Assessment of greening technologies for the IWT sector

Juha Schweighofer, viadonau

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- **Promoting Innovation in the Inland Waterways Transport Sector**

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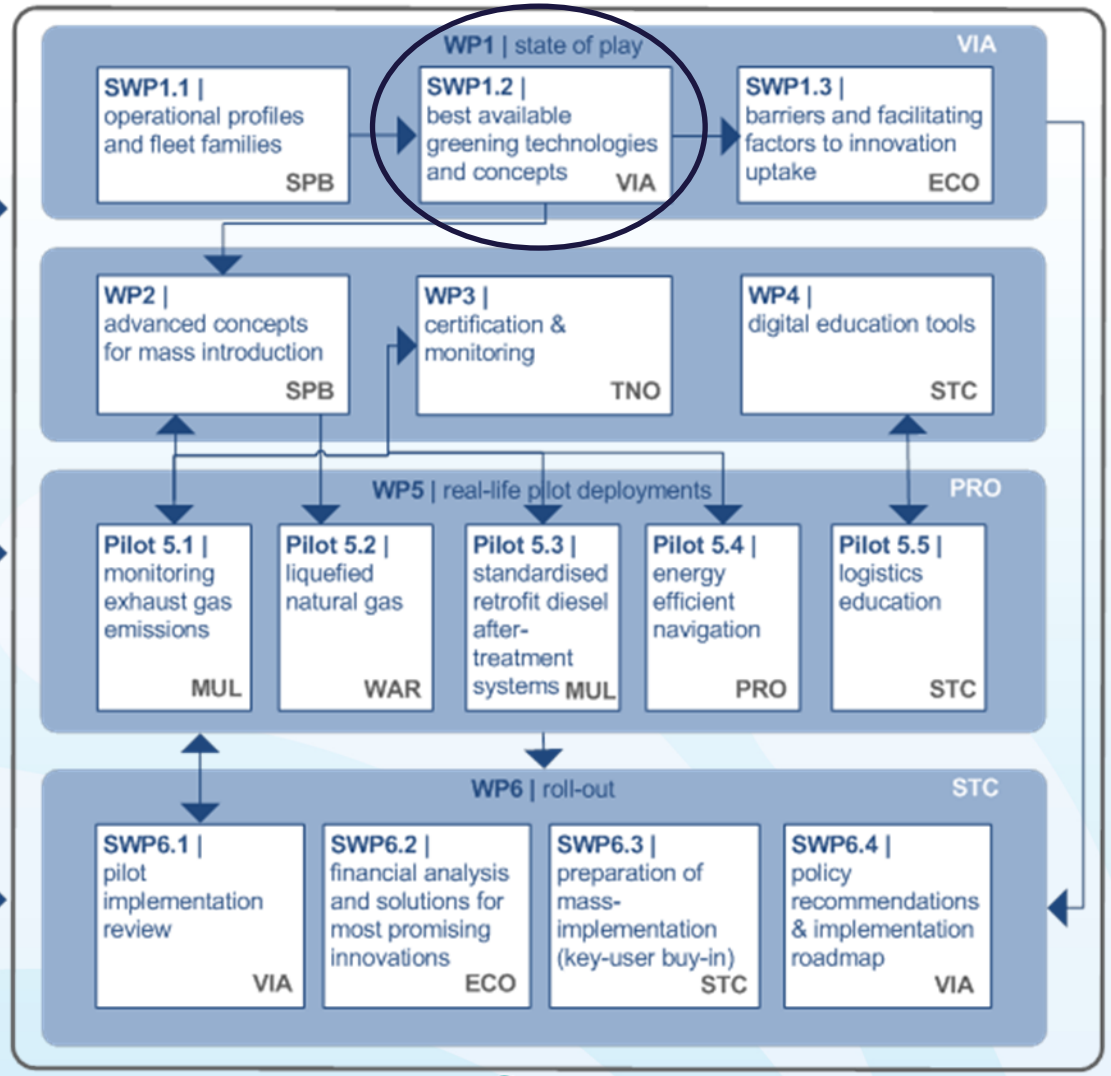
- Duration: 1.5.2015 – 30.4.2018

- In total: 17 beneficiaries
- Lead: Jaap Gebraad, STC-Group (NL), Gebraad@stc-r.nl

- **More information:**
  - http://cordis.europa.eu/project/rcn/193260_en.html
  - http://www.prominent-iwt.eu/


WP7 | project management
STC
SWP7.3 | stakeholder involvement
STC
SWP7.2 | project dissemination
STC
SWP7.1 | administrative & financial management
STC
WP1 | state of play
VIA
SWP1.1 | operational profiles and fleet families
SPB
SWP1.2 | best available greening technologies and concepts
VIA
SWP1.3 | barriers and facilitating factors to innovation uptake
ECO
WP2 | advanced concepts for mass introduction
SPB
WP3 | certification & monitoring
TNO
WP4 | digital education tools
STC
WP5 | real-life pilot deployments
PRO
Pilot 5.1 | monitoring exhaust gas emissions
MUL
Pilot 5.2 | liquefied natural gas
WAR
Pilot 5.3 | standardised retrofit diesel after-treatment systems
MUL
Pilot 5.4 | energy efficient navigation
PRO
Pilot 5.5 | logistics education
STC
WP6 | roll-out
STC
SWP6.1 | pilot implementation review
VIA
SWP6.2 | financial analysis and solutions for most promising innovations
ECO
SWP6.3 | preparation of mass-implementation (key-user buy-in)
STC
SWP6.4 | policy recommendations & implementation roadmap
VIA

Introduction (1)

- Best available greening technologies and concepts:
  - Collection and assessment
  - Part of WP1 (State of Play)
- Which technologies are available?
- What is their potential with respect to the reduction of:
  - Fuel consumption
  - GHG emissions
  - Pollutant emissions

Introduction (2)

- What is their potential with respect to wide-spread implementation?
  - Applicability to largest share of of existing ship types
  - Best match with actual navigation profiles

- What is their potential regarding:
  - Availability in time (pilot implementation till 2017, roll-out till 2020)
  - Costs (affordable prices, market maturity)?

- ***=> Most promising technologies for further consideration***

Longlist of greening technologies

- Projects considered:
  - PLATINA
  - **PLATINA II**
  - MOVE IT!
  - Innovative Danube Vessel
  - + updates on latest developments (e.g. several reports TNO + input from partners WÄR, MUL)
  - Contribution to impact assessment of measures for reducing emissions of inland navigation" (Panteia 2013)
  - TEN-T LNG Masterplan project
  - State of the art energy-efficient navigation (e.g. VoortVarend Besparen)
- Innovation Lab (EICB, 20 leading industrial organisations)
- Navrom + Viking Cruises

- **Identification of more than 70 measures!**

Longlist of greening technologies - areas

- Infrastructure
  - Ports & mooring places
  - Waterway information
  - Waterway Infrastructure
- Ship related measures
  - Fleet structure
  - Fuels, **standardised solutions**
  - Propulsion system, **standardised solutions**
  - Propulsion system, propeller
  - Hydrodynamics
  - Ship structures & weight
- Ship operation
  - Sailing behaviour
  - Maintenance
- Education
- Logistics

prominent

Longlist of greening technologies - example

Type of measure	Area	Measure	Criterion 1: Emission reduction potential (max. %) (not cumulative)	Criterion 2a: Applicability on share of the European fleet 1: >50% 2: 10-50% 3: <10%	Criterion 2b: Economic potential payback period (years)	Criterion 3a: Technological Maturity (TRL) 1: basic R&D needed till 9: full comm. applic.	Criterion 3b: Non-technical Maturity & other hindrances exclusion if overcapacity
Infrastructure	Ports & mooring places	Shore side power	5%	1	n.a.	5	reg. & fin.support
		Optimisation of locking procedure/ traffic mgt.	5%	1	n.a.	6	
	Waterway information	Better pred. of av. water depth (c.f. load factor)	10%	1	n.a.	4	
		Electronic ECDIS charts with actual depth information	5%	1	n.a.	7	
		Real time info on fairw. data (link to energy.eff.nav.)	10%	1	n.a.	5	
	Waterway Infrastructure	Improve fairway conditions (upgrading)	65%	1	n.a.	9	
		Technologies for waterway maintenance	n.a.	1	n.a.	4	
Ship-related	Fleet structure	Use larger vessel units	75%	2	n.a.	9	overcapacity
		Use more coupled convoys	20%	2	7	9	overcapacity
		Lengthening (+25%; Europe type vessel) + nozzle	15%	2	2	9	overcapacity
		Lengthening (+10%; smaller than Europe type vessel)	5%	2	26	9	overcapacity
	Fuels, standardised solutions	Use LNG (Liquefied Natural Gas) (PM reduction)	90%	2	n.a.	5	reg. & fin.support
		Apply dual fuel (LNG and diesel) (PM reduction)	90%	1	n.a.	5	reg. & fin.support
		Apply GTL fuel (PM reduction)	60%	1	n.a.	9	reg. & fin.support
		Apply CNG (PM reduction)	95%	3	n.a.	5	reg. & fin.support
		Apply Methanol (PM Reduction)	95%	1	n.a.	3	reg. & fin.support
		Use hydrogen / fuel cells	100%	1	n.a.	2	reg. & fin.support

TRL 5 - Validation: large scale prototype / tested in relevant environment

Short list of greening technologies (1)

- Focus:
  - Fuels
  - Propulsion systems, standardised solutions (as listed in longlist)
  - Ship-operational measures
- Criterion 1:
  - Energy consumption and emissions: > 5 %
- Criterion 2:
  - Range of impact: economic* and technical feasibilty: >10 % of fleet
- Criterion 3: availability for mass implementation:
  - Technological maturity: TRL > 4
  - Non-technical maturity: Overcapacity to be avoided

* Payback of 10 years not viable!

Shortlist of greening technologies (2)

Type of measure	Area	Measure	NOx	PM	CO2 only	GHG (CO2 & CH4)	Applicability on the fleet	Economic feasibility (ship owner)	Technical maturity	Non-techn. maturity (barriers)
			%	%	%	%	% of fuel consumption in Europe	+++/---	TRL level	+++/---
Ship-related technical measures	Fuels, standardised solutions	Use LNG (Liquefied Natural Gas) - single fuel/ spark ignition	70-80	up to 95	20-25	0-10	10 - 50%	++	6	---
		Apply dual fuel (LNG and diesel)	50-65	50-90	20-25	0-10	10 - 50%	++	6	--
		Apply GTL fuel	10	20	0	0	> 50%	-	9	0
	Propulsion system, standardised solutions	Apply SCR	70-90	0-20	≈ 0	≈ 0	10 - 50%	--	8	-
		Wall flow DPF	0	90	≈ 0	≈ 0	10 - 50%	---	7	-
		Combine SCR and DPF	80-90	90	≈ 0	≈ 0	10 - 50%	---	7	-
		Exchange of main diesel engine (CCR I by CCR II engine)	15-35	40-60%	0	0	> 50%	0/-	9	0
		Exchange of main diesel engine (by Stage V engine)	65	80-90	0	0	> 50%	-	5	--
		Right sizing	0-10	0-10	0-10	0-10	100%	++	9	0
		Diesel-hybrid prop. (no buffer batt.)*	0-10	0-10	0-10	0-10	10 - 50%	+	9	0
		Diesel-hybrid prop. (+ buffer batt.)*	0-10	0-10	0-10	0-10	10 - 50%	+	9	0
Infrastructure	Waterway Information	Real time info on fairw. data	14 (3-25)				>50%	+	5/7	-
Ship-operational measures	Sailing behaviour	Speed adaption					>50%	+	5	-
		Optimised track choice					>50%	+	5	-

Fact sheets

MEASURE: ***(example: LNG fuel)***

Description of Technology

Liquefied natural gas or LNG is natural gas that has been converted to a liquid form for the ease of storage or transport by cooling natural gas to approximately −162 °C. Afterwards, it is stored at essentially atmospheric pressure. Liquefied natural gas takes up about one six hundredth the volume of natural gas in the gaseous state.

Impacts

- **Effects on energy consumption (fuel) and emissions**
  - Energy consumption (%)
  - GHG emissions (CO2, CH4)
  - Air pollutant emissions (NOx, PM)
  - Emission limits that could be achieved
- **Range of impact : Technical feasibility**
  - Technical applicability to fleet families (link to SWP 1.1)
  - Technical requirements for installation (e.g. required space, type/age and state of the engine etc.)
  - Possible combination with other technologies and achievable results
- **Range of impact: Economic feasibility for the ship owner**
  - Investment needed (e.g. ratio of investment related to the capital value of the vessel)
  - Impact on revenues (e.g. higher payload, more trips)
  - Share of savings on annual operational variable costs (%)
  - Risk of investment (sensitivities, uncertainties)
  - Payback period
- **Availability for mass implementation by 2020**
  - Technology status (TLR level)
  - Non-technological maturity, barriers and requirements: Legal, financial, knowledge, market, culture, others

Points of Attention

- Summary of main aspects for quick overview

Conclusions (1)

- LNG:
  - mainly for large vessels
  - savings in fuel costs => high investment costs (LNG tank and fuel system) earned back
  - limited number of vessels suitable for LNG
  - 100% LNG engine is risky (price LNG and Diesel)
  - dual fuel engine is more likely to be selected
  - => reduce costs by means of standardisation (dual fuel engine)
  - => validate in the pilot LNG

- SCR, DPF
  - cost-effective solution to reduce NOx and/or PM emissions for all vessels, and is attractive for environmentally
  - additional costs: urea, maintenance, no cost-benefit to ship owner!
  - cost reductions by means of standardisations and development of modular systems

Conclusions (2)

- Energy-efficient navigation
  - promising technology
  - great number of sailing hours and high fuel consumption
  - push boats and large motor vessels
  - changing waterway conditions (strongly influencing fuel consumption)
  - payback time: depend on the fuel consumption savings

- Hybrid drive trains and right sizing:
  - economics: specific journey, operating profile
  - niche solutions rather than large scale applications
  - little effect on air pollutant emissions

- GTL and replacement CCNR II engines
  - reduce emissions, but are
  - not stand-alone solutions to reach the PROMINENT targets
  - Cost-effective solution in terms of costs per kg + possible combination with other technologies => to be further investigated

Thank you for your attention!

Juha Schweighofer

E-mail: juha.schweighofer@viadonau.org
Tel: +43 50 4321 1624

viadonau
via donau – Österreichische Wasserstraßen-GmbH
Donau-City-Str. 1, 1220 Wien
Austria

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