and along the Elbe.

Within the EU (EU27) inland navigation accounts for in total 5.3 % of the inland modes (road, rail and IWT) traffic performance.

Weaknesses

Despite of its advantages and system strengths, inland navigation by now has only been able to participate in the general transport growth in a limited way and saw its modal share reduced for years, especially compared to road transport. Nonetheless, the transport performance has grown by about 20 % since 1970.

The reasons for this development are manifold. On the one hand system characteristics of this mode, like for instance low density of the network or limited speed, can be mentioned; they hamper the ‘development’ of general cargo with small batch sizes distributed to the “area” and high time requirements.

On the other hand, “external” reasons are to be stated, like for example infrastructure bottlenecks or distorted competitive conditions both intramodal (i.e. within the traffic mode but among the different countries with inland navigation) and intermodal (i.e. among the individual modes of transport.)

Furthermore, for large parts of the fleets modernisation is lacking; in some regions also a shortage of qualified personnel can be stated. Besides, image problems and a limited public perception of this mode have to be considered.

3 SCOPE

Sovereign-institutional framework

When defining the scope of this SRA the question arises if and to which extent a sovereign-institutional delimitation of the SRA should be carried out. This aspect refers to the basic subject as to which research falls to European and which to national level. In general, there are different ways to approach this topic.

In this context it should be considered that inland waterway transport is of different traffic-related, economic and political importance within the different member states. Within the countries of the Rhine regime (above all Belgium, France, Germany and the Netherlands) it is quite significant, even though to a different degree. In contrast, within other areas e.g. the Danube and the Elbe corridor IWT's importance is rather moderate. Within other countries like Spain, Portugal, Italy, Greece, Ireland etc., IWT does practically not exist. Consequently, national research activities covering IWT are quite differently developed within the different member states. A (complete) overview of research related to inland waterway transport on national level is not available up to now.

Due to the international and transborder character of IWT, a European oriented research might be favoured in some degree; IWT's main parameters (infrastructure, fleet, and nautical personnel) are characterized by a high grade of international interdependence. On the other hand, the Treaty on European Union of Maastricht stipulates, that the European Union has to pay attention to the so called "principle of subsidiarity". It lays down that particularly those responsibilities should be assigned to the higher political level (here the EU), which cannot be fulfilled on a lower level (here the member states).

Finally, the question of delimitating between national and European level has to be agreed on by the EU and the national governments. The SRA cannot meet this task.

In this light, the SRA develops the general need for research.

Sector specific challenges

It was agreed on to overcome the described weaknesses, since they impede the efficiency of inland navigation; this is considered as precondition for this mode in order to overtake the envisaged task of releasing other transport modes.

This research agenda covers those of the mentioned areas that are addressed by research; they are dealt with in detail hereinafter. This refers to fields like e.g. fleet development and –modernisation, navigation of ships under more and more complex constraints as well as innovative intermodal transport solutions.

In contrast, other topics are of political or administrative nature, e.g. competitive distortion. They are not subject of this SRA, as they require other tools and approaches. Other work packages within PLATINA have a closer look at part of these topics, like WP 1 (Markets), WP 3 (Jobs and Skills), WP 4 (Image) and WP 5 (Infrastructure). However, cross-cutting aspects of these topics with reference to research will be considered partly within this agenda: While infrastructure bottlenecks basically have a political background (e.g. budget limits or missing political willingness to improve infrastructure, which is excluded from this SRA), research e.g. within the fields of RIS and fleet development can contribute to a better utilisation of existing infrastructure and will therefore be included.

General challenges

Apart from the a.m. topics being characteristic for the sector, this agenda also pays attention to future general aspects of strategic importance, like for example the limitation of fossil fuels or the climate change to be expected. Such developments and their impacts are of far reaching strategic importance and pose a challenge not only to this sector. Together with the aforementioned sector-specific (and research related) challenges they form the framework of this SRA.[5]

Against this background, the aim of this Strategic Research Agenda for IWT is to analyse the current situation and to identify and determine the future demand for research and development in the field of inland navigation. It will determine the needs and directions of future research and innovation activities, thereby considering anticipated developments and relevant economical, political and ecological challenges as mentioned above. It will especially focus on research related targets of strategic importance.

Link to Waterborne

Like maritime navigation, also inland navigation constitutes an important part of waterborne transport. However, the framework conditions under which inland navigation is realised are significantly different from the ones of maritime navigation. Issues being specific to inland navigation are operation under restricted fairway conditions, compliance of vessels with waterway infrastructure, e.g. locks and bridges, compliance with stricter environmental requirements, direct competition with other (land based) modes of transport, partly limited perception by shippers as well as little financial resources for research and development e.g. due to the fact that inland waterway transport is often performed as small family business with only limited funding available.

Basically, the operation of vessels under restricted fairway conditions, e.g shallow water, is complex and demanding, having an influence on the size of vessels, their energy consumption as well as traffic safety. Challenges rise with decreasing dimensions of waterways as well as with increasing vessel size and growing traffic density.

Furthermore, inland vessels have a clearly longer life span than maritime vessels. Bulk vessels on the Rhine are on average about 50 years old; the average age of liquid cargo ships is about 30 years. In consequence, the implementation of technical innovations is rather delayed and – contrary to maritime navigation – modernisation of the existing fleet gains in importance.

Against the background of these particularities this Inland Waterway Transport SRA aims especially at the needs of inland waterway transport. This focus shall contribute to underline the particularities of this traffic mode and its resulting specific research demand. The IWT-SRA consciously wants to stand out from research agendas of other transport modes in order to realize a certain “stand-alone position”, however, without neglecting links and parallels e.g. to maritime navigation.

Accordingly, the structure of this IWT-SRA is intended to be in line with the one of the Waterborne SRA. As a next step, a common SRA incorporating both the Waterborne and the PLATINA – SRA’s is envisaged, e.g. in the framework of the foreseen update of this SRA within the course of PLATINA and the next update of the Waterborne SRA. Thereby, IWT should become more visible within the Waterborne SRA. This document will be the basis for the envisaged updated version.

5 At the same time, the present economic crisis affects the sector intensively; however, this aspect does not result from a lack of R&D activities and therefore will not be addressed in detail within this SRA.

The focus of this SRA will be on long and medium term targets, for instance related to the time horizon 2020 according to “Vision 2020” of Waterborne TP and even further. Besides, also short term aims are considered, for example with respect to the present FP 7, running until 2013.

4 CHALLENGES

4.1 General aspects and approach

Research demand is derived from challenges of superior weight and corresponding strategic goals. The target of the SRA is to identify the core challenges and the strategic goals as well as to elaborate the corresponding research demand. However, the correlation between strategic goals and research demand is manifold and ambiguous: Individual goals can be met by different research topics, and vice versa - individual research topics may be assigned to various challenges and goals[6]. Also overlapping of certain goals as well as research topics occur. Due to these interdependencies, at first the challenges and strategic goals will be developed (chapter 4). In a next step, chapter 5 describes the corresponding research demand and topics.

As already mentioned, the challenges for inland navigation comprise both sector specific as well as ‘global’ challenges with overriding importance. Accordingly, future research activities should cover requirements of both fields.

Further on, the identified challenges are explained, considering the state of the art as well as the strategic goals for each challenge[7].

4.2 IWT specific challenges

Infrastructure conditions and limits

State of the art

The waterway infrastructure in terms of available water levels (and - if applicable- in terms of lock dimensions) sets the frame for IWT capacity and performance potentials. The “weakest” stretch of the waterways determines the vessel’s maximum size and loading draught for the complete considered transport relation. In addition, the waterway depth and its variations both, temporary as well as in the course of the river, clearly affect the relevant fuel consumption and the emissions.

In connection with the trend to enlarge vessel sizes (economy of scale) ships approach more and more the limits set by infrastructure. In this context, also predicted climate changes and their effects on available water depths play an important role (see below).

Against this background, a good exploitation of the existing infrastructure and its limits respectively plays a decisive role. The further development of ships as well as targeted research aiming at increasing the performance of the existing infrastructure without or with only limited physical upgrading measures are to be mentioned here.

6 For example, the development of low-emission propulsion technologies reduces on the one hand the dependency on fossil fuels and on the other the production of emissions.

7 The structure is based on the outcome of the PLATINA-experts meeting, held on May, 27th / 28th 2009 in Duisburg

Also, electronic information systems and tools, for example to improve the knowledge about really available water depth in the course of the river play a significant part concerning the estimation of the max. payload and especially in the context of energy efficient navigation (see below). This also comprises the ongoing development of appropriate RIS-applications, in particular Electronic Navigational Charts, on the one hand and their use aboard the ships as well as targeted tools for the training and education of crew staff on the other.

Strategic goal

- Better exploitation of available infrastructure

Over-aging of large parts of the fleet

State of the art

Apart from the vessel sizes, also the applied technology determines transport costs and thus competitiveness. In this context, several important research and development projects were carried out in the past.

As regards the implementation of innovations into navigation, there are basically two different ways: the new building of an inland ship and the subsequent modernisation of the existing vessels. Due to the long lifetime of inland vessels the share of new buildings remains comparably low, so that the modernisation process in this way can only be effective in the long run. Consequently, a relative over-aging of large parts of the fleet is the result.

The subsequent modernisation of existing vessels would therefore be an approach, to accomplish the implementation of technical innovations. However, research activities so far have mainly concentrated on improvements concerning the new building of inland vessels.

Strategic goal

- Modernisation/retrofitting of the existing fleet

Shortage of / and changing requirements to nautical personnel

State of the art

In view of the mentioned developments, i.e. the future traffic volume, increasing vessel sizes and the subsequent approaching to the infrastructure limits, the challenges caused by climate change like water level fluctuations as well as the growing shortage of nautical staff, the education of nautical personnel becomes more and more important.

This concerns for example the changing requirements as regards the navigation of ships under more and more complex conditions. Also, the trend of further automation and changing electronic equipment, like for instance RIS-applications, claims for an excellent education and high qualification. At the same time in some regions an over aging of large share of nautical personnel, especially boatmasters can be stated. The tendency to employ personnel deriving from other countries, i.e. from Eastern Europe, on West European waterways overlay these aspects. These developments significantly affect cost structures and competitiveness of the IWT system as well as safety and environmental aspects. Also the social component of working in IWT influences the attractiveness of the sector to potential work applicants.

Future education and training concepts should meet these requirements. Research and development can support innovative and up-to-date education concepts and -techniques.

In this context, simulators proved to be efficient as training tool for aviation pilots, marine officers and many other professional staff operating complex systems. Apart from some experience with Radar Simulators, so called “Ship Handling Simulators” are up to now not widely used as training tool for IWT nautical staff.

The required high level of steering experience in IWT is generally gained during years of navigation. Simulators can complete and accelerate such experience, as extreme situations can be trained and better analysed at high frequency and at zero risk level.

Prerequisites to such a new approach are tailored training courses and suitable simulators. Maritime Ship Handling Simulators are hardly suitable for training IWT-nautical staff, as hydrodynamics are rather complex in narrow and shallow inland waters and the bridge size and layout is very different from those on large seagoing ships. Therefore, the development of soft- and hardware for IWT Ship Handling Simulators is requested, once specific requirements have been identified and approved by concerned legal bodies.

Besides targeted education and (life-long) education concepts, which are not considered as part of the Research Agenda, dedicated tools for the support of such concepts are needed. For the development of such instruments however, targeted R&D is considered as necessary. The focus should be on tools for the support of navigational education for the navigation of ships under more and more complex constraints, like e.g. simulators.

Strategic goal

- Coping with increasing nautical requirements and ongoing training of staff

Predicted increases in transport demand

State of the art

An increase in the international division of labour, the growing globalisation of markets as well as the unbroken trend of outsourcing of certain production processes have led to an enormous increase in traffic volume in recent decades. This mainly refers to the transport of general cargo (processed material, semi-final and final products) while transport volumes for bulk cargo rather stagnate. This development is expected to continue in the future once the economic crisis and its impacts on the transport sector have been surpassed.

For the transport and logistics sector this not only means an increase in transport volume, but equally results in a need to develop concepts for new logistics systems that make efficient use of all transport modes for both national and European goods transport as well as for global trade. The attempts of the industrial sector to lower production costs are coupled with increasing outlay for the organisation and completion of transport assignments. Among others, cost advantages can be achieved by bundling and standardising cargo flows; reliability and punctuality are mainly a question of transport organisation.

Inland and coastal waters are not just alternatives for transporting bulk cargo, but are equally suitable for bundling various containerised cargo flows. The clear considerable rate of increase in the transport of sea-freight containers, cars and other general cargo in the recent decades, for instance on the Rhine, proves that these potentials can be utilised. The transport of containerised continental general cargo however still remains an undeveloped market segment for IWT till now.

While bulk cargos (ore, coal, oil, construction material) are usually forwarded by single mode point-to-point solutions, general cargoes require much more sophisticated logistic schemes with participation of often more than one mode. Consequently, the waterborne alternatives for general cargo transports need intelligent transport approaches as well as an efficient system of data monitoring, recording and managing as prerequisites for an efficient integration of IWT into intermodal transport chains.

Policy requires IWT to release other modes and to take over larger parts of the traffic growth from transport modes with environmental and/or capacity restraints. Since the expected increases of transport volume rather focus on 'general cargo and break bulk', a further development of these market segments for IWT is required.

Strategic goals

- Releasing other modes of transport
- Developing intelligent waterborne transport approaches for general cargo
- Increasing the use of modern ICT systems and services for co-modal IWT operations

4.3 ‚Global' challenges

Climate change impacts

State of the art

Expected climate changes will possibly lead to more intensive fluctuations of water levels and larger time spans with lower available water levels. This has to be analysed against the ongoing trend to larger vessels, which are more and more approaching the limits of the waterway infrastructure. Furthermore, extreme low water conditions affect traffic density, manoeuvrability and safety of vessel operations.

In order to cope with this challenge different approaches incorporating both, mitigation as well as adaptation strategies have to be considered. While mitigation mainly focuses on approaches targeting on a reduction of emissions and greenhouse gases (see also the following challenges below), adaptation rather concentrates on strategies to adapt fleet and manoeuvrability to modified infrastructure conditions.

Since vessels usually are adapted to the prevailing infrastructure conditions of the foreseen area of operation, climate change impacts might result e.g. in smaller available draughts leading to a growing need for modification and adaptation of vessels to changing conditions. Respective measures and research might be governed e.g. by innovative ship design concepts to keep the carrying capacity of the individual vessel as large as possible and to reduce the loading draught on account of length and breadth or by innovative features like light weight structures or 'chimera hulls', i.e. hulls that can - to some extent - change their hull shape and displacement according to the actually imposed surrounding conditions.

On the other hand, climate change also may result in new markets for inland waterway transport. Global measures related to mitigation and adaptation may be associated with new demand for transportation to be satisfied most appropriately by inland waterway transport, e.g. the transport of components for wind-power plants or the transport of hydrogen or of CO_2 captured from carbon power plants.

Strategic goals

- Mitigation: reduction of greenhouse gas emissions
- Fleet adaptation: Coping with expected climate change impacts (changed infrastructure conditions influencing possible vessel sizes and draughts)
- Maintain manoeuvrability and safety standards even under extremely varying and extremely low water conditions

Finiteness of the resource ‚fossil fuel'

State of the art

Global crude oil reserves will expire within the visible future. The time of expiration however is open; it will depend on several aspects such as e.g. global demand, discovery and exploitation of further, presently unknown resources as well as technical and price developments. Accordingly, the need to save and subsequently to substitute fossil fuels is inevitable. At present, besides some first applications for passenger vessels, general and commercially viable solutions for non-fossil-fuel propulsion systems hardly exist in inland waterways freight transport.

The general goal is the transition to the 'after-fossil-fuel-era'. Related to short- and mid-term-horizon (e.g. until 2020/2030) this mainly concerns 'conventional' approaches based on conventional technologies and solutions to reduce energy consumption.

On long-term-horizon (e. g. beyond 2030) the substitution of combustion engines by 'non-fossil' engines based on renewable energies, e.g. fuel cells is envisaged.

The goal is complementary to other strategic goals like reduction of fuel consumption and emissions and mitigation of the human influence on climate change.

Strategic goal

- Transition to the "after-fossil-fuel-area"

Limitation of hazardous emissions

State of the art

As already mentioned, greenhouse gas emissions as well as hazardous pollutants, emitted by conventional combustion engines affect climate and environment. Even though considerable and continuing improvements in energy efficiency have been gained within the recent 20-30 years, the transport sector is responsible for approximately 20% of the total air pollution within the EU[8].

For the reason of climate, environmental and health protection it is general understanding that these emissions have to be limited. Accordingly, this refers to both, climate affecting

8 Source: Public-Verlagsgesellschaft, Bingen, Ingenieur Spiegel 2/2009, p. 51-53,

greenhouse gas (GHG) emissions, e.g. CO2 as well as other emissions with polluting and/or toxic impacts.

Any improvement resulting in lower power requirements to move a ship contributes to the reduction of emissions. Since the amount of emissions directly depends on the consumption, less engaged power for the same performance means less fuel consumption and less exhaust emissions.

Most significant reductions of pollutant emissions like NOx and particulate matter may be achieved by proper emission reduction technologies e.g. selective catalytic reduction or particulate matter filters. One of the great challenges for diesel engine manufacturers is also to reduce NOx fraction without increasing the fuel consumption and CO2 emissions. The main challenge is to find efficient and reliable technical solutions for all exhaust emissions with viable prices for a good market acceptance.

As far as emission regulations and legislation are becoming stricter improved environmental friendliness is becoming a competitive factor of increasing significance.

The general goal is the further reduction of fuel consumption and emissions, complementary to the goals described above with regard to climate change and the finiteness of fossil fuels.

Accordingly, approaches like energy efficient navigation, improvement of engine and propulsion technologies, reduction of the resistance of ships, modification of combustion engines for operation on LNG and development of solutions for substitution of combustion engines and application of non-fossil renewable energy approaches for IWT contribute to this goal as well as to the aforementioned. Also, co-operation of research activities with other parties supports this goal, e.g. concerning engine technologies developed for trucks or concerning building equipment.

Besides, another option has to be mentioned in this context. Due to its – compared to other modes – relatively high energy efficiency and corresponding low emission rates the IWT mode can considerably contribute to a reduction of transport related emissions: Therefore, IWT has to play a more pronounced role not only in the transport of bulk cargo, but also within intermodal transport chains. Accordingly, innovative intermodal transport solutions as well as targeted promotion activities clearly support this goal.

Strategic goals

- Further reduction of fuel consumption and emissions
- More pronounced role of IWT within intermodal transport chains

The aforementioned explanations clearly illustrate the core challenges of IWT. Accordingly, the identified strategic goals determine the frame and direction of future research activities. The corresponding research topics will be further outlined in the following chapter 5.

5 RESEARCH DEMAND AND TOPICS

5.0 Approach

The strategic goals outlined in chapter 4, address a large variety of research topics reaching from shipbuilding technologies, vessel refitting, technologies for power supply and propulsion over hydrodynamics, energy efficient navigation and safety aspects till intermodal transport solutions and advanced RIS applications.

Due to the large number a structuring (clustering) of the research topics is necessary. Based on the focal points as regards content 3 groups (pillars) are defined. In the first group, headed ‘strengthening of competitiveness’ the focus is on the ship as a whole.

A second focus is on environmental aspects, headed ‘environmental sustainability’ (pillar 2). This mainly comprises endeavours to reduce fuel consumption and the transition to the “post-fossil fuel era”. Even though the content of pillar 2 considerably supports the strengthening of competitiveness, these topics are summarized in a separate pillar of their own due to their importance within the overall context.

The 3rd group ‘Matching growth and changing trade patterns’ comprises those topics, which were not classified under the first two pillars. Thereby, topics like innovative intermodal solutions, human sources and security aspects or advanced RIS-application are considered.

Nevertheless, overlapping between certain research topics is inevitable. Considering the fact, that an inland waterway vessel is temporarily autonomous, i.e. local improvements cannot be seen insulated from the rest if this affects the autonomous operation (e.g. less energy density of a new kind of prime energy etc.). Being a floating island, weight and payload balances link technically independent measures, for example, a more energy efficient prime mover could be inferior if its benefit is outbalanced by its too heavy weight and this way a reduced payload of the vessel. It can be concluded, that none of the aspects of an inland waterway vessel can be seen insulated, in a way they are all directly or indirectly depending on each other.

Figure 3 gives an overview on the challenges and strategic goals on the one hand and the described research pillars and the assigned research topics on the other. Furthermore, figure 3 provides an allocation of the single research topics to the strategic goals.

Thereafter, the different research topics are described in detail. Thereby, the following general structure is applied for each research topic:

- *Reference to aforementioned challenges and strategic goals*
- *Brief description of research demand*
- *Expected research outcome*

	Research Pillars	Strengthening competitiveness						Environmental sustainability						Managing growth and changing trade patterns				
Challenges	**Strategic Goals** / Research Topics	Refitting vessels	Fleet adaptation to climate change	Innovative vessel design	Shipbuilding technology	Structural strength of the hull	Handling, maintenance, repair	Means to reduce emissions of existing technologies	New technologies for power supply on board	Energy efficient navigation	Hydrodynamics	Equipment on board	Advanced safety standards	Intermodal solutions	Advanced RIS services	Advanced security standards	Support of education and training	New markets
Infrastructure conditions and limits	Better exploitation of available infrastructure		x	x		x				x	x				x		x	
Over-ageing of large parts of the fleets	Modernisation of the fleet	x		x	x		x	x	x		x	x	x					
Lack of/ Increasing requirements to nautical personnel	Coping with increasing requirements on professionals			x			x						x			x	x	
Predicted increases in transport demand	Releasing other modes of transport	x		x								x		x				x
	Intelligent IWT-approaches for general cargo	x		x	x	x						x	x	x	x		x	x
	Improvement of data management and information systems												x		x	x		
Climate change impacts	Reduction of greenhouse gas emissions							x	x	x	x			x				x
	Coping with expected infrastructure conditions		x	x			x			x	x		x		x			
	Maintain manoeuvrability and safety standards		x	x									x		x		x	
Finiteness of the resource ‚fossil fuel'	Transition to the "after-fossil-fuel-era"			x				x	x	x							x	
Limitation of hazardous emissions	Further reduction of fuel consumption and emissions	x		x				x	x	x	x				x		x	
	More pronounced role of IWT within intermodal transport chains			x										x	x		x	

Fig. 3: Overview of challenges and strategic goals and corresponding research pillars and -topics

5.1 Research topics aiming to strengthen competitiveness

5.1.1 Refitting vessels of the existing fleet

Reference to aforementioned challenges

- Over-aging of the fleet
- Increase/changes in transport demand
- Limitation of hazardous emissions

Research demand

Investigation and developing conceptual designs for new vessels following the state-of-the-art of specific knowledge, technology, logistic requirements and market demands represent one important direction of research efforts. This field of research activities aims at providing references for more specific research fields addressed to refitting concepts of existing vessels.

Due to a usually very long lifetime of inland vessels it comes to a situation that many ship components, although technically in excellent condition, can not provide performances of the corresponding components of modern vessels being built upon the state-of-the-art knowledge. These components are for instance engines, propeller and rudder arrangements and shapes, deck and especially electronic equipment, but also hull form and hull structure. Moreover, changed market and logistic requirements after 20 or more years of service of an existing ship could set-up new requests for performances like more carrying capacity or more speed, combined with less fuel consumption and emissions.

These circumstances impose the need to investigate feasibility of various modernisation measures. Contemporary knowledge in hydrodynamics, building technology, materials, structural strength and various equipment parts becoming standard on newbuildings should be applied in developing refitting concepts and in assessment of their effects.

Developing refitting strategies, concepts and efficient methods to improve performances of existing vessels seems to be an imperative to impede the process of the fleet over-aging. Thereby, approaches on how to implement research results, gained for newbuildings, also into existing vessels are of crucial importance.

Expected Research outcome

- Approaches to speed up the implementation of technical innovations into the existing vessels (refitting technologies and strategies)
- Decision support tools for vessel owners for the ranking of alternative technical measures to upgrade the vessel, thereby considering cost-efficiency of single measures and under consideration of limited financial means of SME's in the IWT branch

5.1.2 Adaptation to climate changes

Reference to aforementioned challenges

- Infrastructure conditions and limits
- Climate change impacts

Research demand

The economy of inland waterway vessels operating in restricted waterway conditions is especially sensitive on changing parameters of infrastructure like water depth and stream flow rate. Predicted climate changes could alter the usual parameters, especially those on free-flowing rivers. Design and principal particulars of inland ships nowadays are based and optimised among others on the infrastructure conditions these vessels are used for. Considerably altered discharge, depth, width, flow rate as well as amplitude and frequency of their changes on major European free-flowing waterways like long segments of Rhine, Danube or Elbe, could strongly affect optimal ship particulars to match these new conditions.

Research should consider the development of appropriate models for the analysis of interactions between infrastructure, vessel-type, -size, -propulsion system, energy requirements and cost structures.

Expected Research outcome

- Tools and criteria for the development of dedicated vessels (e.g. types, forms and sizes), depending on the specific infrastructure conditions of the foreseen area of operation
- Optimisation and possibly flexible response of ship design respecting shallow and low water conditions
- Design for service strategies, impeded by the possibly changing demands during the lifespan of the vessel
- Decision support for vessel owners and investors

5.1.3 Innovative vessel design

Reference to aforementioned challenges

- Infrastructure conditions and limits
- Over-aging of the fleet
- Lack of qualified nautical personnel

- Predicted increase/changes in transport demand
- Climate change impacts
- Finiteness of the fossil fuel resources
- Limitation of hazardous emissions

Research demand

Innovations in ship design are fostered by growing competition in the transport sector in which shipowners and shipbuilders try to maintain or eventually improve their position. Creating a sustainable competitive advantage, among others by means of innovative concepts and design solutions, is the imperative for the IWT industry to keep pace with competing modes.

The area is very wide and remains open for a variety of ideas focused on ship design which could improve the IWT performances. Ship design can be adapted to new commodity groups, new cargo units, new materials, to a new transhipment and stowage technology, manning and accommodation standards, new propulsion and steering devices and control systems, up to the application of physical principles such as drag reduction, and new prime energy sources. Each particular design innovation can be assigned to a particular field of research but if two or more new features are integrated in the same ship design then the most efficient and reliable way to assess the added value is to compare new design with conventional one or, if conventional ship of such a kind does not exist yet, with performances of other modes on the same transport task. Due to the complexity of this field and large versatility of specific goals, which might be given priority, the research demand might be addressed to optimisation of ship design focused on infrastructure conditions (primarily technical issues), optimisation of ship design focused on logistic requirements (primarily economic issues), optimisation of ship handling and safety (working conditions, ergonomic design), implementation of new prime energy sources and the expected consequences to ship design, development of means, methodologies and tools to optimally match logistic demand and ship particulars and performances etc.

One segment of research has to be dedicated to the development of ship design methodology based on an iterative process and multidisciplinary optimisation coupling different tools (e.g. general purpose optimal design, structure dedicated optimisation, naval architecture tool etc.).

Expected Research outcome

- Solutions enable matching logistic demand and ship particulars and performances
- New ship designs adapted for the application of new prime energy sources
- Designs with innovative propulsion and steering technologies
- Ships with “flexible particulars” – adaptable to various / extreme nautical conditions
- Ships optimised for extreme nautical conditions (e.g. extremely shallow water or small cross sections of canals)

- Multidisciplinary ship design optimisation tools
- Optimisation to labour friendly ships, in respect to handling, maintenance and safety

5.1.4 Shipbuilding technology

Reference to aforementioned challenges

- Over-aging of the fleet
- Increase and changes in transport demands

Research demand

This part concerns actions and activities of European shipbuilding industry and follow-up branches - equipment and component manufacturers including technologies dedicated or convenient for an application in shipbuilding.

The objectives concerning building technologies are a reduction of building costs and their environmental impacts as well as a facilitation of the building, maintenance and repair. Moreover, the question of vessel recycling after its decommissioning must be taken into account.

These objectives can be reached by technical improvements concerning different aspects of building technologies, such as special nesting, cutting, welding and gluing techniques, etc.

A major concern has to be paid to modular building and equipment with a standardisation of modules. This could facilitate speed up assembling, repairing and eventually vessel recycling at the end of its service life. Moreover, modular components would enable to create new ships with new length, new power pack, new bow shape, new propulsion, and in certain cases with even new purpose, containing a high percentage of standardised modules.

Expected Research outcome

- Strengthening of the competitive position of European shipbuilding
- New approaches for the modernisation of the IWT-fleet
- Modular shipbuilding concepts and solutions
- Building techniques suitable for new materials such as composites

5.1.5 Structural strength of the hull

Reference to aforementioned challenges

- Infrastructure conditions and limits
- Predicted increase/changes in transport demand

Research demand

Research activities would be addressed towards light weight structures, enhanced passive safety and crash worthiness, application of wear-resistant materials, tailor-made hull structures and construction details dedicated to specific cargoes.

The in general restricted water depth in inland navigation restricts the allowable draught and thus the possible displacement of a vessel within its predetermined length and breadth. Moreover, due to possible climate changes, which could impose even extremer variations of water depth, this limitation may become even more restrictive, at least for unpredictable or too long periods of low water. This means that the own weight of the inland vessel is becoming more and more a crucial issue.

New construction concepts and materials (special steel alloys, light alloys, composites) which provide sufficient structural strength of the hull and simultaneously demonstrate an additional weight saving potential have to be investigated for their applicability in inland ships.

Ship structural scantlings are calculated from general formulas based on classification societies' rules, usually containing considerable safety margins. Wherever possible, a refinement of those formulas or adaptation of customised stress calculation methods (FEM) would be a suitable way to reduce ship weight and cost.

Effects on aging, costs, maintenance, reliability, recycle-ability, robustness, strength, sustainability, yielded net weight saving need to be assessed, improved and made fit for the application in inland waterway vessel design.

Expected Research outcome

- A better weight to payload ratio of vessels
- Applicability of light structure concepts and materials in terms of costs, durability, maintenance needs and recycling processes

5.1.6 Handling, maintenance and repair

Reference to aforementioned challenges

- Over-aging of the fleet
- Lack of well trained nautical personnel

- Climate change impacts

Research demand

The research activities have to address easier, simpler, safer and faster handling with particular equipment components, devices, systems and hence the ship as a whole. Simultaneously also maintenance, failure checks, replacement of wear components as well as overhaul procedures have to be optimised.

Although each particular achievement could be of relatively small value the overall potential of possible improvements is large due to a wide area of applications. Therefore the achievements in this field could considerably contribute to mitigate the identified challenge ‘shortage of qualified man-power’.

One of the possible concerns could be for instance to develop special paintings and coatings dedicated to inland navigation. Good antifouling characteristics in fresh water could reduce frictional resistance fraction and consequently the energy requirements. Furthermore, the period between two dry-dockings in order to clean the hull could be eventually extended contributing to the mitigation of costs. On the other side the new anti-slip deck coatings could ensure higher friction between deck and sole and thus a better safety for crew on deck, eventually with also longer wearing endurance and lower costs.

Expected Research outcome

- New materials
- New engineering methodologies, applications and standards

5.2 Research topics aiming to ensure environmental sustainability

5.2.1 Improving existing engine technologies to reduce emissions

Reference to aforementioned challenges

- Over-aging of the fleet
- Climate change impacts
- Finiteness of fossil fuel resources
- Limitation of hazardous emissions

Research demand

The most usual inland vessels are diesel powered self-propelled vessels or barge trains. Rarely applied are diesel-electric concepts, mainly when a huge electric energy demand exists, e.g. by the hotel service of passenger vessels. In the scenario of increasing fuel prices these systems might become attractive even to inland waterway freight transport.

Besides the permanent efforts to reduce fuel consumption and emissions due to economic and ecological reasons, the goal to match finiteness of the fossil fuel resources is the transition to the 'after-fossil-fuel-era'. Related to short- and mid-term-horizon (e.g. until 2020/2030) this mainly concerns 'conventional' approaches based on conventional technologies and solutions to reduce energy consumption.

Combustion engines should be further improved aiming simultaneously at a lower specific fuel consumption (leading to lower CO2 emissions), mitigation or elimination of hazardous substances from exhaust (NOx, pm, etc.) as well as at an optimal regulation of combustion over the entire range of engine load and rate of revolutions.

Improvement of conventional engine technologies (engines transferring heat produced by internal fuel combustion in cylinders directly into mechanical work – to shaft revolutions) might be based on the full or partial substitution of fossil fuels like marine diesel or gas oil by natural gas e.g. LNG (liquefied natural gas) or by fuel gained from renewable energy sources (e.g. "bio"-fuel).

This research activity focused on the reduction of fuel consumption and exhaust emissions should be prevailingly assigned as short to medium term task.

Improved hydrodynamic properties of vessels also considerably contribute to reducing emissions. Lowering drag and increasing propulsion efficiency result in a higher overall propulsion efficiency as a quotient of power needed to move the ship at a certain speed and power developed by the engine to realise it.

Expected Research outcome

- Further improvement of diesel powered engines,
- Implementation of alternative fuels e.g. LNG and "bio"-fuels in internal combustion engines
- Increase of ship propulsion efficiency

5.2.2 New technologies for power supply on board

Reference to aforementioned challenges

- Over-aging of the fleet
- Climate change impacts
- Finiteness of fossil fuel resources

- Limitation of hazardous emissions

Research demand

Alternative prime energy sources need to be considered to reduce or even to eliminate hazardous and greenhouse gas emissions and simultaneously to anticipate on the 'after-fossil-fuel' age. Therefore, the further development of renewable energy solutions and their application in IWT will be one of the focal points of research. Due to the long lifetime of vessels and the long way to go research has to be accelerated accordingly.

In a first step the application of gas engines using natural gas (e.g. LNG) or bio-gas (methane) in inland navigation seems to be feasible, offering the advantage that this technology is already developed for other modes of transport and the investment costs may be compensated by significantly lower fuel costs, provided the fuel will be exempted from taxes as fossil fuels currently used in inland waterway transport.

On long-term the application of fuel cells being operated on or using hydrogen derived from natural gas or bio-fuel may become feasible, and, finally, the direct application of hydrogen derived cost-efficiently from renewable energy sources can be thought of. First applications are expected to be niche applications (shorter distances, smaller regions, dedicated transport) e.g. in environmentally sensitive areas, followed by replacement of auxiliary units.

Further research activities have to be pointed towards the recovery of waste heat, utilisation of solar energy as well as usage of electrical power via e.g. shore side supply or electric cells with high energy storage density.

Expected Research outcome

- Gas engine solutions for inland waterway transport
- Fuel cell solutions for inland waterway transport
- Further investigate and promote waste heat recovery systems
- Solar energy systems for heating and onboard electricity
- Storage systems for electrical power with high energy storage density

5.2.3 Energy efficient navigation

Reference to aforementioned challenges

- Infrastructure conditions and limits
- Climate change impacts

- Finiteness of fossil fuel resources
- Limitation of hazardous emissions

Research demand

The aim is the development of suitable and reliable tools for the timely provision of information on varying, locally and temporarily available water depths and corresponding targeted tracking, resulting in the continuous optimisation of the speed and consequently an energy efficient navigation.

Expected Research outcome

- Tools for the provision of information on the optimum track of the fairway and the corresponding optimum speed for energy efficient navigation
- Advanced voyage planning systems considering real-time fairway information directly in front of the ship and combining this with other RIS information sets
- Interactive voyage planning with data adjustments between vessels themselves and with infrastructure and service operators resulting in guaranteed path with pre-booked timeslots

5.2.4 Hydrodynamics

Reference to aforementioned challenges

- Infrastructure conditions and limits
- Over-aging of the fleet
- Climate change impacts
- Finiteness of the fossil fuel resources
- Limitation of hazardous emissions

Research demand

Better hydrodynamic properties will improve the performance of the ship either by further reduced power demands or by a reduced turnover time (higher speed attained by the same power engaged). As the resistance of the ship is a multiplying factor to power demand, all quantities related to the power of the prime mover are reduced when innovation leads to a reduced ship's resistance. Keywords in this respect are: Introduction of vanguard techniques, such as air lubrication and turbulence control.

Insight in physics of fluid turbulence, described by the highest Reynolds number that occurs in transport techniques through the water (higher than in aeronautics), meaning that the rather traditional transport means ‘ship’ is demanding one of the most fundamental physics of flow research approaches.

Propulsion and steering performances and efficiencies are also a permanent subject of improvements. Efficiency of propulsion and steering devices are in tight relations with underwater hull shape, fairway conditions as well as the speed of the ship. Hull form optimisation for given conditions must be always considered in conjunction with propulsion and steering solutions to be applied.

Hydrodynamic improvements contribute simultaneously to strengthening the competitiveness of the mode (lower energy demand and consequently lower operational costs, higher speed at the same power and consequently reduced turnover time) and to ensuring environmental sustainability (lowering exhaust emissions and reducing wash).

Expected Research outcome

- Techniques to control or avoid turbulence in order to reduce drag and in this way propulsion energy
- Optimisation of ship performances focused on application of drag reducing devices and technologies
- Reducing the resistance of ships (total as well as partial: caused by waves, by hull form and by friction between hull and water),
- New concepts and solutions for propulsion and steering arrangements
- Adaptation of optimal hull forms for innovative propulsion and steering concepts
- Exploitation of drag reducing devices such as profiles and spoilers
- Application of innovative propulsion techniques such as distributed thrust, biometric propulsion and stationary hauling systems
- New techniques, e.g. drag reduction and other physical solutions and optimisation techniques like vanguard CFD applications

5.2.5 Equipment on board

Reference to aforementioned challenges

- Over-aging of the fleet
- Lack of well trained nautical personnel

Research demand

Advanced equipment on board should facilitate the navigation to make it safer and more reliable. Activities should be focused to researches on efficient cargo handling system, sophisticated stowage systems, automatic ballasting systems in order to optimise trim and heel automatically, implementation of electric or hydro-electric drive instead of manual (deck-hands) activities, remote control solutions etc. Most of these technologies already exist but their implementation on board an IWT vessel is often too expensive nowadays.

Research on equipments which include monitoring systems could also be sustained in order to help to prevent failures and injures.

Research on equipment should indirectly contribute to decrease pollution. This objective can be reached by for instance remotely controlled systems, automation of processes on board, improvement of exhaust purifying systems, use the clean ways to supply on-board electricity for purposes other than propulsion, improvement of on-board sewage treatment systems etc.

Expected Research outcome

- Reliability and safety in ship handling
- Reduced pollution
- Improved ergonomic features

5.2.6 Advanced safety standards

Reference to aforementioned challenges

- Lack of qualified nautical personnel (insufficient qualification to new techniques)
- Predicted increases in transport demand
- Climate change impacts
- Over-aging of the fleet

Research demand

Changing climate conditions and rising transport demand might cause additional requirements to safety standards of ship operation. This would emphasize the need for innovative approaches to improve safety standards for crew, ship and cargo.

Two aspects of safety should be considered: active and passive safety. Active safety comprises solutions, means and methods to avoid and prevent an accident while passive corresponds to measures to mitigate accident consequences if an accident already happens.

For crew on board an active safety means how to avoid injuries by any activity on board and passive would be how to evacuate crew and save lives in case of calamity. For the ship an active safety would comprise e.g. steering performances, early detection of collision hazard, automatic collision avoidance, front scanning echo-sounder and early warning system to prevent grounding, systems to prevent collision with bridges, especially important for container ships having usually a considerable air draught. Ships' passive safety includes design and structural improvements to remain afloat after grounding/collision or to prevent leakage of cargo after damage the outer hull.

Expected Research outcome

- Improvement of active and passive safety of vessel
- Improved safety of crew and cargo

5.3 Research topics aiming to match growth and changing trade patterns

5.3.1 Innovative intermodal transport solutions

Reference to aforementioned challenges

- Predicted increase/changes in transport demand
- Limitation of hazardous emissions
- Climate change impacts

Research demand

A further integration of IWT into logistic chains is considered as a precondition in order to further develop the market segment "general cargo" and hence to contribute to releasing other modes of transport. Transport solutions based on IWT have to be economically attractive, flexible, reliable and safe in order to be competitive with the existing services provided by land based modes. Research should be addressed to innovative ideas for waterborne solutions, technical feasibility for their realisation including relevant service performances and their economic indicators.

Solutions are required for the hinterland transport of maritime containers on those waterways, where these transports are presently underdeveloped This refers e.g. to the Danube Corridor or to smaller waterways with restricted draughts or air draughts. Also, competitive approaches for the transport of containerized continental general cargo are still missing.

Research should focus on innovative intermodal approaches considering technical, organisational and economical aspects as well as up-to-date standards for the accompanying information flow.

Expected Research outcome

- Innovative, flexible, reliable and competitive intermodal waterborne transport solutions and up-to-date standards for the accompanying information flow
- Increased intermodal competitiveness of IWT in order to attract (and shift) larger parts of the transport volume to this mode

5.3.2 Advanced River Information Services (RIS)

In the research area on River Information, several sub-areas have been identified, which are outlined in the following chapter. The following reference to aforementioned challenges applies to all sub-areas.

Reference to aforementioned challenges

- Infrastructure conditions and limits
- Lack of well trained nautical staff
- Increase/changes of transport demand
- Climate change impacts
- Limitation of hazardous emissions

Research area River Information Services: Next generation of River information systems (RIS) positioning, communication and charting technologies and on-board navigational support systems

Research demand

The following technologies will have to be developed further and/or its application in RIS will have to be studied: (a) UMTS successor and emerging broadband mass-market satellite services, local high bandwidth data transmission using W-LAN successor. (b) AIS+ (3rd channel, possible change of frequencies, new AIS messages), AIS from space and Galileo services. (c) ECDIS version X.X allowing for 3D display and visualisation using dynamic water-level models and dynamic traffic information and (d) Development of advanced field-measurement technologies for efficient creation of electronic charts.

In the future, the navigational decisions of the skippers will have to be supported in a better way in order to maintain the excellent safety performance of IWT despite the expected increase in traffic density. Therefore, integrated support systems have to be created, which are expected mainly in the following areas: (a) Navigational support by using highly accurate positioning from combined GPS+ and Galileo, combined with local/global augmentation data. (b) Highly (cm) accurate ship positioning including heading data allowing for automated docking assistance, path keeping and auto-piloting. (c) Integrated navigation system tracking and fusing radar and AIS data showing real and accurate vessel outlines in 3D I-ECDIS display. (d) Automatic collision detection and emergency manoeuvring using intelligent algorithms on board

Expected Research outcome

- Feasibility studies and demonstrators how the emerging telecommunication services and Galileo services can be applied in River Information Services
- Feasibility studies and demonstrators making use of the next generation of the Automatic Identification System and Inland ECDIS Charts
- Feasibility studies and demonstrators of the next generation on-board support services

Research area River Information Services: Next generation of RIS-based integrated transport management services

Research demand

According to EU Freight Logistics Action Plan, "e-freight", denotes the vision of a paper-free, electronic flow of information associating the physical flow of goods with a paperless trail built by ICT. It includes the ability to track and trace freight along its journey across transport modes and to automate the exchange of information for regulatory or commercial purposes. Within EU research project RISING, first services for logistics users include the integrated event management services, river information transport logistics service and voyage plan service. These services have been driven from the mostly traffic-related RIS Services, developed and demonstrated.

(a) Design and development of next generation RIS transport logistics services (RIS TLS) based on previous results (e.g. RISING, eFreight) with special focus on tracking and tracing of cargo.

(b) The acceptance and usage of new RIS transport logistics services (RIS TLS) through the IWT market operators implies that all legal framework conditions for exchanging RIS TLS between countries and between legal entities are in force. Necessary actions for solving these legal barriers will contribute to this demand from the IWT sector.

(c) The promotion incl. information campaigns and training actions of RIS transport logistics services will foster the implementation and roll-out of RIS TLS in the European IWT sector.

Expected Research outcome

- Development of new RIS transport logistics services with regard to cargo identification and tracing, based on RIS especially considering hazardous goods
- Conception work and preparation of recommendations for solving legal barriers in the field of RIS data exchange from (a) authority to authority, (b) authority to business and (c) business to business considering data protection issues of EU member states and third countries

- Information campaigns and training concepts on RIS transport logistics services for increasing the awareness, visibility and usage of new RIS services in the IWT sector
- Harmonisation and standardisation of new RIS transport logistics services.
- Further development and demonstration of advanced functionalities of national and European services based upon international data exchange (position information, cargo and voyage data, hull data, etc.)

5.3.3 Support of education and training

Reference to aforementioned challenges

- Infrastructure conditions and -limits
- Insufficiently trained personnel for new demands in transport
- Predicted increases/changes in transport demand
- Limitation of hazardous emissions

Research demand

Expected developments like e.g. increasing traffic volumes, increasing vessel sizes and the subsequent approaching to the infrastructure limits, climate change impacts like decreasing water levels etc. describe the expected future frame conditions for navigation on inland waterways, thereby constituting an increasing level of navigational challenges and complexity. Also, the trend of further automation and increased application of technical and electronic equipment, like for instance RIS-applications, has to be mentioned in this context.

Such developments claim for excellent and high efficient training and education concepts and tools.

Simulators are considered as an innovative tool which can support and accelerate nautical education, as extreme situations can be trained and better analysed at high frequency and at zero risk level. However, contrary to other professions like aviation pilots or marine officers, so called “Ship Handling Simulators” are up to now not widely used as training tool for IWT nautical staff.

Accordingly, the development of dedicated IWT Ship Handling Simulators including the necessary hard- and software components is considered as a promising approach to efficiently support (and speed up) existing education and training concepts. Targeted research activities are required to close this gap.

Expected Research outcome

- Provision of ‘tailored’ IWT simulators (covering the entire scope of activities on board)

- Improved efficiency of education and training, e.g. in terms of targeted and risk-free training of dangerous situations
- Improved safety of operation, simulators accommodating new ship types
- Mutual interaction ship simulators (i.e. ships sailing alongside each other such as supplying or overtaking/encountering each other)

5.3.4 Advanced security standards

Reference to aforementioned challenges

- Increase/changes in transport demand
- Changing requirements to nautical personnel

Research demand

Predicted increases of transport demand and higher degrees of automation of operation will underline the question of security issues in IWT.

Higher transport volumes together with trends to develop new markets with possibly higher value commodities imposes the need to develop systems and procedures to enhance security against stealing, smuggling of goods and persons, frauds and eventually also acts of terrorism.

New standards, procedures and means for permanent monitoring of vessels and cargoes during voyage and especially during stay at berth as well as technologies and methods to prevent illegal actions have to be investigated and tested.

Expected Research outcome

- Systems for permanent and efficient monitoring of cargo and means to prevent illegal actions

5.3.5 Development of new markets

Reference to aforementioned challenges

- Climate change impacts
- Predicted increase/changes in transport demand

Research demand

The technology of carbon capture and storage (CCS) is one possible approach to reduce greenhouse gas emissions. Even though it mainly refers to the energy sector, certain transport tasks from the locations of production (carbon power plants) to the locations of storage (e.g. coastal areas) are necessary. While many carbon power plants are located in the direct vicinity of large and navigable rivers, IWT could be a reliable and competitive option for these transport tasks.

Due to the specific transport requirements (pressure, temperature etc.) dedicated research activities are required for the case that the development of CCS-technology will be continued and applied. Topics of concern are competitive and reliable solutions for the expected strong technical and safety requirements.

Expected Research outcome

- Solutions for IWT transport of captured CO_2

5.1 Strengthening competitiveness

5.1.1 Refitting vessels of the existing fleet
- Strategies to refit existing vessels
- Decision support for owners

5.1.2 Adaptation to climate changes
- Matching vessel particulars to infrastructure
- Service strategies during the lifespan of ship
- Decision support for owners

5.1.3 Innovative vessel design
- Matching vessel particulars to market demands
- Matching vessel design to new prime energy sources
- Matching design to propulsion and steering technologies
- Ship design with "flexible particulars"
- Ship design to match extreme nautical conditions
- Optimisation to worker friendly ships

5.1.4 Shipbuilding technology
- Strengthening position of the EU shipbuilding industry
- New approaches for the modernisation of the IWT fleet
- Modular shipbuilding concepts and solutions
- Building technologies suitable for new materials such as composites

5.1.5 Structural strength of the hull
- Increasing payload efficiency
- Applicability of light structure concepts

5.1.6 Handling, maintenance and repair
- New materials
- New engineering methodologies and standards

5.2 Environmental sustainability

5.2.1 Improving existing technologies to reduce emissions
- Further improvement of diesel powered engines
- Implementation of LNG as fuel
- Increase of propulsion efficiency

5.2.2 New technologies for power supply on board
- Gas engine solutions
- High energy storage density electric cells
- Fuel cell solutions
- Waste heat recovery
- Solar energy for onboard electricity

5.2.3 Energy efficient navigation
- Onboard tool for support of energy efficient navigation
- Voyage planning based on real-time fairway information
- Voyage planning with pre-booked timeslots

5.2.4 Hydrodynamics
- Reducing power requirements
- Reducing wash

5.2.5 Equipment on board
- Increase reliability and safety in ship's handling
- Preventing air and water pollution

5.2.6 Advanced safety standards
- Active and passive safety of vessel
- Safety of crew and cargo

5.3 Managing growth and changing trade patterns

5.3.1 Innovative intermodal solutions
- Innovative intermodal transport solutions
- Increased intermodal competitiveness

5.3.2 Advanced RIS implementations
- Positioning, communication and charting technologies
- On-board navigational support systems
- National "single windows"
- New technologies
- Integrated transport management services

5.3.3 Support of education and training
- Dedicated simulators for navigation
- Improved efficiency of education and training
- Improved safety of operation
- Mutual interaction ship simulators

5.3.4 Advanced security standards
- Monitoring of vessels and cargoes

5.3.5 Development of new markets
- IWT solutions for CO2 transport (related to CCS technology)

Figure 4: Overview on research topics (green boxes) and expected research outcome (white boxes)

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