Solutions to green the inland shipping industry: the H2020 EU project PROMINENT

Juha Schweighofer (viadonau)

Ministerul Transporturilor

This project is co-financed by the European Union.

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

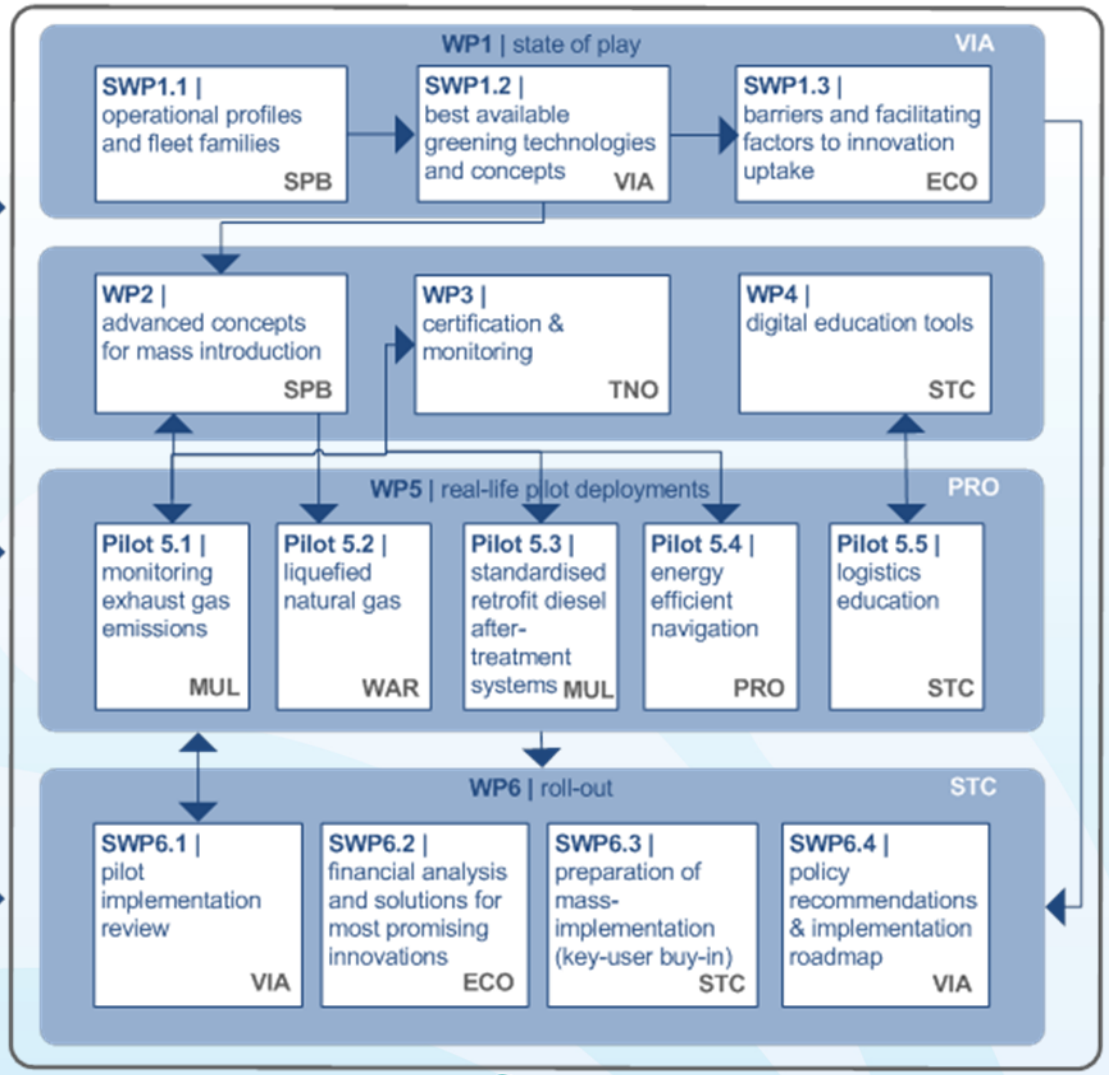
- Funded under the EU H2020 research and innovation program (budget: ca. 6.5 Mill EUR)

- 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/

- **Efficient and clean vessels**
- **Certification and monitoring of emission performance**
- **Harmonisation and modernisation of professional qualifications and integration of IWT into transport chains**
- **Cost effective solutions:**
  - **70 % of the fleet**
  - **30 % reduction of implementation costs**
- **Involvement of relevant stakeholders**
- **Removal of implementation barriers by 2020**


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***

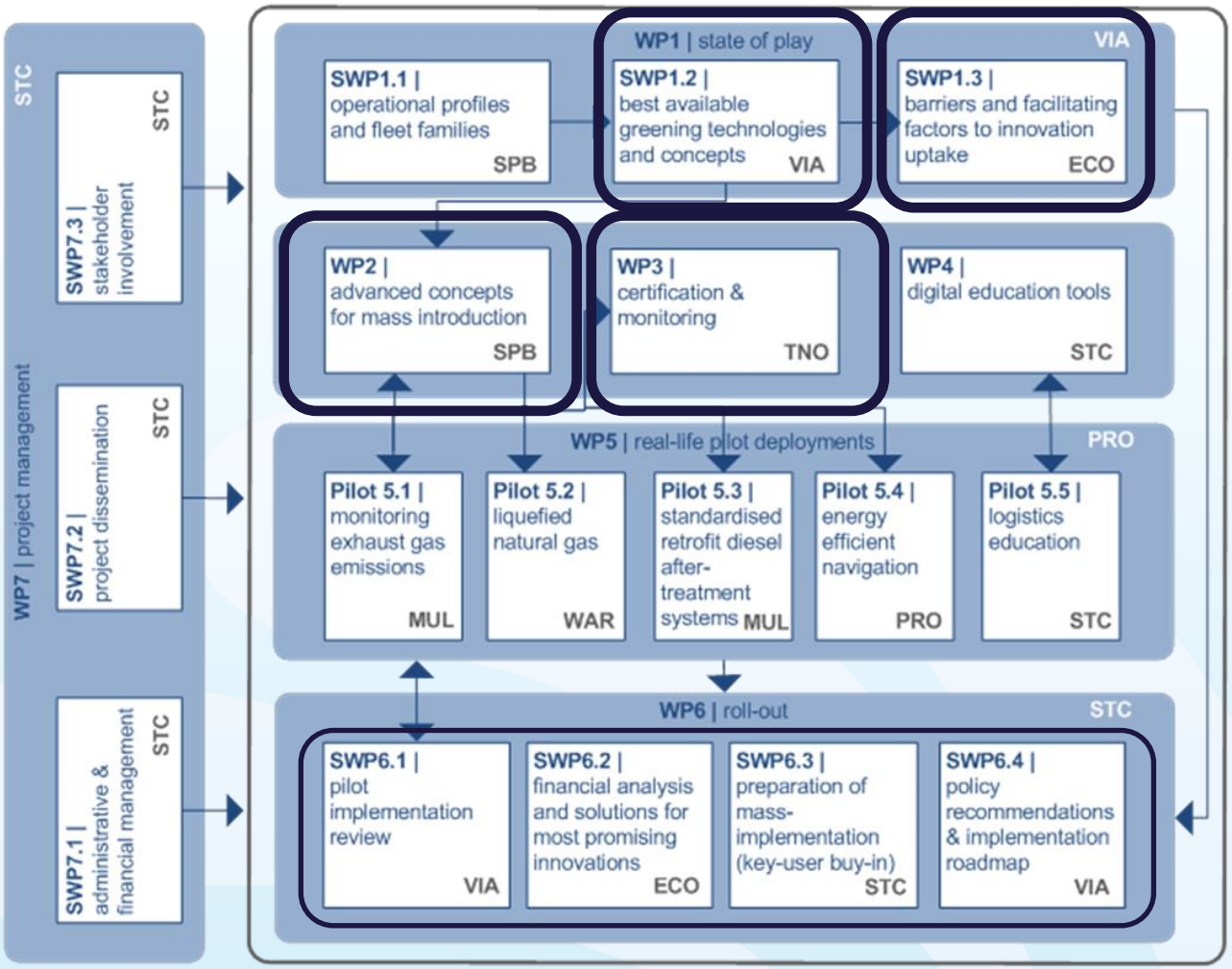
Introduction (3)

- Avoid duplication of work already done in other projects
- Utilisation of outcomes of existing projects

- Validation of outcomes
  - Stakeholder involvement
  - Interviews for additional project relevant information
  - Combination with expert meetings or events of other projects (e.g. PLATINA II)

- ***Support other WPs and choice of technologies***

Interrelations



The team of SWP 1.2

Responsible organisation	Principle author
VIA	Gudrun Maierbrugger Juha Schweighofer
SPB	Bas Kelderman
DST	Berthold Holtmann
TNO	Ruud Verbeek
PRO	Robert Rafael
ECO	Johan Gille Linette de Swart
STC-Nestra	Martin Quispel

Work carried out

- Method

- State of the art and promising technologies: greening technologies and concepts for inland vessels
  - Long list of promising technologies
  - Short list of promising technologies

- Best available greening technologies and concepts for the European inland fleet
  - Targets
  - Detailed assessment criteria
  - Main European fleet families and their requirements towards greening technologies and concepts
  - Description of the best available greening technologies and concepts

- Conclusions and recommendations

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

Targets regarding emission reduction

No	Emission limits In gram per kWh	Reference	Diesel / Emission control technologies assumed: (or PROMINENT target)
1	NOx < 1.8 PM: no INCREASE	NOx requirement of Latest proposal NRMM Stage V for IWP > 300 kW	Retrofit solution for SCR
2	NOx < 1.8 PM < 0.045	EPA Tier 4 marine diesel (for engine > 600 kW)	Target for LNG engines (dual-fuel)
3	NOx < 1.8 PM < 0.015 Particle Number limit: PN <$1x10^{12}$ per kWh	Latest proposal NRMM Stage V for IWP > 300 kW	Retrofit solution for SCR + DPF

Table 3 Proposed emission targets within PROMINENT

Add No. 3: Interinstitutional File: 2014/0268 (COD) of the Council of the EU, 14 April 2016

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

Main attention to be paid

- LNG
- SCR, DPF
- Energy-efficient navigation
- In addition:
  - Installation of new engines (assessment: measurements, simulations)
  - Hybrid and right sizing concepts (assessement: measurements, simulations)
  - GTL (monitoring of vessels)

Delivered

- D1.2 : List of best available greening technologies and concepts [VIA, M4]
  - Public report
  - Short list of best available technologies and concepts for greening the European fleet.
  - Characteristics and cost structures => input for further elaboration in WPs.

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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