Clean Shipping Project Platform
in conjuction with BSR electric

Proceedings of the Workshop

Electric Mobility on Waters
Contributions for Clean Shipping

June, 18 2019

Funded by the Interreg Baltic Sea Region Program

Contents

Preface **5**

Presentations of the Workshop **9**

CSHIPP - The Platform Project 11

Experiences of operations of Solar electric Ferries . . . 25

Projects on Electric waterbound Mobility and alternative Fuels 35

Storage technologies for Hydrogen for mobile Applications 47

Autonomous maritime Systems 57

Autonomous maritime Cargo Robots 67

Digital remoted Ships Inspection 75

Imprint 86

Preface

One of the objectives of the Clean Shipping Project Platform (CSHIPP) is the development of the state of the art and future needs in the field of clean shipping, in particular marine electrical propulsion (BSRelectric).

As part of this, a series of workshops for implementation in different locations were offered. Together with stakeholders and experts, relevant topics are presented and discussed in order to find approaches for economic use and future projects.

The size and the style of these workshops were determined so that presentations and discussions in a manageable group are possible, but also interested trade visitors can be involved.

In the planning were three topic blocks.

A: Alternative fuels, energy converters and drives

- Requirements and potential for electric ferry connections in northern Germany
- Hydrogen as a fuel alternative for inland and ferry shipping
- Campfire - A Hydrogen Initiative for the Maritime Economy
- Best practice examples in the EU area on hydrogen and electromobility

B: Electromobility, autonomous driving and "smart" technology

- Electromobility and "smart applications" in everyday life from the point of view of an energy consultant
- Autonomous maritime systems - opportunities, risks, perspectives
- Electric Drives Autonomous Maritime Cargo Robots

C: projects and implementation

- Presentation of the Project frames, the Motivation and backgrounds of the EU projects BSR electric and CSHIPP were
- Digital ship inspection for reliable ship operation

The topic of autonomous driving as well as autonomous maritime systems was included in the program due to current events.

Invitation and **Agenda** of the **Workshop**

Electric Mobiltity on Waters and Contributions for Clean Shipping

State of play – future needs – opportunities for projects and new business

Venue: Steigenberger **Hotel Sonne** | Neuer Markt 2 | 18055 Rostock

Tuesday, 18.June 2019, 13:00 .. 16:30

13:00	Hr. A. John, ATI Küste GmbH	Eröffnung, Ablauf, Ziele
	Hr. A. John, ATI Küste GmbH	CSHIPP & BSR electric – Interreg projects on electric mobility in urban areas and on waters and Clean Shipping Motivation, Hintergründe, aktuelle Entwicklungen
13:20	Prof. Rafoth, HS Wismar/ Warnemünde	Simulation von Schiffsmaschinenanlagen vor dem Hintergrund elektrischer Antriebe in der Schifffahrt
13:40	Hr. R. Garbe, Weiße Flotte GmbH	Praktische Erfahrungen im Betrieb von Solar-Elektrofähren im ÖPNV Berlin
14:00	Fr. L. Voss, HS Stralsund	Projekt ELMAR „Maritime Elektromobilität“ Stand und Ausblick sowie Ausblicke auf das Projekt Campfire
14:20	Dr. G. Buttkewitz, ATI Küste GmbH	Wasserstoffspeicher für mobile Anwendungen
14:40		Kaffeepause
15:00	Hr. T. Noack, DLR Neustrelitz	Autonome maritime Systeme – Chancen, Risiken, Perspektiven
15:20	Prof. G. Prause HS Wismar	Autonomous maritime Cargo Robots – Konzeptuelle Zugänge
15:40	Hr. R. Garbe, NautiTronix UG	Digitale Schiffsinspektion für den zuverlässigen Schiffsbetrieb
16:00	Hr. R. See, See Energieberatung	Elektromobilität und „Smarte Anwendungen“ im Alltag aus Sicht eines Energieberaters
16:20		Abschluss, Zusammenfassung Ende der Veranstaltung

Changes reserved.

Depending on the availability of speakers, stakeholders and participants etc. the following agenda has been proceeded. The workshop “Electric Mobiltity on Waters – Contributions for Clean Shipping” took place in Rostock at Steigenberger Hotel on June, 18th 2019.

The presentations given on the workshop are displayed in the following.

Presentations of the Workshop

CSHIPP - The Platform Project

Alexander John

ATI Küste GmbH
Gesellschaft für
Technologie und Innovation
Rostock

CSHIPP & BSR electric – Interreg projects on electric mobility in urban areas and on waters and Clean Shipping Motivation, Background and current Developments

CSHIPP

- BUSINESSES
- RESEARCH ORGANISATIONS
- POLICY MAKERS

Workshop

Rostock, 18. June 2019

CSHIPP
Clean Shipping Project Platform

Agenda

CSHIPP	BSR electric	Activities
Proposal for autonomous driving	Project approaches	Future cooperation

Three most significant interests

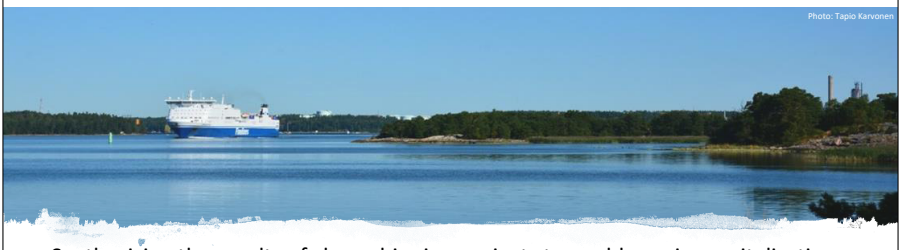
- Technology and societal change
  digitalization and informationalization
- Energy issues and Clean tech
  propulsion and drives, alternative fuels, waste processing
- Mobility: Clean / electric / smart / water bound
  reduction of environmental impact and pollutions

Incentives & motivations

- Learn new and from others, share know-how and knowledge
- Cooperate and develop transnational skills and networking
- Enhance the own and the companies' capacities
- Encourage SMEs to do it in their own way

Learn more truth – earn more joy – be more perfect *(ckg)*

CSHIPP – Platform project



- Synthesising the results of clean shipping projects to enable easier capitalization
- Increasing the uptake of scientific information into policymaking
- Enhancing co-operation of businesses and the maritime industry with research and academia

Key facts

Duration	October 2018 – September 2020
Funding source	INTERREG Baltic Sea Region Programme 2014-2020
Specific Priority	Clean Shipping
Total Budget	1,082,581.75 €
Partnership	13 partners, 8 countries, 13 associated organisations
including EUSBSR Policy Areas 'Ship', 'Safe' and 'Transport'.	
Lead Partner	University of Turku, Centre for Maritime Studies of Brahea
Centre Communication	Centrum Balticum Foundation

Project	Summary
EnviSuM	Addressing measurement and modelling strategies to assess present and future cost and the health and environmental effects of ship emissions in view of the IMO emission regulations that entered into force in January 2015.
BONUS SHEBA	Taking a holistic view on environmental effects of shipping through modeling current and scenario shipping emissions to air and water (including underwater noise), their dispersion and transformation as well as impacts on human health and marine and land ecosystems and the associated socioeconomic impacts.
ECOPRODIGI	Increasing eco-efficiency in the Baltic Sea region maritime sector by creating and piloting digital solutions in close cooperation between industry end-users and research organisations.
GoLNG	Focusing on increasing adoption of LNG as a clean fuel for ships in the Baltic Sea Region by creating collaboration in the LNG value chain and adding new users to the existing ones, supporting the development of new infrastructure and identifying potential investors and users for future LNG infrastructure.
BalticLines	Increasing transnational coherence of shipping routes and energy corridors in Maritime Spatial Plans (MSP) in the BSR as well as improving access to relevant transnational MSP datasets. This prevents cross-border mismatches and secures transnational connectivity as well as efficient use of Baltic Sea space.
BSR Electric	Fostering e-mobility solutions in urban areas in the BSR, focusing particularly on e-ferries and implementation in urban transport to reduce carbon dioxide emissions. Additionally, exploring unseized potentials and demonstrates applications of various types of urban e-mobility solutions.
Smartup Accelerator	Focusing on building consumer cleantech ecosystems, activating its innovation actors and improving their skills to identify ideas and foster teams committed to creating new businesses to reduce the environmental burden of consumption.

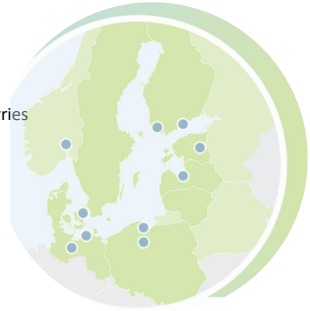
BSR electric – Fostering urban electric Mobility

BSR electric focuses on potentials of

- different e-mobility solutions
- for future city traffic and spatial development
- these include e-bikes, e-scooters, e-buses, e-logistics, and e-ferries

BSR electric is geared towards national and EU policies

- that focus on reducing emissions in the transport sector and
- phasing out traditional vehicles in urban areas by 2050.



BSR electric – Key facts

Duration	October 2017 – September 2020
Funding source	INTERREG Baltic Sea Region Programme 2014-2020
Specific Priority	3.5 - Environmentally friendly urban mobility
Total Budget	3,8 mio. EUR
Partnership	15 partners, 8 countries, 28 associated organizations,
Lead Partner	Hamburg University of Applied Sciences, Germany

BSR electric – Partners and use cases

Use cases

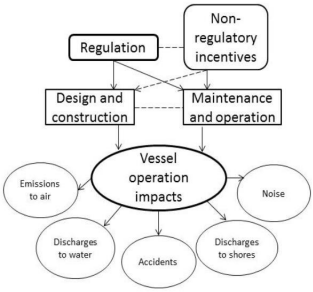
1. Urban logistics (Kobenhavn, Gothenburg)
2. E-Logistics (Turku)
3. E-Busses (Hamburg, Tartus)
4. E-Bikes for commuters (Gdansk)
5. E-Bikes for families (Helsinki)
6. E-Scooters (Riga)
7. Ferries (Rostock, Gdansk, Oslo)

What means clean shipping?

All measures leading to minimization of environmental impact caused by shipping. Impacts can be caused by

- sailing through waters itself – wave generation impacting the shore zone ..
- propulsion – Emissions by noise for aquatic/ marine fauna, chemicals Oil spills, gases SO_2, NO_x and the acids thereof H_2SO_3 etc. ..
- transport of cargo – cargo as a source of danger, oil spills ..
- ships operation – over board waste, chemicals (antifouling, cleaning agents, detergents, lubricants)
- ships traffic in water ways – dangers of collisions with mentioned impacts

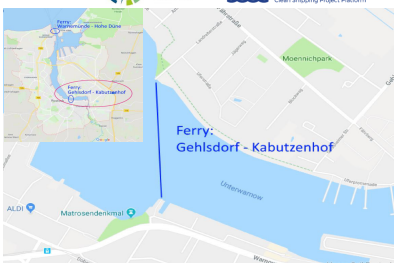
Electric propulsion can be meaningful for Clean Shipping



Use case: E-Ferries

Example Rostock City Ferry: Gehlsdorf – Kabutzenhof
Implementation / replacement by an electric boat.

Travel distance	ca. 500 m
Travel time	ca. 7-10 Minutes
Frequency	ca. 30 per day.



Ferry "Gehlsdorf", Rostock, John

Fährbär (Berlin), Weiße Flotte

Technical issues – (electric – hybrid – Diesel – Hydrogen ..)

- Dealing with questions of suitable implementations
- Finding Approaches to Business Opportunities

Hybrid Ferry "Berlin" of Scandlines. Photo: John

Categories

1. Ferries in urban spaces (rivers, lakes, sheltered waters..)
2. Medium sized, for cars/trucks/passengers
3. Ferries in ocean like waters (across the baltic sea)

Cat.	Power*	Travel Dist.*	Travel time*	Travel freq.*	Energy-Syst.
1	100 kW	0,5 km	10 Minutes	40/Day	FE
2	1.000 kW	5 km	20 Minutes	35/Day	FE / Hybrid
3	10.000 kW	50 km	2 Hours	10/Day	Hybrid
**all data are approximations*					*FE = Fully electric*

Socioeconomic issues

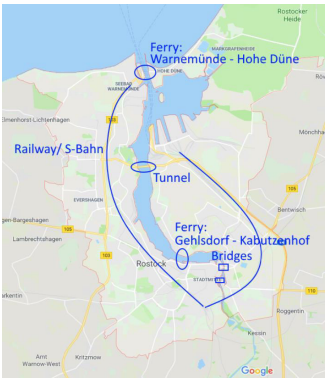
Concurrent traffic with ferries

- Railroad (S-Bahn)
- Tram & Buses
- Tunnel

Concurrent plans ..

- Pedestrian bridge competes with ferry

Questions. Where and under which circumstances ferry links are meaningful and economic?



Autonomous driving

… with the Hanseatic City of Stralsund.

- Smart xyz
- Mobility strategy
- Regaining urban space and areas
- Clean and silent traffic in the city
- Pilot project and possible role model for other cities towards future mobility solutions.

→Discussions between ATI-Küste GmbH and the Department of Transportation and urban Green of Stralsund on issues of smart city and diverse research led to the decision of an undertaking focusing on Autonomous driving. This led to a participation in the “OLLI Fleet Challenge” of Local Motors.

Hansestadt Stralsund

Hansestadt Stralsund

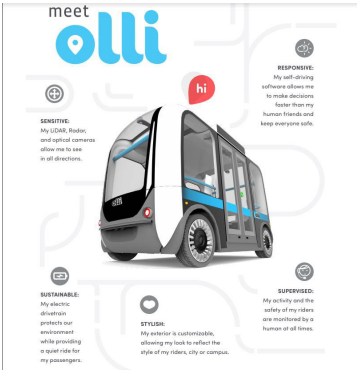
Why Stralsund?

- Nice and worth to see City and surrounding
- Part of the World heritage
- Tourist Magnet
- Center of regional Economy and ecucation
- A running project – BSR electric – made it possible

Photo: Stralsund, OLLI, Collage

Hansestadt Stralsund

Who / what is OLLI?



local motors

RANGE	
Average Range	60km/40mi (Nominal) 40km/25mi (Max Load, Max AC)
CAPACITY	
Max Passengers	Up to 12*
	*Capacity varies based on regulatory restrictions and seating layout.
MOTOR	
Max Torque	240Nm
Continuous Torque	120Nm
Max Power	100kW
Continuous Power	30kW
Max Speed	40km/h (25mph)
Type	Brushless Synchronous AC
POWER SYSTEM	
Max Capacity (kWh)	18.5 Max (16.2 Usable)
Charger Type	6.6kw Max
Charge Time (230V A/C single-phase)	Approx. 4 Hours
DRIVETRAIN	
Transmission	9.59:1 Gear Ratio
CHASSIS / SUSPENSION / BRAKES	
Chassis	Aluminum
Front Suspension	Macpherson
Rear Suspension	Macpherson
Front Brakes	Disc
Rear Brakes	Disc
Front Tire	215/50/R17
Rear Tire	215/50/R17
Emergency Brake	Yes

SENSORS	
LiDAR	2 Std Def, 1 HD
Radar	2F+2R SRR, 1FWD ESR
Internal Measurement Unit	Yes
Optical Camera	Optional
Bumper Switch	Front, Rear
GPS	2 GPS Antennas
COMMUNICATION / DATA	
GSM/LTE Modem	
On Board Data Recorder	
HVAC CONTROLLER	
Heating/Air Conditioning Standard	
DIMENSIONS	
Length	3920mm (12.86ft)
Width	2050mm (6.73ft)
Height	2500mm (8.20ft)
Wheelbase	2526mm (8.29ft)
Passenger Room Height	1950mm (6.40ft)
WEIGHT	
Curb Weight	1860kg (4100lbs)
Carrying Capacity	540kg (1200lbs)

Hansestadt Stralsund

Place & Route

Possible routes have been discussed:

- A shuttle transfer from/to OZEANEUM and a park&ride space
- Diverse round trips through the Old Town, City and Harbour
- A simple one was chosen

Chosen route for the pilot:

https://www.google.de/maps/dir/54.3026449,13.1006211/Ozeaneum,+Hafenstra%C3%9Fe,+Stralsund/@54.3024671,13.0996861,644m/data=!3m1!1e3!4m19!4m18!1m10!3m4!1m2!1d13.1021907!2d54.3014126!3s0x47ab63a366a0ab7d:0x82a762e945ba3a24!3m4!1m2!1d13.1060669!2d54.305488!3s0x47ab63bcf5f39a87:0x7f08e7efa1a246a0!1m5!1m1!1s0x47ab63c831d2c3fb:0x7b3921dbc2ab1cf6!2m2!1d13.0971878!2d54.3156346!3e1

Future projects – Cooperation – Themes

Clean

Alternative fuels (Hydrogen – FC – Converters – Storages)

Exhaust – Waste – Recyle – Reuse

Smart

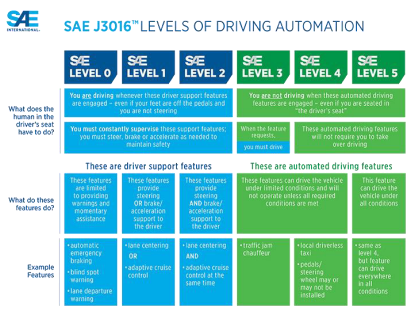
Digital – Connected– Controlled – Surveilled – Autonomous

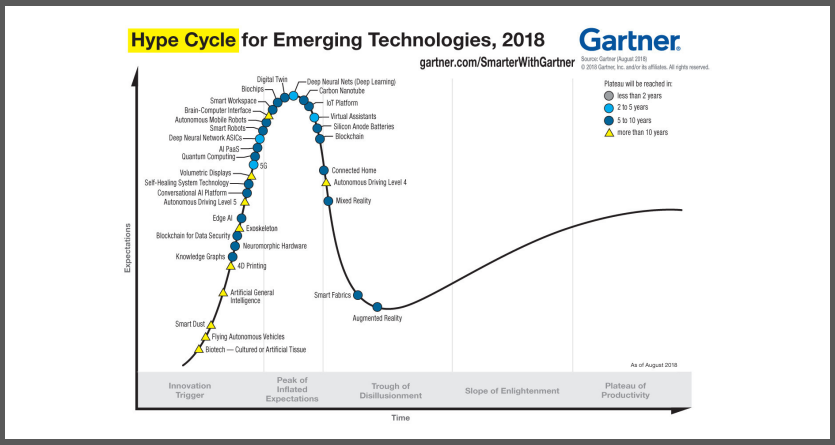
Individualized – Shared – Fast

Future projects – Cooperation

Autonomous …
traffic on waters and land bound

- Use case scenarios
- Pilots & experience exchange
- Implementation & support
- Development of business opportunities and models
- Scientific accompaniment



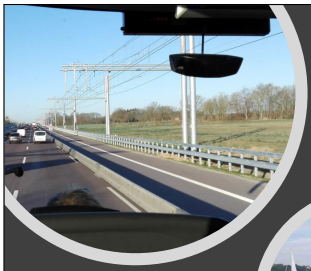


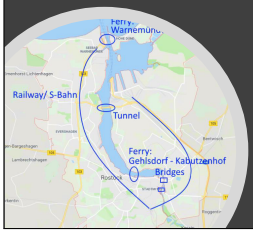
Ideas – Approaches – Business potential

- Engines – equipment, materials, services
- Propulsion – electric & hybrid,
- Layout and setup – engine appliances & equipment optimization,
- Energy storage – battery, super capacitors,
- Alternative fuels – H_2, HCOOH, fuel cells, reformers, fuel design, fuel treatment
- Light weight – construction and materials and manufacturing technologies

Ideas – Approaches – Business potential

- Interconnected – manufacturing, operations, society
- Equipment – fine mechanics, sensors, analytics, instrumentation
- Waste to energy – waste to product, chemicals, materials, bio- / syn-gas, cycles systems, Exhaust gas cleaning
- Port reception facilities – recycling, reuse, repair industry busimess models





The End

Thank you for your attention

Alexander John
ATI Küste GmbH Rostock
John@ati-kueste.de

Experiences of operations of Solar electric Ferries

Robert Garbe

Weiße Flotte GmbH

Experiences made and Best Practice in daily operations of Solar-Electric Ferries in Public Transport in Berlin

Weiße Flotte

Innovation leader in the area of solar-powered vessels

Solar-powered vessels

emission-free • innovativ • economical
E - ferry
made in Mecklenburg-Vorpommern

✓emission-free ✓silent ✓economical

Weiße Flotte

Solar-powered vessels
- Berlin

emission-free • innovativ • economical
E - ferry
made in Mecklenburg-Vorpommern

- Established in 2014
- Operating **4 different innovative solar-powered ferries** and a rowing boat ferry
- 2 year-round routes plus 2 seasonal lines on the river Spree and around the lakes of Berlin
- Passenger volume: approx. 400.000 per year
- Shuttle traffic up to **15 hours service per day**


Solar-powered ferry

Weiße Flotte

Solar-powered vessels
- Berlin

emission-free • innovativ • economical
E - ferry
made in Mecklenburg-Vorpommern

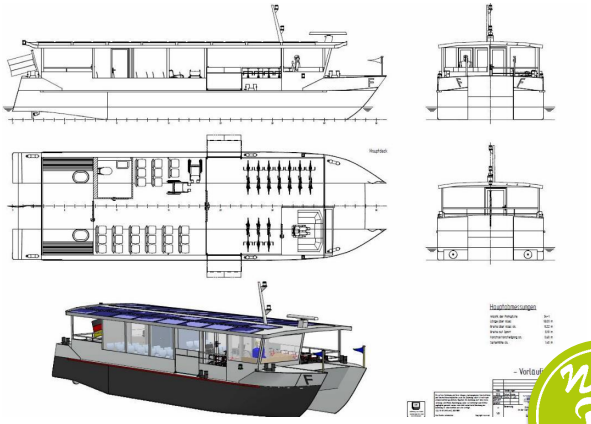
- Length over all 18,5 m
- Moulded breadth 5,22 m
- Moulded depth 3,46 m (excluding mast)
- Maximum draft 0,60 m
- Weight 20,0 t
- Top Speed 12 km/h
- Seats 35 - 49, 2 wheelchairs, 10 bikes
- Solar system 60 m² with 10,6 kw
- External power in 365 days and ~14 h service per day: 22 T kw/h = ***approx. 0,83 € per hour***

Made in Stralsund

Weiße Flotte

Solar-powered vessels
- Berlin

emission-free • innovativ • economical
E - ferry
made in Mecklenburg-Vorpommern



Weiße Flotte

Solar-powered vessels
- Wolfsburg

emission-free • innovativ • economical
E - ferry
made in Mecklenburg-Vorpommern

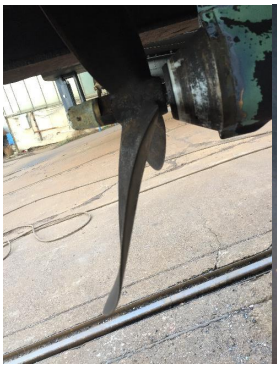
- Length over all 18,5 m
- Moulded breadth 5,22 m
- Moulded depth 3,46 m (excluding mast)
- Maximum draft 0,6 m
- Weight 18,0 t
- Top Speed 15 km/h
- Seats 60, two wheelchairs
- Solar system 66 m² with 10,6 kw

Made in Stralsund

Weiße Flotte

Solar-powered vessels
- Known issues: propeller

emission-free • innovativ • economical
E - ferry
made in Mecklenburg-Vorpommern



Weiße Flotte

Solar-powered vessels
- Known issues: battery charger

emission-free • innovativ • economical
E - ferry
made in Mecklenburg-Vorpommern

Weiße Flotte

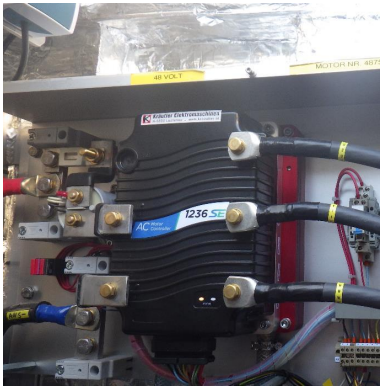
Solar-powered vessels
- Known issues: winch

emission-free • innovativ • economical
E - ferry
made in Mecklenburg-Vorpommern

Weiße Flotte

Solar-powered vessels
- Known issues: high current screw connections

emission-free • innovativ • economical
E - ferry
made in Mecklenburg-Vorpommern



Weiße Flotte

Solar-powered vessels
- Advantages: magnets

emission-free • innovativ • economical
E - ferry
made in Mecklenburg-Vorpommern

Weiße Flotte

Solar-powered vessels
- Advantages: corrosion-free

emission-free • innovativ • economical
E - ferry
made in Mecklenburg-Vorpommern

Weiße Flotte

Solar-powered vessels
- Advantages: reliability

emission-free • innovativ • economical
E - ferry
made in Mecklenburg-Vorpommern

Weiße Flotte

Solar-powered vessels
- Advantages: weight

emission-free • innovativ • economical
E - ferry
made in Mecklenburg-Vorpommern

Weiße Flotte

Thank you for your attention!

Weiße Flotte

Projects on Electric waterbound Mobility and alternative Fuels

Liane Voss

University of Applied Sciences Stralsund

HOST
Hochschule Stralsund
University of Applied Sciences

Project ELMAR „Maritime Electric Mobility“ State and future Work; Outlook on the Project "Campfire"

ELMAR –
Supporting South Baltic SMEs to enter the international supply chains & sales markets for boats & ships with electric propulsions

Liane Voss
Stralsund University of Applied Science
Institute for Renewable Energy Systems

About the ELMAR Project

About the ELMAR Project

Stralsund University of Applied Science • Zur Schwedenschanze 15 • 18435 Stralsund (Germany) 2019-06-18

Project - Partners

Project - Partners

Germany:
- Economic Development Corporation Vorpommern
- University of Stralsund

Poland:
- Polish Sailing Cluster
- Yacht Technology Association
- Gdańsk University of Technology
- The Electrotechnical Institute / Gdansk Branch
- Motus Foundation

Lithuania:
- Klaipėda University
- Traditional and Historical Ships Association
- Zalieji Laivai / Green Boats

Associated partners

Associated partners

- Marina Association Baltic Sea (DE)
- Maza M-V – association of maritime suppliers (DE)
- ATI Küste GmbH – technology & innovation corporation (DE)
- IHK Neubrandenburg / chamber of commerce (DE)

- West Pomeranian University of Technology in Szczecin (PL)
- North South Logistics and Transport Cluster (PL)
- Polish Maritime Cluster (PL)

- Swedish Maritime Technology Forum (SE)
- Maritime Development Center (DN)

Overall goal

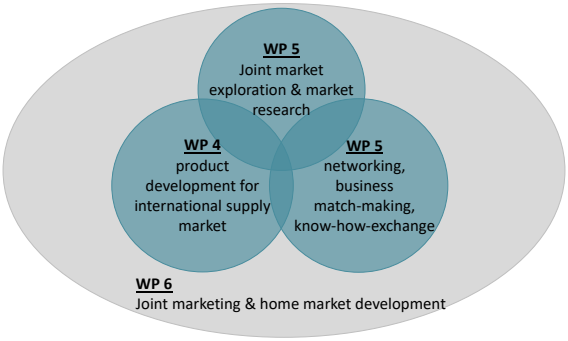
Overall goal:

To support the boat & shipbuilding sector in the SB area to adapt to marine e-mobility by…

- promoting marine e-mobility products (e-boats/-ships, related products & services) on international markets
- demonstrating the innovation potential of e-boats & e-ships from the SBA towards potential buyers & municipal decisionmakers/infrastructure providers
- Developing the SBA as home-market for low-emission boating, catching up international market trends
- Building up & strengthening the cross-border supply chains both within the SBA and to essential suppliers outside

Work packages

Work packages



Communication & Dissemination

WP 2: Communication & Dissemination

WFG will mit ELMAR ein neues Netzwerk in der maritimen Wirtschaft aufbauen

Vorpommern setzt
auf **maritime Elektromobilität**

WP 3

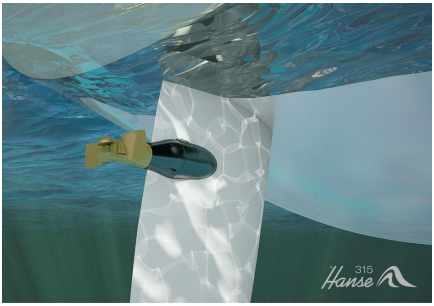
WP 3: Joint Exploration of the International Marine Electric Mobility Sales Markets

Study Tours for Companies:

- Focus electric ships & ferries: Norway (September 2018)
- Focus marine electric mobility region: South Germany-Austria-Switzerland (10th until 12th September 2019)
- Focus electric boats & small pax vessels: e.g. Sweden (planned 2020)

WP 4

WP 4: Product Development for the International Supplier Market



WP 4

WP 4: Product Development for the International Supplier Market

Open source" demo boats & facilities – Construction:

- small pax vessel / retrofit in Lithuania
- wooden boat / replica in Lithuania
- charter sailing boat in Poland
- 1 demo facility of a floating e-boat service station in Lithuania

Work-in-progress workshops on demo boats

Video documentation about construction process

small pax vessel/ retrofit by Green Boats (Lithuania)
above: design planning below: implementation

Stralsund University of Applied Science • Zur Schwedenschanze 15 • 18435 Stralsund (Germany) 2019-06-18

WP 5

WP 5: Product Development for the International Supplier Market

electric & hybrid marine WORLD EXPO 2019

WP 5

WP 5: Product Development for the International Supplier Market

Mapping of international supplier markets:
- SBA suppliers
- Suppliers outside SBA

Examination of gaps & business oppurtunities in the international supply chain

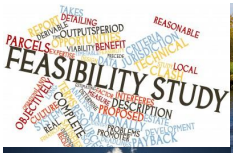
Examination of need for supply chain extension for the future technology

Trainings Seminars
- Technological & practical aspects
- Legislation, standards, funding, business model devlopment

Stralsund University of Applied Science • Zur Schwedenschanze 15 • 18435 Stralsund (Germany) 2019-06-18

WP 6

WP 6: Sales promotion / marketing / development of the domestic market



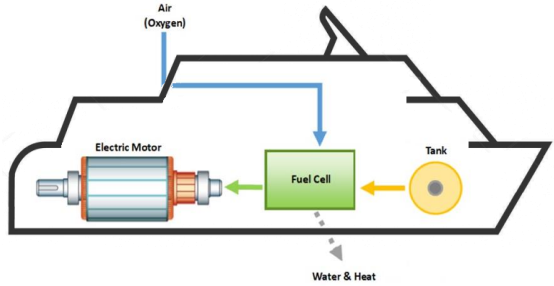
Feasibility studies

Market research for…
- Poland
- Lithuania
- Mecklenburg-Vorpommern

Dialogue forums

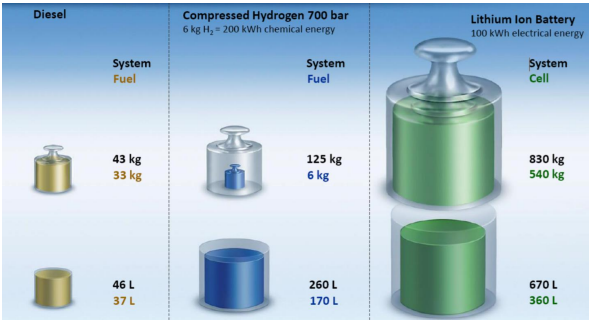
Hydrogen for maritime propulsion

Hydrogen for maritime propulsion



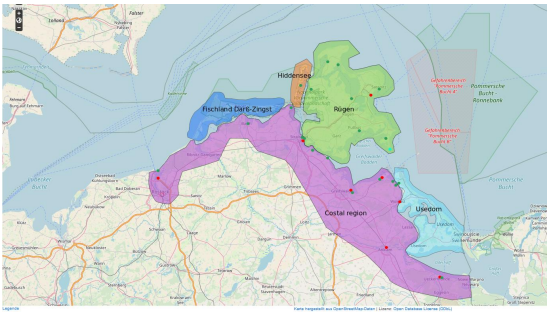
Why Hydrogen?

Why Hydrogen?



Coastal Area

The Coastal Area in Detail



divided into five areas:

- Coast region
- Fischland Darß-Zingst
- Hiddensee (Island)
- Rügen (Island)
- Usedom (Island)

Three catergories:

- industrial harbors (red) - 8
- base harbors with a petrol or diesel filling station (green) – 29 (not all shown)
- stage ports – 69 (not shown)

Previous Results

Previous Results

- All ports or harbours have a normal electrical connection
- Some of this ports have a fast charger station (3)
- In some port in coastals areas have we the problem with the water depth (min. 1.0 m)

The next steps…

- Analyse the distance for elctrical boats (from port to port)
- Investigation the boats weigth and the water depth
- Examine of the charging infrastructure of the inland water area (Lake Müritz and Feldberger Seenlandschaft…)

Lake Schmaler Luzin *

* https://www.geo.de/reisen/reise-inspiration/19372-bstr-die-zehn-schoensten-schnorchelspots-europa/254103-img-schmaler-luiz-deutschland

Study Tour

Study Tour - from 10th until 12th September 2019

Austria	Germany	Switzerland
10th September 2019	11th September 2019	12th September 2019
• Boats Yard Frauscher • Marian Boats (Lake Wolfgang) • Boats Yard Heistracher (Chiemsee – Fraueninsel)	• Torqeedo • Marina in Bernried on Lake Starnberg • Hanke & Dorsch	• Kräutler Elektromotoren GmbH • Designboats Schweiz AG • University Konstanz • Bodensee-Schiffsbetriebe Konstanz

26th REGWA Energy Symposium

26th REGWA Energy Symposium of the Stralsund University of Applied Science

Use of regenerative energy sources and hydrogen technology (REGWA)

When: 6th until 09th November 2019

Where: Stralsund University of Applied Science

more Information:
regwa.hochschule-stralsund.de

Thank you for your attention!

Liane Voss
Stralsund University of Applied Science
Institute of **R**enewable **E**nergy**S**ystems – **IRES**
Zur Schwedenschanze 15
D-18435 Stralsund

E-Mail: Liane.Voss@hochschule-stralsund.de

Stralsund University of Applied Science • Zur Schwedenschanze 15 • 18435 Stralsund (Germany) 2019-06-18

Storage technologies for Hydrogen for mobile Applications

Dr. Gerhard Buttkewitz

ATI Küste GmbH
Gesellschaft für
Technologie und Innovation
Rostock

Storage technologies for Hydrogen for mobile Applications - Comparisons and Considerations

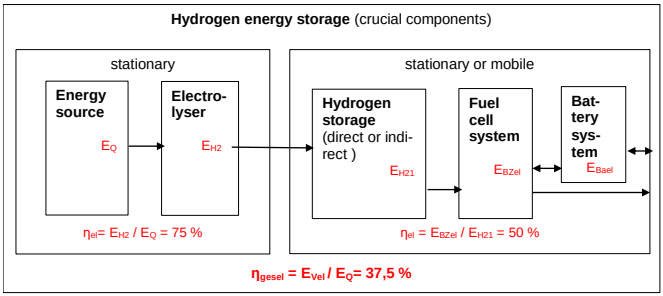
Storage of electrical energy for mobile applications with hydrogen

Dr. Gerhard Buttkewitz

Crucial criteria of evaluation of storage systems for electric energy for mobile Applications

- Properties of use
  - Time of charge
  - Range of operation → volumetric and gravimetric energy density
- Safety of operation
- Systems reliability
- Environmental footprint of manufacturing
- Consumption of resources of manufacturing
- Energy efficiency

Schematic Diagram of a Hydrogen Energy storage system



High temperature electrolysis (800 -1.000 °C) → $\eta_{el} = E_{H2} / E_Q > 85\ \%$

Example 1

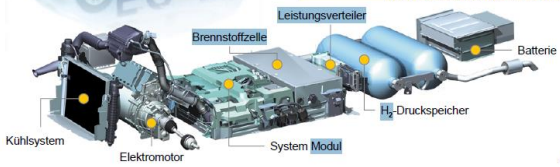
Hydrogen storage	Fuel cell system	Battery system	
Pressure tank 700 bar ca. 1,1 kWhH2/kg 4 kg H_2 for ca. 500 km range Weight ca. 120 kg	ca. 100 kW Efficiency ca. 50 % ca. 50 kg	ca. 5 kWh ca. 30 kg	Drive + Onboard energy supply

Cruicial parameters

- **Overall Energy desnsity: ca. 0,3 kWh/kg**
- **Charging: analogue to refuelling of to natural gas < 5 Minuten**

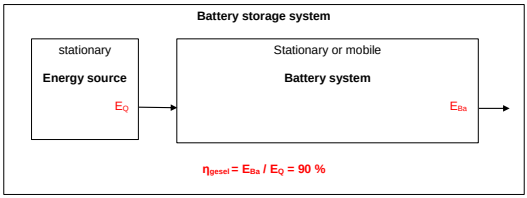
Example 2

Fahrzeugtyp	Mercedes-Benz A-Klasse
Brennstoffzelle	PEM - 72 kW (97 PS)
Antrieb	Elektromotor Leistung (Dauer- / Spitzenleistung): 45 kW / 65 kW (87PS) Max. torque: 210 Nm (156 ft.-lb.)
Kraftstoff	Wasserstoff (350 bar)
Range	150 - 180 km (NEFZ)
Max Geschwindigkeit	140 km/h
Batterie	NiMh, luftgekühlt, Leistung (Dauer- / Spitzenleistung): 15 kW / 20 kW; Kapazität: 6 Ah, 1.2 kWh



Quelle: Daimler

Principle Depiction of a Battery storage system



Energy storage densities

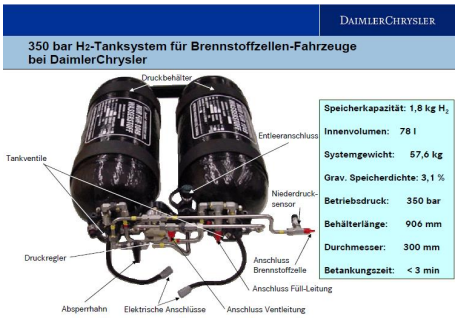
Gravimetric electric energy density kWhel / kg overall mass	**ca. 0,2**
Volumetric electric energy density kWhel / Liter	**ca. 0,4**

Beispiel

Quelle: Elektroauto Plattform MEB © Fotoquelle und Bildrechte: Volkswagen AG

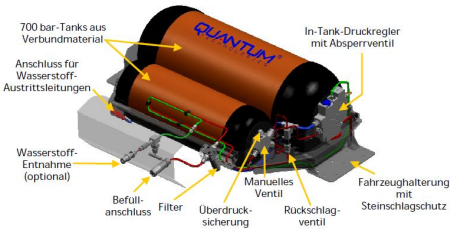
Pressure tank storage

Example 1



Example 2

700 bar CFK-Pressure tank

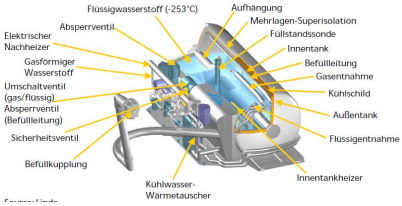


Energiedichten bei 700 bar mit CFK-Druckbehälter

Gravimetric electric energy density at η_{BZel} = 50 % kWhel / kg overall mass (H_2+CFK-Druckbehälter)	**ca. 0,9**
Volumetric electric energy density at η_{BZel} = 50 %kWhel / Liter	**ca. 0,7**

Liquified gas storage

Example



Quelle: Linde

Energy densities

Gravimetric electric energy density at η_{BZel} = 50 % kWhel/kg overall mass	**ca. 0,7**
Volumetric electric energy density at η_{BZel} = 50 %kWhel / Liter	**ca. 0,6**

Metal hydride storage

- Metal + Hydrogen → Metal hydride + heat
- Charging time: 15 to 20 minutes
- Pressure: > 10 bar

Example

Quelle: Daimler

Energy densities of NT-Metallhydrides

Gravimetric electric Energy density at η_{BZel} = 50 % kWhel / kg overall mass	**ca. 0,25**
Volumetric electric Energy density at η_{BZel} = 50 % kWhel / Liter	**ca. 0,4**

Storage of Hydrogen by means of Adsorption

- MOF's (Metal Organic Framework) Metal-organic Frameworks are well strucured porous chrystalline materials.
- Zeolithe are Alumosilicate with definined porous structures of very large inner surface.

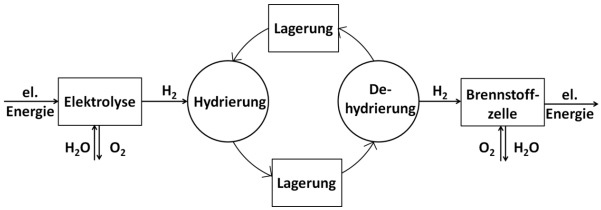
Both materials did not come to application yet.

- A special configuration of MnH_2 (Kubas Mangan Hydride-1 – University of Lancaster) is promising (at an pressure of adsorption of 120 bar).

Density of Storage with MnH_2

Gravimetric storage density g H_2 / kg overall mass	105
Gravimetric energy density kWhH_2 / kg overall mass	3,5
Gravimetric electric energy density at η_{BZel} = 50 % kWhel / kg overall mass	**1,8**
Volumetric storage density g H_2 / Liter	197
Volumetric energy density at kWhH_2 / Liter	6,6
Volumetric electric energy density at η_{BZel} = 50 % kWhel / Liter	**3,3**

Chemical Hydrogen storage



Especially interesting for mobile applications are LOHC (Liquid Organic Hydrogen Carrier) und Methanol.

- **LOHC**
  - Temperatures ca. 200 °C for Hydration and Dehydration necassary.
  - Pressures of 30 bis 50 bar for Hydration necassary.

Energiedichten

Gravimetric electric energy density at η_{BZel} = 50 % kWhel/kg overall mass	**ca. 0,9**
Volumetric electric energy density at η_{BZel} = 50 %kWhel / Liter	**ca. 0,9**

Methanol

- Temperatures ca. 100 to 150 °C for Hydration and Dehydration necessary.
- Pressures of ca. 30 bar for Hydration necessary.
- CO-issue

Energy densities

Gravimetric electric Energy density at η_{BZel} = 50 % kWhel / kg overall mass	**ca. 1,2**
volumetric electric Energy density at η_{BZel} = 50 % kWhel / Liter	**ca. 1,4**

Comparison – Efficiency vs. Energy densitiy

Nr.	Storage system	Electric overall Efficiency η_{gesel} / %	Gravimetric elektric Energy density at η_{BZel} = 50 % e_{gel} / kWhel/kg	Volumetric elektric Energy density at η_{BZel} = 50 % e_{gel} / kWhel/L	Remarks
	direct Hydrogen storage				
1	**Pressured gas storage 700 bar**	33	0,9	0,7	State oft he art
2	**Adsorption MnH_2 120 bar**	37	1,8	3,3	Under development
	indirect Hydrogen storage				
3	LOHC	27	0,9	0,9	– Under development – Temperatures ca. 200 °C for Hydration and Dehydrattion necessary. – Pressures of 30 bar for Hydration necessary.
4	**$CH_3OH + H_2O$**	25	1,2	1,4	– Under development – Temperatures ca. 100 bis 200 °C for Hydration and Dehydrattion necessary. – Pressures of ca. 30 bar for Hydration necessary. – CO-issue
	Battery systems – State oft he art				
5	**Li-Ion**	90	0,2	0,4	State oft he art
	Theoretical potential of battery systems				
6	**Li-S**	90	2,6	2,8	Basic research
7	**Al-Ion**	90	1	1	Basic research
8	**Li-Air**	90	11,4	6	Basic research

All values are approximate.

Evaluation of relevant Storage systems for electric Mobility

Lfd. Nr.	Storage system	essential characteristics of use		Energiy efficiency (over all stages)	Additional parameters	
		Energy density / Range	Charging time		positive	negative
1	**H_2-Pressure tank systems 700 bar**	+	++	+	**No CO**	– **Acceptance** – **Low reliability of the system**
2	**H_2-Adsorption MnH_2 120 bar**	+++	++	+	– **No CO** – **Acceptance higher than 1** – **Reliability of the system higher than 1**	
3	**$CH_3OH + H_2O$**	++	++	–	**Experience of handling**	– **traces of CO** – **toxic**
4	**LOHC**	++	++	–	**No CO**	– **toxic** – **fossile base of LOHC**
5	**Li-Ione-Accumulators**	–	–	+++	**High reliability oft he system**	– **environmental impact of production** – **consumption of resources**

Thank you !

Autonomous maritime Systems

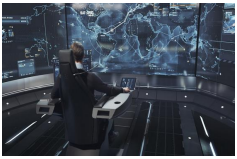
Thoralf Noack

Deutsches Zentrum für
Luft- und Raumfahrt e. V.
Neustrelitz
Institute for Communication
and Navigation

DLR Deutsches Zentrum für Luft- und Raumfahrt

Autonomous maritime Systems – Chances, Risiks, Perspectives

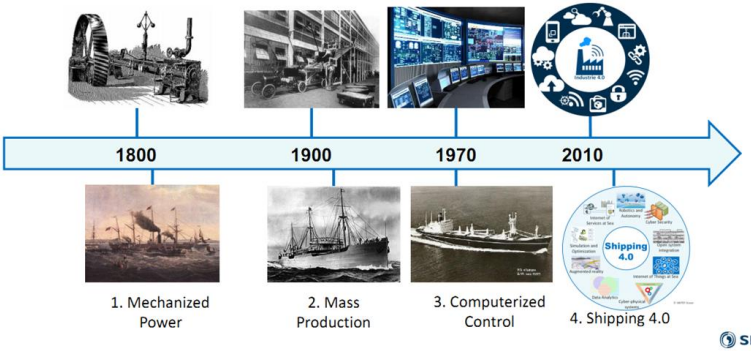
Autonome maritime Systeme
Chancen, Risiken & Perspektiven



Thoralf Noack et.al.

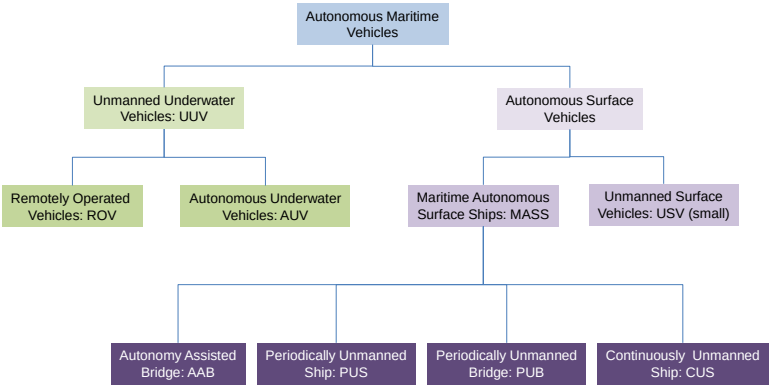
DGON – Deutsche Gesellschaft für Ortung und Navigation e.V.
Fachgremium Schifffahrtskommission
Arbeitsgruppe Autonome Maritime Systeme

The four technical revolutions



Source: L Ørnulf Jan Rødseth, SINTEF Ocean/NFAS/INAS

Classification of Autonomous Maritime Systems



Source: NFAS

Definitions: Automated vs. Autonomous

- If data or information is transferred to a system with the aim of completing a specific task without the intervention of an operator, but the possibility of continuous intervention is still given, then it is an **automated** system.
- If, on the other hand, the system recognizes and decides *independently* when and how a special task must be completed and the intervention of an operator is no longer necessary or even excluded, then we speak of an **autonomously** acting system.

IMO MSC - 4 Degrees of Ship Automation for MASS

Degree one: Ship with *automated processes and decision support*: *Seafarers are on board* to operate and control shipboard systems and functions. Some operations may be automated and at times be unsupervised but with seafarers on board ready to take control.

Degree two: *Remotely controlled ship with seafarers on board*: The ship is controlled and operated from another location. Seafarers are available on board to take control and to operate the shipboard systems and functions.

Degree three: *Remotely controlled ship without seafarers on board*: The ship is controlled and operated from another location. There are no seafarers on board.

Degree four: *Fully autonomous ship*: The operating system of the *ship is able to make decisions and determine actions by itself*.

Source: IMO MSC: 100th session held on December 3-7, 2018.

Opportunities and Open Issues

- Autonomous shipping is *technically feasible* and has *significant potential*
- Autonomous systems *should assist the crew* in safe and efficient operations
- Technology should help to *automate ship operations* and *routine works on board and in ports*
- *Prerequisites and conditions must be defined*, under which ships can operate autonomously
- The implementation of a *revised regulatory framework is the key*
- The new technology must *seek acceptance by the crew* and must get reflected by *new work profiles for officers and crew*

Source: Lennart Swoboda, Bernhard Schulte GmbH & Co. KG

Current Developments (Snapshots)

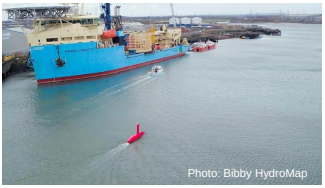
L3 ASV C-Worker Autonomous vessel (USA/UK)

- Type: Autonomous multi-purpose vessel for offshore and coastal tasks
- Specific task: hydrographic survey for the production of maps off the coast of Alaska
- Features: proprietary software and control systems

SEA-KIT Unmanned Surface Vessel (UK)

- Type: USV as part of the „Maritime Autonomy Regulation Lab“
- Task: salvage of autonomous underwater vehicles
- Note: Finalist des Shell Ocean Discovery X-Prize Competition

Current Developments (Snapshots)



Autonomous measurement platform DriX (iXblue / France)

- Type: 8-m Autonomous Unmanned Survey Vessel (AUSV)
- Task: Off-shore and Coastal Exploration
- Features: different operating modes like remote controlled, semi-autonomous and fully autonomous

The Sailbuoy – first unmanned sailboat (Norway)

- Type: Autonomous Sailboat
- Task: to cover the route from Newfoundland to Ireland without any human intervention in 80 days
- Features: Internal autopilot battery pack lasts around six months without recharging (batteries are recharged via solar modules)

Current Developments (Snapshot)

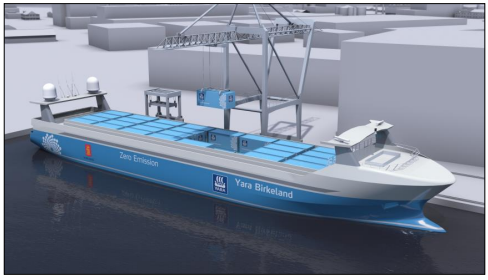
Unmanned platform MESSIN (DE)

- Type: Unmanned Research Catamaran
- Tasks: Case studies for automated navigation and optimized maneuvering of connected and cooperative operated vessels in harbor areas
- Note: Part of the German Galileo Nautic2 project to test an assisted ferry crossing from Rostock to Gedser

Oceanalpha Unmanned Surface Vessels (China)

- Type: small size autonomous vessel
- Tasks: bathymetric survey in shallow water and inland-waterways
- Note: shall help by the project „Clouddrift“ to develop autonomous merchant vessels

The YARA Birkeland Project



Source: ©Kongsberg

- first worldwide project of combining Electro Mobility and Autonomous Driving within a full operable container ship
- ship shall be ready for operation in 2020 (at first in manned operation)
- From 2022 it is planned to operate the vessel in complete autonomous and unmanned manner.

Challenges (Risks)

Cyber Security
- Resilience of systems
- Authentication
- Interference mitigation (Jamming/Spoofing)

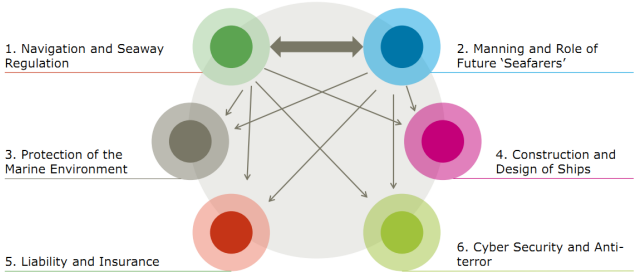
Reliability of data
- Single sensors vs. multiple sensors
- Backup functionalities and systems
- Integrity functionalities for data and information

Verification and Standardization
- Definition of test scenarios
- Generation of Benchmarks und dedicated metrics
- Deployment of simulation facilities and test-fields
- Standardization of data and systems

Regulatory and Legal Issues

OVERVIEW OF LEGAL AND REGULATORY ISSUES

THERE ARE ISSUES ACROSS THE REGULATORY AND LEGAL FRAMEWORK THAT REQUIRE CONSIDERATION



CORE

Bjarke Holm Hansen, www.corelaw.dk

Near Perspectives

Inland waterway transport
- Small ferries
- „last mile“ operations
- Individual point-to-point connections

Coastal areas
- Island ferries
- Supply vessels
- Monitoring and Maintanence of OWP

Maritime transport (ocean shipping)
- Bulker
- Tanker

Autoferry Test Operation Trondheim
Source: NTNU / Kai Dragland

Project Roboat © AMS Institute MIT Senseable City Lab

Idea of a Ferry between Altefähr and Stralsund, Source/MONTAGE: BENJAMIN BARZ/ OSTSEESTAAL / JÖRG BANDITT

Summary

„Autonomy will not happen as a sudden disruption but gradually“

Lennart Swoboda, Bernhard Schulte GmbH & Co. KG

„Autonomy is not the target itself“

Per A. Brinchmann, Massterly

But autonomy in shipping can (will) contribute to

- Less energy consumption
- Better use of clean technologies
- Less risk for personal and handling
- Safer navigation and maneuvering
- Reduced costs for cargo handling

Autonome maritime Systeme - Chancen, Risiken & Perspektiven

Deutsche Gesellschaft für Ortung und Navigation e.V. (DGON)
Kölnstr. 70
53111 Bonn

Vertreten durch:
Vertretungsberechtigter Vorstand:
Dipl.-Ing. Holger Mahnke (Vorsitzender)
Prof. Dr.-Ing. Dirk Kügler
Prof. Dr.-Ing. Uwe Plank-Wiedenbeck

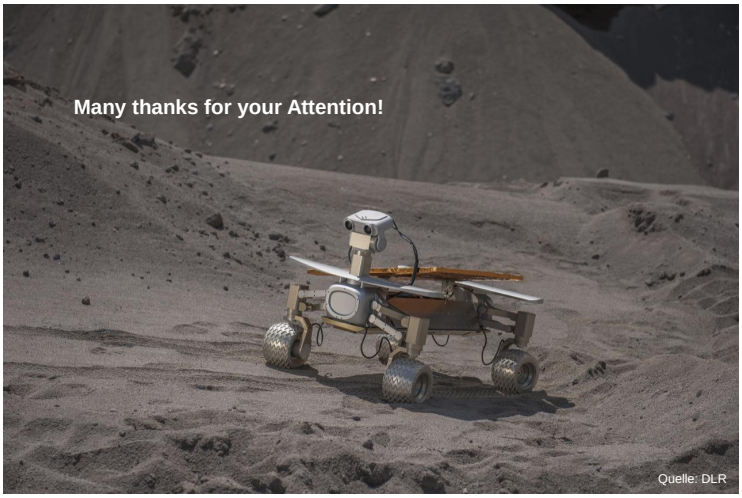
Kontakt:

Telefon: +49-228-20197.0
Telefax: +49-228-20197.19
E-Mail: dgon.bonn@t-online.de

Invitation for participation and contributions to the DGON Working Group for Autonomous Maritime Systems

Holger Klindt (Klindt Consulting), Doreen Thoma (BSH), Thoralf Noack (DLR)

Autonome maritime Systeme - Chancen, Risiken & Perspektiven



Autonomous maritime Cargo Robots

Prof. Gunnar Prause

University of Applied
Sciences Wismar

Autonomous maritime Cargo Robots – Conceptual Approaches

Autonomous Maritime Cargo Robots

–

Conceptual Approaches

Gunnar Prause

HS Wismar

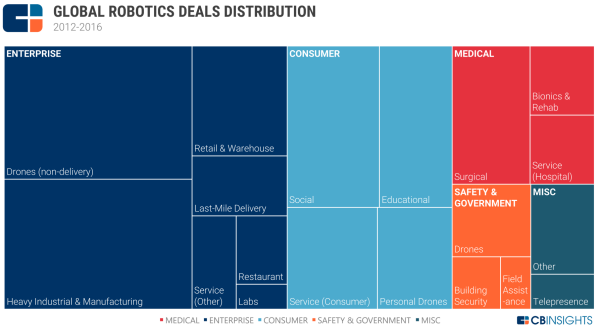
Rostock, 18. Juni 2019

Current situation: delivery robots

https://www.youtube.com/watch?v=dagjQW_jgtE

- More than a half-dozen startups offering delivery robot services, which seems to be part of a larger trend of retail automation involving artificial intelligence (AI) and robotics.
- McKinsey predicted an about 80% “last-mile delivery” for ground robots or delivery drones.
- The use of automatic delivery robots rises the question about unemployment. Currently, about 500,000 people work as delivery drivers and couriers in USA with a median salary of about $30,000. In Europe comparable figures can be assumed. Some of these couriers might be substituted but on the other side also people are still needed to monitor and control delivery robots.
- Ahti Heinla of Starship Technologies sees delivery robots in different areas rather complementing classical delivery with couriers in suburbs with low traffic.

Investments into robotics



worldwide spending in 2017 on robotics that reached the $100 billion level and is forecasted to doubled till '21
Around 48% of the deals went to startups building enterprise robots for heavy industries & manufacturing.
Consumer robots accounted for 28% of the total deal share over the last 5 years.
Medical sector received 13% of deal share.
A small percentage of the deals, around 6.5%, went to startups focused on security and rescue applications.

Case Study: Starship Technologies

- **Autonomus delivery robots can take over logistics services but how to organise contracts in M2M environment?**
  - **Only 90% self-guided & 10% still supervised by control center**
- **How frame conditions have to be shaped for delivery robots?**

Starship Technologies is a delivery robot company of Skype founders

https://www.youtube.com/watch?v=MczGB9cw9I4

Robovan' (Starship Technologies) and Mercedes-Benz Vans: model of the logistics of the future

https://youtu.be/lzwz1UsxYdk

Properties: Starship Delivery Robot

- Starship Delivery Robot:
  - weight of less than 20 kg
  - electric-powered and designed for driving on sidewalks
  - maximal speed 6 km/h
  - local delivery of goods within 15–30 min and a radius of up to 5 km
  - price of under 1 Euro per delivery.
  - freight of up to 10 kg
- Robots are equipped with a couple of sensors and tracking systems comprising 9 cameras, GPS, and an inertial measurement unit (IMU) for special orientation. Also equipped with microphones and speakers enabling them to communicate with humans.
- Only 90% autonomous vehicles,
- continuously supervised by command centre
- Permanent exchange of data, including life-video transfer, between the robot and the control centre via public telecommunication networks.

Specifics of Starship Technologies

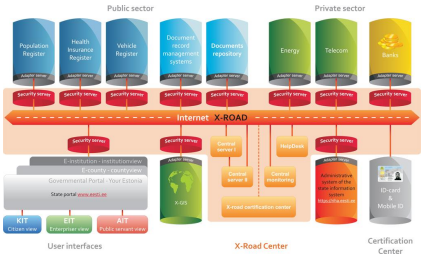
- Tallinn is not randomly the place of Starship Technologies
  - Skype founders in Tallinn sold their shares to Microsoft and reinvested into Starship
  - Estonia is the leading European country in e-government
  - Estonias are highly enthousiastic about new technologies
  - Estonia understand itself as startup – nation
  - Well developed e-service and IT – infrastructure in Estonia
- Important asset for development of delivery robots
  - E-Estonia and its services
    - Estonia is fully equipped with broadband
  - Digitalization has priority in legal acts
  - Credo of E-Estonia
    - everything except marriage, divorce and real estate transactions shall be done online

E-Estonia: X-TEE (X-Road)

- IT – Infrastructure und backbone of e-Estonia
  - Central planning & structuring on national level
- Each institution only knows ist own data
- in usage the data are consolidated via eID-Karte & ID-Code
- All data belong to the persons
  - Access to own data id possible & display of log-files with access data
- **Idea: *data protection & privacy through distributed storage!!!***

X-tee includes also private institutions
- Banks, insurances, utilities, telecom.

Ca. 4000 e-Services
- Majority are national e-Services
- Tallinn: ca. 500 e-Services
- Once-Only-principle



Source: e-estonia.com

Regulatory Framework - Last-Mile Delivery Robots

- Hoffmann, T.; Prause, G. On the Regulatory Framework for Last-Mile Delivery Robots. Machines 2018, 6, 33.
  - The more and more frequent appearance of delivery robots in public traffic reveals shortcomings in the regulatory framework of the usage of these autonomous vehicles—despite the maturity of the underlying technology. The related regulatory questions are reaching from data protection over liability for torts performance to such mundane fields as traffic law, which a logistic service provider has to take into account. The paper analyses and further develops the regulatory framework of autonomous delivery robots for packages by highlighting legal implications.

Small Maritime Cargo Robots

Quiet waters

Open sea

Source: maritime robotics

Situation in Mecklenburg - Vorpommern

Possible applications of maritime delivery robots

- Delivery in marinas
- Delivery of survival kids for lifeguards
- Automatic small ferries for passengers & cargo on lakes or rivers
- Express deliveries of medicine via maritime shortcuts
- Delivery service for water tourism via mobile apps
  - Canoeing / paddling
  - Sailing on lakes
  - Recharged batteries for mobile phones
- Gastronomic maritime deliveries on lakes
- Avoiding traffic jams by maritime deliveries on rivers

Contact: Prof. Dr. Gunnar Prause

Hochschule Wismar
Fakultät für WiWi
Philipp-Müller-Str. 14
23966 Wismar

gunnar.prause@hs-wismar.de

Mobil: +49 178 280 4882

Digital remoted Ships Inspection

Robert Garbe

NautiTronix UG

Digital remoted Ships Inspection for reliable Ships Operations

Digital ship inspection - Acting, instead of reacting

CSHIPP Workshop, 18.06.2019

ATI KÜSTE

NautiTronix

NautiTronix

- Small Startup founded in January 2019

Robert Garbe

- Electrical Engineering and Electromobility
- Employee at Weiße Flotte GmbH Stralsund

Hartmann Schleifer

- Computer Science
- IT Consultant

Practical experience has shown...

- Technical problems on ships are often not detected in time
- Shipping and ferry companies therefore have to contend with considerable annual losses due to their loss of vessels
- Technical failure and human error also have a negative impact on the environment
- Our approach
  - Acting, instead of reacting - ship technology does not have to fail before it can be repaired
  - A complex system is in constant need of action

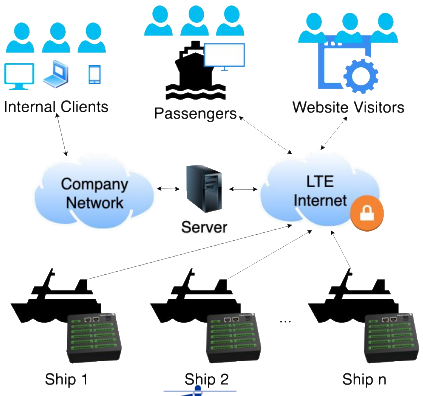
NautiTronix pro…

- monitors any operationally relevant parameters of a ship
- draws attention to shortcomings and deficiencies by means of an early warning system
- helps to avoid sources of error and to initiate preventive measures in good time
- Vessels are maintained with foresight and resources are conserved

NautiTronix pro

- ... consists of two core components:
  - data acquisition on the ship by means of a specially designed industrial PC
  - the preparation and evaluation of the data on a central server by means of a software platform

Architecture



Industrial PC as sensor source

- Specially designed for diesel and electric ships
- Can be retrofitted to all existing vessels
- 11cm x 12cm x 4,5cm
- Sensor technology
  - Charger
  - Solar charger
  - Batteries
  - Navigation
  - Rudder propellers
  - Tank capacity
  - Bow thruster
  - Diesel engine
  - ...

Software platform

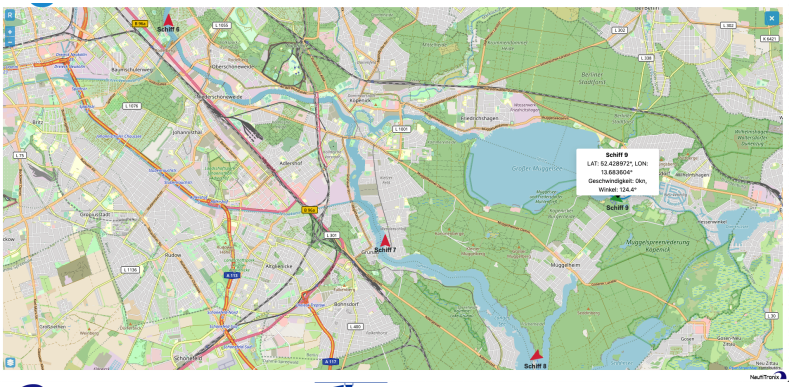
- State-of-the-art technologies with client-server architecture
  - Flexible and adaptable - even with customer branding
  - Concepts from Big Data, Predictive Maintenance, IoT, Workflow and SCADA systems
- Central server directly at the customer as "on-premise" solution
  - Data is stored directly with the customer (and belongs to him)
  - Windows or Linux Server
  - Sensor PCs send data continuously via LTE to the central server
  - Alternative: Cloud server

Software platform

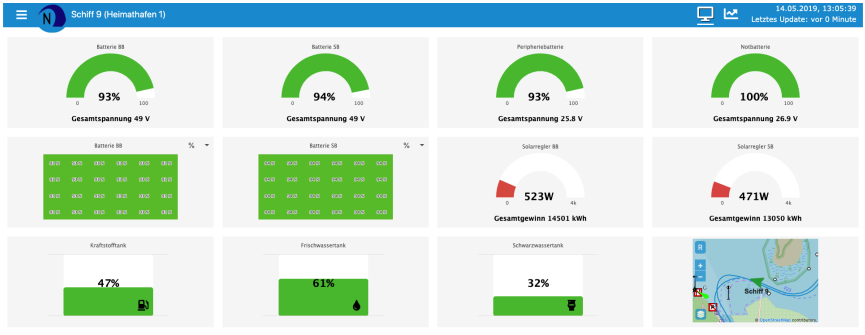
- Clients
  - Internal web client for shipping companies
    - All values and alarms available at all times - also mobile
  - External portals for passengers on ships and website visitors
- Focus on IT security for all involved components

Example: Fleet overview

Example: Map representation of a location



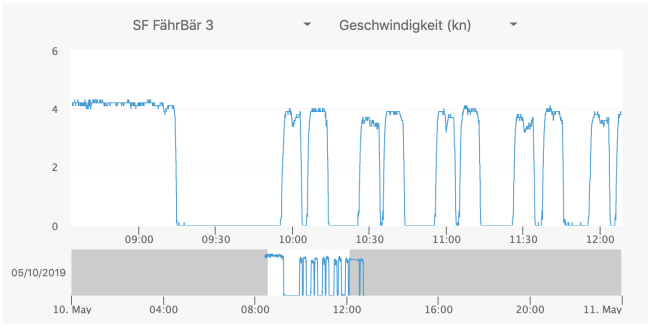
Example: Ship overview



Example: Ship overview

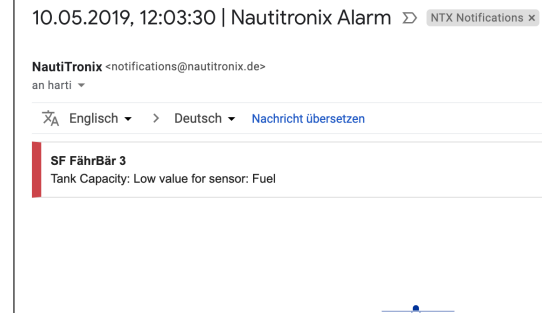
Example: Historical Data

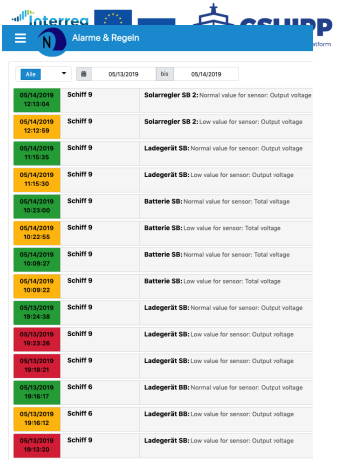
- East wind with 18-21km/h



Example: Historical Data

Example: Alarms

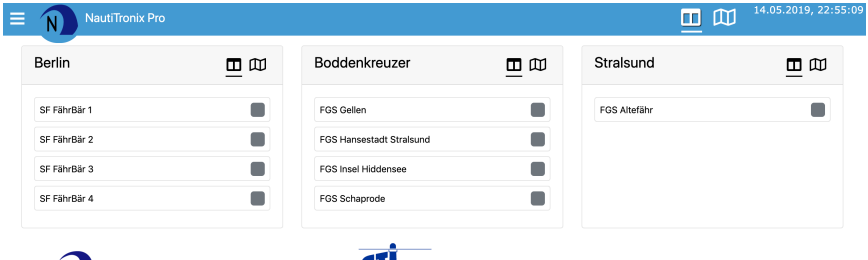




Example: Passenger information system

Pilot project: Weiße Flotte GmbH Stralsund

- 4 Electric vessels
- 5 Diesel vessels
- Currently in implementation



Live Demo

Any questions?

NautiTronix

NautiTronix UG (haftungsbeschränkt)
Circus 16, 18581 Putbus, Deutschland
+49 38301 887515
www.nautitronix.de
info@nautitronix.de
Geschäftsführung: Robert Garbe, Hartmann Schleifer

Imprint

Workshop Oranization
Project: CSHIPP & BSRelectric
Project partner: ATI Küste GmbH, Rostock
Dipl.-Ing Alexander John
e-Mail: john@ati-kueste.de

Websites:
https://cshipp.eu/
https://www.bsr-electric.eu/