





DECARBONIZING SHIPPING

APRIL 27, 2021

06:00 AM MIAMI | 12:00 HAMBURG

GATERS – Gate Rudder System as a Retrofit for the Next Generation Propulsion and Steering of Ships

By

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# What is A GATE RUDDER SYSTEM (GRS)?



- Classical single-rudder behind the propeller arrangement is replaced by twin-rudder blades with asymmetric cross-sections which are positioned either side of the propeller
- The Gate Rudder System, therefore, takes advantage of additional thrust generated by the two rudder blades, in contrast to the additional resistance resulted by the conventional rudder
- Each rudder blade can be controlled individually to affect the direction of the propeller's slipstream (i.e. to vector) and hence to steer the vessel with increased manoeuvring and motion control capability.



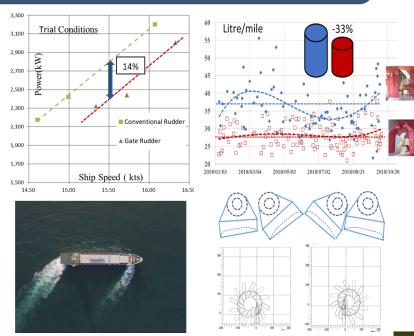




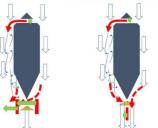
## What are the advantages of A GATE RUDDER SYSTEM (GRS)?

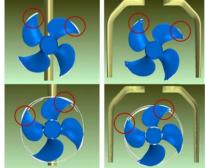


- Remarkable fuel saving (up to 14% in trials), especially in-service and rough weather (up to 30%)
- Reduced vessel motions (in yawing and rolling) in waves
- Improved steerability and manoeuvring (especially in harbours) without stern thrusters
- Reduced propeller loading and hence less vibration and URN
- Low wash wake due to hull waves & propeller slipstream
- Shorter ship length or more space at aft compared to the vessel with a conventional rudder behind the propeller
- Effective use of the bow thrusters at higher ship speeds
- Reduced risk of running anchor











# A brief history of GATE RUDDER SYSTEM (GRS)



- GRS had its origin in "Frame Rudder" proposed and tested by <u>Mr Sadamoto Kuribayashi</u> of Kuribayashi Steam Co Ltd, Japan in 2011.
- Frame Rudder was tested and further improved by R&D conducted in NMRI of Japan by <u>Dr Noriyuki</u> Sasaki and this led to the 1<sup>st</sup> (Japanese) patent for the early version of GRS with a single rudder stock [ # JP 2014-73815 A]
- Further R&D work in Japan and the UK at the Newcastle and Strathclyde Universities led by Dr Sasaki as the Visiting Professor resulted in the current shape of the GRS with two separate rudder stocks and the 2<sup>nd</sup> (European) Patent [#EP 3103715 A1]
- GRS was first applied on a 400TEU Japanese Container vessel "Shigenobu" through the R&D project sponsored by Nippon Foundation and a Japanese Consortium in 2017. The comparison of performance with her sister ship "Sakura" was well above the predictions.



















## First GRS application in Japan



- First application of the GRS was on a new build 400TEU Container vessel SHIGENOBU in 2017
- SHIGENOBU is the sister ship of SAKURA with the same size and engine power but with conventional (flap) rudder built in 2016
- As part of an R&D programme sponsored by Nippon Foundation and the Japanese Consortium the performance of both vessels were compared in speed trials in 2017 and later on through continuous performance monitoring in-service

SHIGEN	ови		
Length overall	L <sub>OA</sub>	(m)	111.40
Length between perpendiculars	L <sub>BP</sub>	(m)	
Breadth	В	(m)	17.80
Draught (midship)	T	(m)	5.24
Displacement	Δ	(ton)	
Service Speed	Vs	knots	15.5
Rudder			GR





SAKURA			
Length overall	L <sub>OA</sub>	(m)	111.4
Length between perpendiculars	L <sub>BP</sub>	(m)	
Breadth	В	(m)	17.8
Draught (midship)	Т	(m)	5.24
Displacement	Δ	(ton)	
Service Speed	Vs	knots	15.5
Rudder			CR





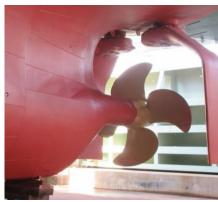


# So far, GRS APPLICATIONS



	<b>SHIGENOBU</b> (1 <sup>st</sup> Application, 2017)	<b>KOHSIN MARU</b> (2 <sup>nd</sup> Application, 2020)	SHINMON MARU (3 <sup>rd</sup> Application, 2020)
Type of ship	Container (400 TEU)	General cargo (509 GT)	General Cargo (499 GT)
Lpp	101.9	69	72
В	17.8	12	12
Т	5.24	4.11	4.13
C <sub>B</sub>	0.67	0.70	0.70
Design Vs	14.5	13	13
Fn (Lpp)	0.2436	0.267	0.267
L/B	5.72	5.75	5.75
Stern shape	V shape	Stern bulb	V shape













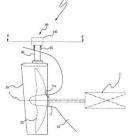
## **Current commercial status of GRS**

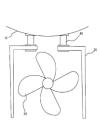


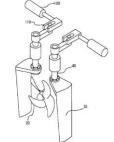
- A Japanese Consortium (JC) involving Kay Seven Co., Ltd., (Kuribayashi Steam Co Ltd); Mr. Noriyuki Sasaki, National Institute of Maritime, Port and Aviation Technology, Yamanaka Shipbuilding Co., Ltd. and Kamome Propeller Co., Ltd owns the Gate Rudder Patent (European Patent: EP 3103715)
- Further R&D and promotion activities in the University of Strathclyde (Glasgow) and Visiting Prof Noriyuki Sasaki attracted Wartsila Propulsion to purchase the commercial license from the JC to use the Gate Rudder technology protected by the Licensed Patent in 2020
- GATERS Project funding was granted by the EC (H2020) in December 2019 and the GATERS Consortium signed sub-license agreement with Wartsila Netherlands BV in 2021 on behalf of the Patent Holders hence:

"GATERS has an official sub-licence agreement with Wartsila Netherlands BV to utilise the Gate Rudder Patent (EP 3103715) at specific retrofit projects of vessels sizes below 15,000. DWT. GATERS is sponsored by the EC H2020 Programme (ID: 860337) with the aims and objectives independent of Wartsila Netherlands BV"





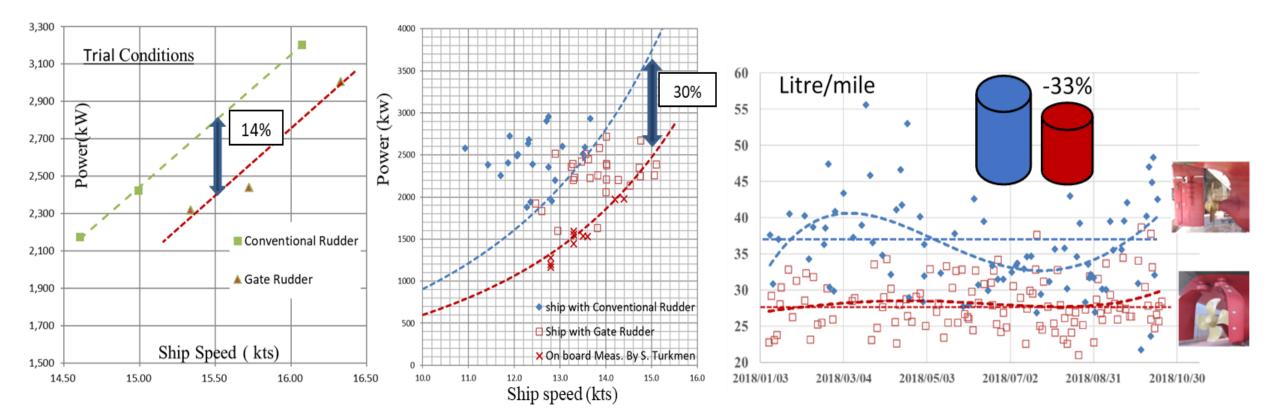






# **Fuel saving advantage of GRS**





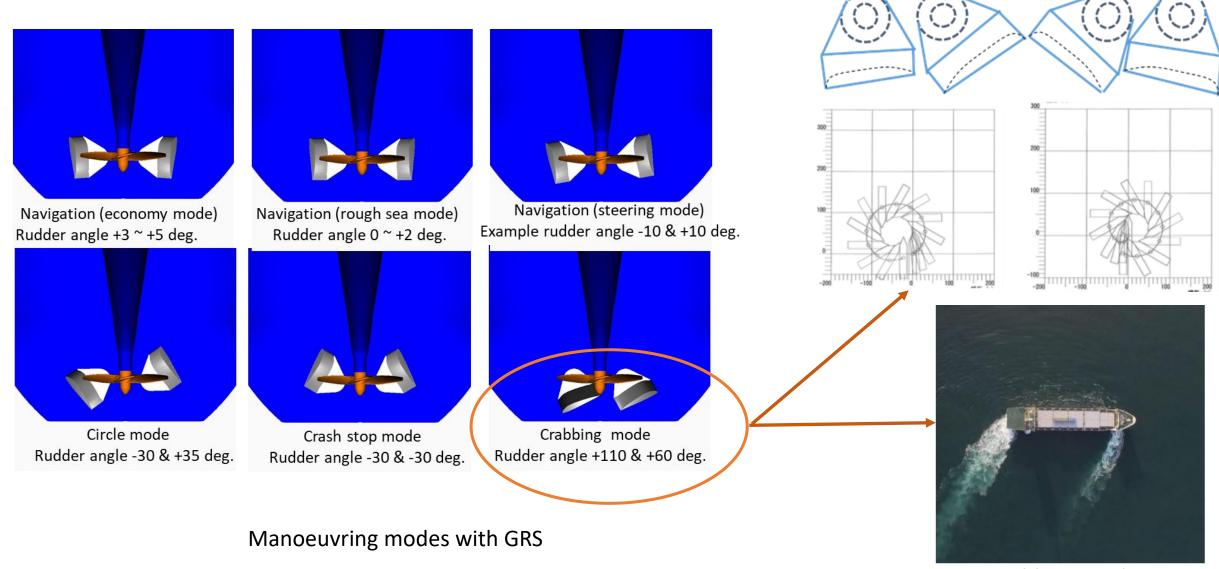
Trials (calm water) and in-service (including rough weather) powering performance comparisons of two sister ships: one with Gate rudder system, other with Conventional flap-rudder system

In-service fuel consumption comparisons of two sister ships, Shigenobu with GRS (red) and Sakura with CRS (blue)



# Manouverability advantage of GRS



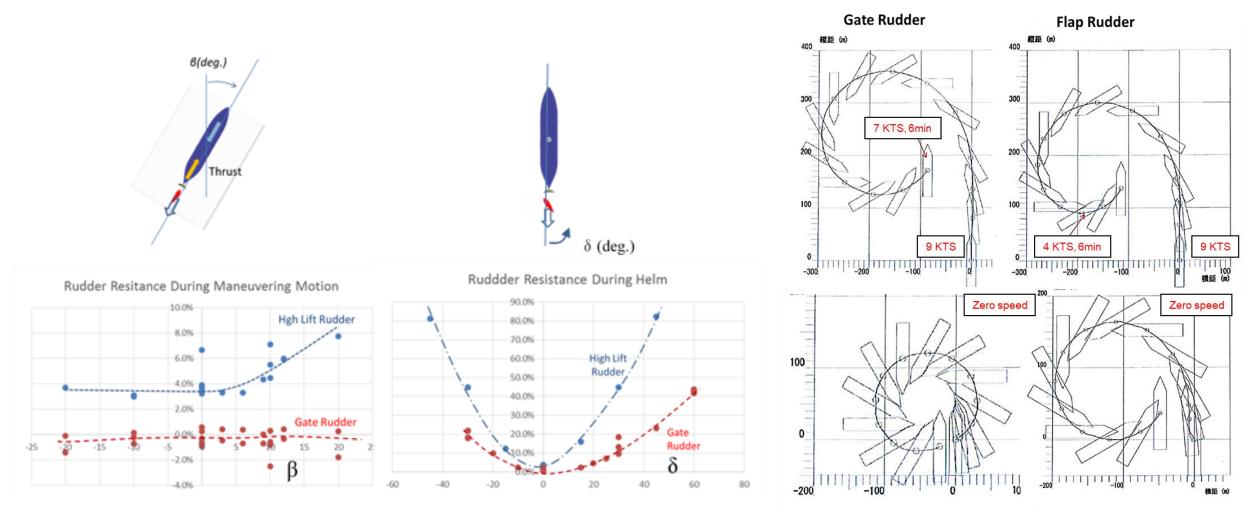


Crabbing mode



# Manouverability advantage of GRS





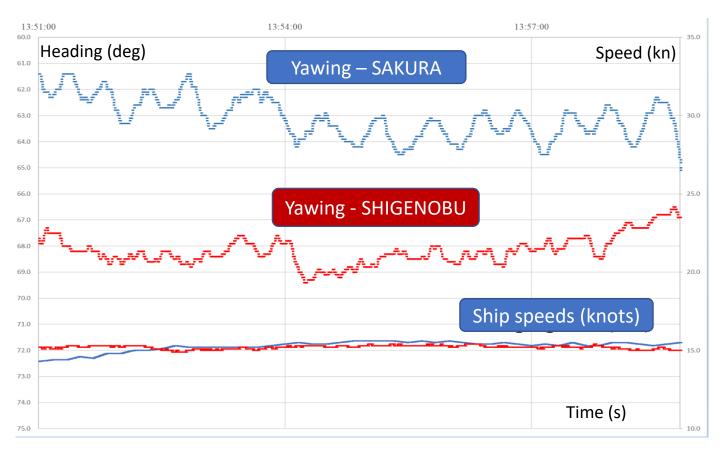
Comparison of rudder resistance (% Thrust) due to manoeuvring for conventional rudder and GRS.

Full-Scale 35<sup>o</sup> Circle Test (Low Speed and Zero Speed) for Ship with conventional (flap) rudder and GRS



## **Seakeeping advantage of GRS**





Comparison of time history yawing motions recorded in (almost) sideby-side trials with SAKURA (CR) and SHIGENOBU (GRS) containerships



#### **Sea conditions:**

Wind speed: 12-24 knots Wave height: 1.5 – 2.0m

Direction 250-270<sup>o</sup>

Period: 30 sec

Rolling motion recorded on inclinometer:

SAKURA  $\rightarrow$  3-5° SHIGENBOU  $\rightarrow$  1-3°



## **Motivations for GATERS Project**





- The proposal responded to the H2020 Innovation Action call under the heading "Retrofit Solutions and Next Generation Propulsion for Waterborne Transport" (ID: LC-MG-1-8-2019).
- Although there was one new ship application of GRS ("Shigenobu"), there was/is no current application of the Gate Rudder System as a "retrofit" device, and hence it is proposed in GATERS for the first time and this, in fact, was the primary motivation of the GATERS proposal.
- GATERS, therefore, addressed the call text explicitly "to develop and demonstrate to TRL 6 and higher innovative, cost-effective retrofit solution for marine shipping which will provide substantial improvements regarding environmental impacts and life cycle cost".
- Recent IMO proposal for introducing the attained *Energy Efficiency Existing Ship Index (EEXI)* for ships of 400 GT and above







# G (See ) TERS

### **GATERS – Aims**

- To bring together 18 technology experts and prime stakeholders, including the patent holder, to demonstrate and exploit the benefits of this system by two main deliverables:
- ➤ To demonstrate the GR system for the European short sea shipping operations by installing and operating on a target coastal vessel.
- To explore the GR system, conceptually, for the oceangoing shipping operations, including fleet level.
- Hence to demonstrate if the Gate Rudder System can be the next generation propulsion and steering system for the waterborne transport.







# **G** TERS

# **GATERS** – Objectives

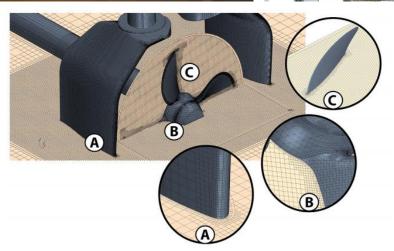
- 1. To investigate technical challenges of the Gate Rudder System (GRS) and to establish the best practice of application as a retrofit by using a combination of the computational, experimental and full-scale procedures.
- 2. To design a retrofit GRS at a detailed level, to manufacture and install on the coastal target cargo vessel. Hence, to demonstrate the effectiveness of the GRS by sea trials and voyage monitoring as well as its impact on the existing IMO regulations (i.e. EEDI, EEOI and Minimum power requirements) and the Life Cycle Cost (LCC).
- 3. To assess the overall impact of the retrofit GRS applications to major ship types for the European SSS operations and the Oceangoing Shipping (OS) operations on the existing (IMO) regulations and Life Cycle Cost (LCC) for both individual vessels as well as the fleet-level services.









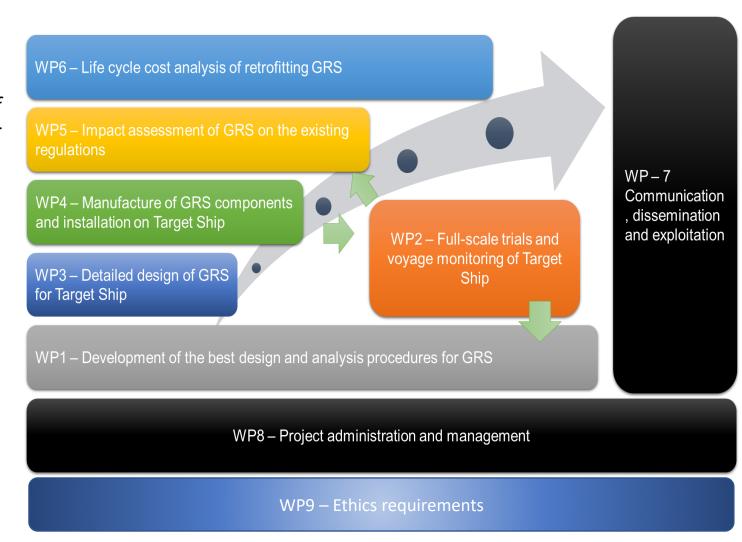




## **GATERS – Methodology**



- Phase-1 (Feb'21 Feb'22): "Development of the best procedures for the design, manufacturing and retrofitting of the GRS" Critical design parts of the works to achieve the retrofitting of the GRS for the target cargo vessel will be completed.
- Phase-2 (Feb'22 Feb'23): "Detailed design, manufacturing and application of the GRS retrofitting on the target ship as well as its demonstration and further procedure development" <u>Retrofitting on Sept'22</u>
- Phase-3 (Feb'23 Feb'24): "Impact of the GRS retrofitting on the existing and forthcoming regulations and life cycle cost for the European SSS operations and the Oceangoing Shipping operations" An overall impact assessment of the GRS retrofitting for the major ship types at a fleet level will be conducted in this phase.





# **GATERS – Partners**













	Participant No.	Participant organisation name	Acronym	Country	
<b>&gt;</b>	1 (Coordinator)	UNIVERSITY OF STRATHCLYDE	UoS	UK	
	2	HAMBURGISCHE SCHIFFBAU- VERSUCHSANSTALT GMBH	HSVA	DE	4
<b>⇒</b>	3	BUREAU VERITAS MARINE & OFFSHORE REGISTRE INTERNATIONAL DE CLASSIFICATION DE NAVIRES ET DE PLATEFORMES OFFSHORE	BV	FR	
	4	GLAFCOS MARINE EPE	GME	EL	
<b>⇒</b>	5	CONSIGLIO NAZIONALE DELLE RICERCHE	CNR	IT	
	6	HIDROTEKNIK YAT GEMI DENIZ YAPILARI TASARIM TEKNOLOJILERI SANAYI VE TICARET LIMITED SIRKETI	HYD	TR	
<b>&gt;</b>	7	ISTANBUL TEKNIK UNIVERSITESI	ITU	TR	









# **GATERS – Partners** (continued)

















	Participant No.	Participant organisation name	Acronym	Country
<b>&gt;</b>	8	TWI LIMITED	TWI	UK
	9	NAVAL ARCHITECTURAL SERVICES LIMITED	NAS	MT
<b>&gt;</b>	10	CAPA DENIZCILIK NAKLIYAT SANAYI VETICARET LIMITED SIRKETI	CAPA	TR
	11	SINTEF OCEAN AS	SINTEF	NO
<b>⇒</b>	12	DANAOS SHIPPING COMPANY LIMITED	DANAOS	CY
	13	STONE MARINE PROPULSION LIMITED	SMP	UK
<b>⇒</b>	14	GURDESAN GEMI MAKINA SANAYI VE TICARET ANONIM SIRKETI	GURD	TR
	15	UNIVERSITY OF NEWCASTLE UPON TYNE	UNEW	UK
<b>⇒</b>	16	STAR BULK SHIP MANAGEMENT CO. (CYPRUS) LTD	STARB	CY
	17	INFORMA UK LTD (LLOYD'S LIST INTELLIGENCE)	LLI	UK
<b>→</b>	18	CETENA S.P.A.	CETENA	IT



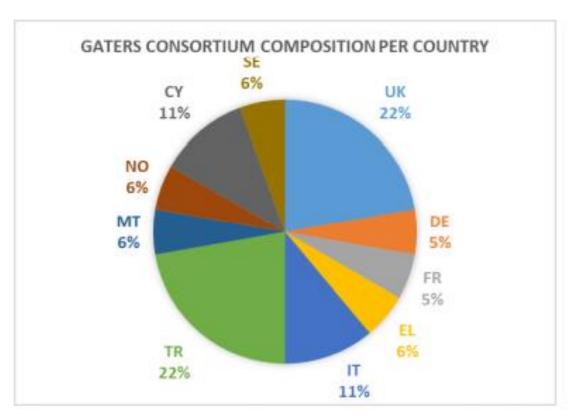


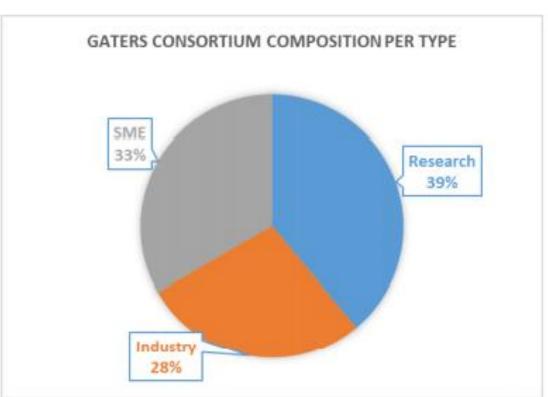






# **GATERS** – Partners background summary



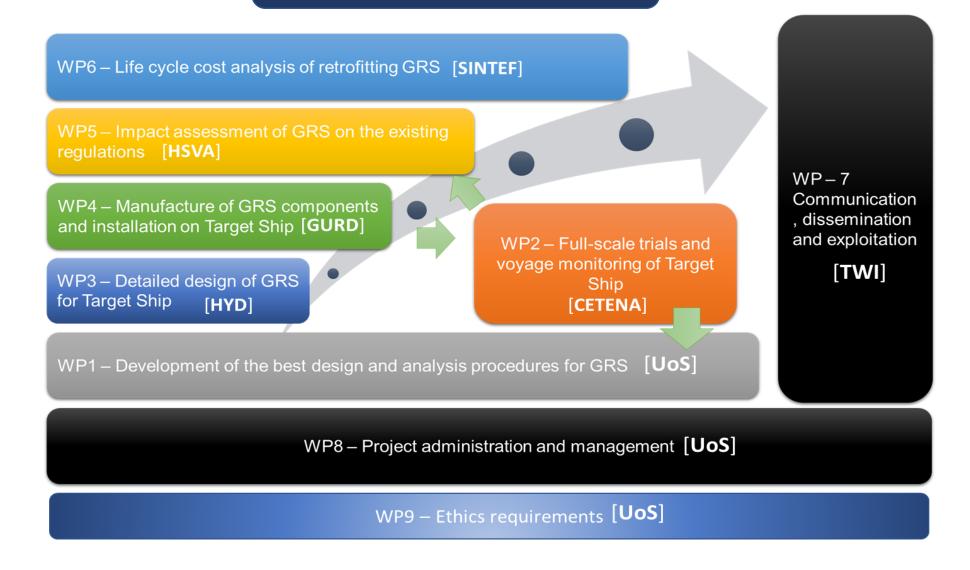


Distribution of GATERS Partners' background by Country (Left) & Type (Left)



# **GATERS – Work Packages**





Schematic of GATERS Work Breakdown Structure in terms of Work Packages(WP) and associated leaders (WPL)



## Target vessel – MV ERGE To be retrofitted with GRS



- MV ERGE (IMO No: 9508603) 5650 DWT (2993GT) General Cargo ship, built in Weihai PRC and delivered in 2011.
- She operates in European Coastal waters, Black Sea, Red Sea and North African waters
- She is owned by partner CAPA and she has sister vessel MV ERLE with conventional flap rudder

Davamatav			MV Erge								
Parameter	Symbol	Units	Ballast Load	Design Load	Full Load						
Length overall	L <sub>OA</sub>	(m)		89.95							
Length between perpendiculars	L <sub>BP</sub>	(m)		84.95							
Breadth	В	(m)		15.4							
Draught (midship)	T	(m)	3.3	5.6	6.45						
Draught (AP)	T <sub>A</sub>	(m)	3.8	5.6	6.45						
Draught (FP)	$T_{F}$	(m)	2.8	5.6	6.45						
Displacement	Δ	(ton)	3607	6339	7241						
Block coefficient	C <sub>B</sub>		0.818 0.827 0.84								
Prismatic coefficient	C <sub>P</sub>		0.823 0.829 0.843								
Midship area coefficient	$C_M$		0.994	0.997	0.997						
Waterplane area coefficient	$C_WP$		0.854	0.916	0.944						
Longitudinal centre of buoyancy	LCB	(m) (+ fwd)	46.866	43.025							
Longitudinal centre of floatation	LCF	(m) (+ fwd)	46.246 39.748 39.8								
Longitudinal centre of gravity	LCG	(m) (+ fwd)	46.903	45.91	43.036						
Verticle centre of gravity	VCG	(m)	3.23 5.4 6.095								
Speed	$V_S$	knots		12							

















# **GATERS** – Implementation



#### WP1 - DEVELOPMENT OF THE BEST DESIGN & ANALYSIS PROCEDURES FOR GRS

GATE RUDDER SYSTEM AS A RETROFIT FOR THE NEXT GENERATION PROPULSION AND STEERING OF SHIPS (GATERS)				Phas	se-1							Ph	ase-2								Phase	-3			
Work packages & Tasks	M1 M2	М3	M4 M5	М6	M7 I	M8 M9	M10 N	И11 M12	M13	M14 M15	M16	M17 M1	M19	M20 M	21 M2	22 M23 M2	4 M25	M26 N	И27 M	128 M29	M30 M	31 M32	мзз мз	4 M35	M36
WP 1 DEVELOPMENT OF THE BEST DESIGN AND ANALYSIS PROCEDURES FOR THE GRS																									
T 1.1 Investigation and data collection of the existing vessels with the GRS and selection of other vessel types																									
T 1.1.1 Collection of the relevant data of the existing vessel with the GRS																									
T1.1.2 Collection of the relevant technical and operational data for the target vessel																									
T 1.1.3   Selection and data collection of representative vessel types for EU SSS and OS operations			_	$\Rightarrow$																					
T 1.2 Initial design tool development for GRS																									
T 1.2.1 Establish simple algorithm to estimate the main particulars of the basic GRS components			$\Longrightarrow$	>																					
T 1.2.2 Determination of the preliminary dimensions of the GRS for the target ship				$rac{1}{2}$																					
T 1.2.3 Further enhance the accuracy of the initial design tool iteratively												$\pm$			士		>								
T 1.3 Development/implementation of accurate model test procedures for ship models with GRS																									
T1.3.1 R&P, seakeeping, noise and cavitation tests with an existing 5m container model at ITU facilities								$\Longrightarrow \triangleright$																	
T1.3.2 Manoeuvring tests with the free sailing container model in the ITU campus lake		0						$\Longrightarrow$																	
T1.3.3 Manufacture of a 12m container model and R&P tests in the HSVA towing tank						$\Rightarrow$																			
T1.3.4 R&P, seakeeping, noise and cavitation tests with a 6m target ship model at the CRN-INM facilities								$\Longrightarrow \triangleright$																	
T1.3.5 Manoeuvring tests with the free sailing tanker model in the CNR-INM lake facilities					-			$\Rightarrow$																	
T1.3.6 Detailed flow investigation around GRS system using laser-based devices in ECT								$\Longrightarrow$																	
T1.3.7 Dedicated performance and load measurements of GRS in open waters and waves in KHL								$\Rightarrow$																	
T 1.4 Development of accurate CFD procedures for the full-scale performance prediction of a ship with GRS																									
T 1.4.1   Calm water powering performance prediction in the model and full scale for the container vessel with GRS												$\pm$			÷		>								
T 1.4.2 Calm water powering performance prediction in the model and full scale for the target vessel with GRS															$\pm$		>								
T 1.5 Development of accurate Manoeuvring and Seakeeping simulation tools for a ship with GRS																									
T 1.5.1 Manoeuvring in calm water and seakeeping in waves for the model and full-scale container vessel												$\pm$			$\pm$	<del></del>	>							$oldsymbol{ol}}}}}}}}}}}}}}}}}}$	
T 1.5.2   Manoeuvring in calm water and seakeeping in waves for the model and full-scale target vessel												_			$\pm$		>							$oldsymbol{ol}}}}}}}}}}}}}}}}}$	
T 1.6 Development of accurate structural design and analysis procedures for GRS																								$oldsymbol{ol}}}}}}}}}}}}}}}}}}$	
T 1.6.1 Full-scale structural analysis of the GRS for the container vessel												$\rightarrow$			$\pm$		>								
T 1.6.2 Full-scale structural analysis of the GRS for the target vessel															$\pm$		>								
T 1.7 Structural design and weight optimisation of the GRS using new materials																								$\perp \!\!\! \perp \!\!\! \perp$	
T 1.7.1 Investigation of potential new materials for GRS (GFRP/CFRB) and lab based material testing												_			÷		>							$\perp \!\!\! \perp \!\!\! \perp$	
T 1.7.2 Implementation and demonstration of the weight optimised GRS															$\pm$		>							$\perp$	



#### WP 2 – FULL-SCALE TRIALS & VOYAGE MONITORING OF TARGET SHIP



#### WP 3 – DETAILED DESIGN OF GRS FOR TARGET SHIP

WP 2   Full-scale trials and voyage monitoring of target ship   Description   Descript																											
Work packages & Tasks  Wit No. 198 Me No. 19	GATE RUDGER SYSTEM AS A RETROET FOR THE NEXT GENERATION PROPULISION AND STEERING OF SHIPS (CATERS)					Phase	Q.								thase.2							Ph	aso.3			_	Q
WP2   Euil-scale trials and voyage monitoring of target ship   T21			M2 M3	M4	M5			8 M9	M10 N	/11 M	12 M1	3 M14	M15 M1			M20 M21	M22 M	23 M24	M25 M	126 M2	7 M28			M32 M3	8 M34	M35 M	36
T2.11   Onboard data measurements with the target ship by sea trials and vyoage monitoring in-service	The first parting of the first	-		-	. Inter			, ,			-							es me			1	nes ins			1		=
T2.11   Onboard data measurements with the target ship by sea trials and voyage monitoring in-service	tun a Full collection and conservation of terror to big																	-									
T2.1.1 Strategic planning to conduct the onboard and off-board measurement activities    T2.1.2 Fitting of a voyage performance monitoring system to the target ship   T2.1.3 Conduct of voyage performance monitoring inservice before the GRS retrofitting   T2.1.4 Drydock the vessel and clean the hull   T2.1.5 Conduct of decidated sea trials just after the GRS retrofitting   T2.1.6 Conduct of decidated sea trials just after the GRS retrofitting   T2.1.7 Conduct of voyage performance monitoring in-service after the GRS retrofitting   T2.1.7 Conduct of voyage performance monitoring in-service after the GRS retrofitting   T2.1.7 Conduct of voyage performance monitoring in-service after the GRS retrofitting   T2.1.1 Conduct of the URN measurements with the target ship by one the retrofit		-																		+				+			4
T2.1.2 Fitting of a voyage performance monitoring system to the target ship  T2.1.3 Conduct of voyage performance monitoring in-service before the GRS retrofitting  T2.1.5 Conduct of dedicated sea trials just before the GRS retrofitting  T2.1.6 Doyadc of dedicated sea trials just before the GRS retrofitting  T2.1.7 Conduct of voyage performance monitoring in-service after the GRS retrofitting  T2.1.7 Conduct of voyage performance monitoring in-service after the GRS retrofitting  T2.2 Off-board data (URN) measurements with the target ship by sea trials  T2.2.1 Conduct of the URN measurements with the target ship before the retrofit  T2.2.2 Conduct of the URN measurements with the target ship before the retrofit  T2.2.2 Conduct of the URN measurements with the target ship and dasa approval  T3.1 Dosign of GRS for the target ship and dasa approval  T3.1.1 Conduct the detailed structural design and optimisation of the GRS  T3.1.3 Produce manufacture drawings and secure class approval  T3.1.3 Produce manufacture drawings and secure class approval  T3.1.3 Review and conduct of the detailed structural design and analysis of the propeller  T3.2 Conduct of the detailed structural design of the propeller to fit in the existing shaft  T3.1.3 Specification of the steering gear machinery and control systems  T3.3.1 Specification of the steering gear machinery and control systems  Specification of the steering gear machinery and control systems  Specification of the steering gear machinery and control systems  Specification of the steering gear machinery and control systems  Specification of the steering gear machinery and control systems  Specification of the steering gear machinery and control systems  Specification of the steering gear machinery and control systems  Specification of the steering gear machinery and control systems  Specification of the steering gear machinery and control systems  Specification of the steering control clause placetion	• • • • • • • • • • • • • • • • • • • •	_		_							_						++			+			+	+	+		- 1
T2.13 Conduct of voyage performance monitoring in-service before the GRS retrofitting  T2.14 Drydock the vessel and dean the hull  T2.15 Conduct of dedicated sea trials just before the GRS retrofitting  T2.16 Conduct of voyage performance monitoring in-service after the GRS retrofitting  T2.17 Conduct of voyage performance monitoring in-service after the GRS retrofitting  T2.18 Conduct of voyage performance monitoring in-service after the GRS retrofitting  T2.19 Conduct of voyage performance monitoring in-service after the GRS retrofitting  T2.10 Conduct of voyage performance monitoring in-service after the GRS retrofitting  T2.10 Conduct of voyage performance monitoring in-service after the GRS retrofitting  T2.10 Conduct of voyage performance monitoring in-service after the GRS retrofitting  T2.10 Conduct of voyage performance monitoring in-service after the GRS retrofitting  T2.10 Conduct of voyage performance monitoring in-service after the GRS retrofitting  T2.10 Conduct of voyage performance monitoring in-service after the GRS retrofitting  T2.11 Conduct of voyage performance monitoring in-service after the GRS retrofitting  T2.12 Conduct of the URN measurements with the target ship byse atrials  DETAILED DESIGN OF THE GRS FOR THE TARGET (TANKER) Ship  DETAILED DESIGN OF THE GRS FOR THE TARGET (TANKER) Ship  DETAILED DESIGN OF THE GRS FOR THE TARGET (TANKER) Ship  DETAILED DESIGN OF THE GRS FOR THE TARGET (TANKER) Ship  DETAILED DESIGN OF THE GRS FOR THE TARGET (TANKER) Ship  DETAILED DESIGN OF THE GRS FOR THE TARGET (TANKER) Ship  DETAILED DESIGN OF THE GRS FOR THE TARGET (TANKER) Ship  DETAILED DESIGN OF THE GRS FOR THE TARGET (TANKER) Ship  DETAILED DESIGN OF THE GRS FOR THE TARGET (TANKER) Ship  DETAILED DESIGN OF THE GRS FOR THE TARGET (TANKER) Ship  DETAILED DESIGN OF THE GRS FOR THE TARGET (TANKER) Ship  DETAILED DESIGN OF THE GRS FOR THE TARGET (TANKER) Ship  DETAILED DESIGN OF THE GRS FOR THE TARGET (TANKER) Ship  DETAILED DESIGN OF THE GRS FOR THE TARGET (TANKER) Ship  DETAILED DESIGN OF THE GRS		=		+	_		_	+	+	_	+	+		+			++	_	$\vdash$	+	+	+	+	+-	+	-+	$\dashv$
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T 3.3.2 Specification of the steering control (autopilot) requirements and supplier selection	T 3.3 Specification and purchase of the steering gear machinery and control systems																										$\exists$
1 3.3.2 Specification of the steering control (autophiot) requirements and supplier selection	T 3.3.1 Specification of the steering gear requirements and supplier selection			$\top$						$\Rightarrow$	$\triangleright$																$\exists$
	T 3.3.2 Specification of the steering control (autopilot) requirements and supplier selection									T																	$\neg$
T3.4   Overall detailed design integration of the GRS	T 3.4 Overall detailed design integration of the GRS			$\top$													$\top$		$\Box$		$\top$						$\exists$
T 3.4.1 Review the SG room and explore the possible alteration options	T 3.4.1 Review the SG room and explore the possible alteration options								$\vdash$	$\Rightarrow$	Т						$\top$										$\exists$
T 3.4.2 Integration of all the GRS components and evaluation of its impact on the existing steering gear room	T 3.4.2 Integration of all the GRS components and evaluation of its impact on the existing steering gear room			$\top$							4	>					$\top$				$\top$						$\neg$
T 3.4.3 Conduct of the structural analysis to evaluate the impact of the GRS on the SG room (floor)	T 3.4.3 Conduct of the structural analysis to evaluate the impact of the GRS on the SG room (floor)			$\top$							45	▶					$\dagger \dagger$				$\top$						$\exists$
T 3.4.4 Structural alteration designs of the SG room (floor), hydrostatic analysis and class approval	T 3.4.4 Structural alteration designs of the SG room (floor), hydrostatic analysis and class approval			$\top$							#	>					$\top$				$\top$				$\top$		$\exists$
T 3.4.5 Conduct hydrostatic analysis for the retrofited target vessel and class approval	T 3.4.5 Conduct hydrostatic analysis for the retrofited target vessel and class approval											>															



# WP 4 – MANUFACTURING OF GRS COMPONENTS & INSTALLATION ON TARGET SHIP



# WP 5 – IMPACT ASSESSMENT OF GRS ON EXISTING & FORTHCOMING REGULATIONS

WP 6 – LIFE CYCLE COST ANALYSIS OF RETROFITTING GRS

$\Box$	· · · · · · · · · · · · · · · · · · ·				<u>-</u>		-(1)																						
GATE RI	JODER SYSTEM AS A RETROFIT FOR THE NEXT GENERATION PROPULSION AND STEERING OF SHIPS (GATERS)					Phi	ase-I									Phase	-2								Phar	se-3			
	Work packages & Tasks	M1	M2 N	13 N	14 MS	M6	M7	M8	M9 M	10 M1	1 M12	M13	M14 M	15 M16	M17	W18 N	119 M2	0 M21	M22 M	123 M2	4 M25	M26	M27	M28 M2	9 M30	M31 N	432 M	3 M34	M35 M36
WP 4	MANUFACTURING OF THE GRS COMPONENTS AND INSTALLATION ON THE TARGET SHIP			1																					1 1				
T 4.1	Strategic planning of the GRS installation on the target ship																												
T 4.1.1	Review of the target ship's original steering gear room and machinery												$\vdash$		.														
T 4.1.2	Review of the GRS components and their installation requirements in the steering gear room												$\vdash$		$\cdot$														
T 4.1.3	Making plan (i.e. procedure steps) for the installation process													$\Rightarrow$															
T 4.2	Manufacture and purchase of the GRS components																												
T 4.2.1	Manufacturing of the gate rudder blades and delivery to the ship yard																												
T 4.2.2	Manufacturing of the new propeller blades and delivery to the ship yard																												
T 4.2.3	Purchasing of the steering gear machinery and autopilot and delivery to the shipyard														->														
T 4.3	Installation of the GRS on the target ship																												
T 4.3.1	Removal of the existing Steering Gear (SG) system and enhancement of the SG room														$\frac{1}{2}$														
T 4.3.2	Installation of the GR system components as required and planned															$\Rightarrow$													
WP 5	IMPACT ASSESSMENT OF THE GRS ON THE EXISTING AND FORTHCOMING REGULATIONS																												
T 5.1	Impact on the IMO requirements and EU regulations for the target vessel			$\perp$																									
T 5.1.1	To assess the impact on the target ship in terms of the IMO's requirements															$\pm$				<b>1</b>	>								
	To assess the impact on the target ship in terms of the EU regulations													+	$\vdash$	$\pm$	+	+	_	#	>								
T 5.2	Impact on the IMO requirements and EU regulations for wider ship types and different operations																												
T 5.2.1	To assess the impact on the representative wider ship types for the EU SSS operations																										$\triangleright$		
T 5.2.2	To assess the impact on the representative wider ship types for the OS operations																										$\triangleright$		
T 5.3	Impact on the IMO requirements and EU regulations for wider ship types at fleet level operations																												
T 5.3.1	To assess the impact on the representative wider ship types for the EU SSS fleets																										$\pm$		$\Rightarrow$
T 5.3.2	To assess the impact on the representative wider ship types for the OS fleets																										$\pm$		<b>→</b>
WP 6	LIFE CYCLE COST (LCC) ANALYSIS OF RETROFITTING A GRS																												
T 6.1	Cost effectiveness analysis and comparison amongst GRS solutions and against other ESDs																												
	Development of CAPEX and OPEX for different types and sizes of vessels equipped with GRS																	$\Rightarrow$					$\Box$						
T 6.1.2	Comparative CAPEX and OPEX analysis of GRS for new build and retrofited ships																	$\Rightarrow$											
T 6.1.3	Comparative CAPEX and OPEX analysis of GRS against other selected energy-saving devices																	₽											
_	LCC analysis for the GRS retrofit																												
T 6.2.1	LCC analysis of retrofitting the GRS for the target ship																		$\pm$	#	>								
T 6.2.2	LCC analysis of retrofitting the GRS for the wider ship types for the EU SSS and OS																							$\pm$			$\triangleright$		
T 6.2.3	LCC analysis of retrofitting GRS to the fleets																										$\pm$		$\Rightarrow$
																					_								



## WP7 – COMMUNICATION, DISSEMINATION & EXPLOITATION ACTIVITIES



#### WP8 – PROJECT ADMINISTRATION & MANAGEMENT

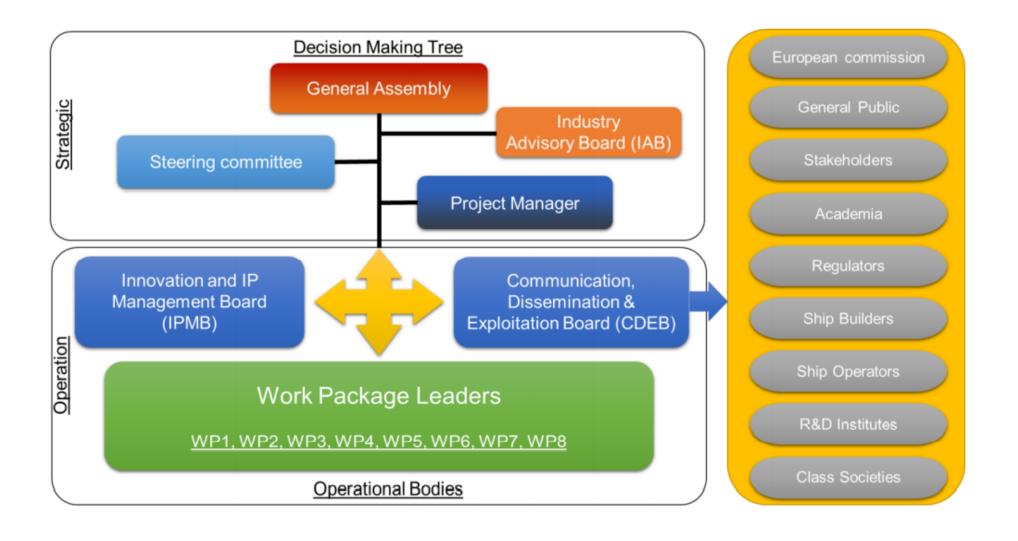
### **WP9 – ETHICS REQUIREMENTS**

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GATE	RUDDER SYSTEM AS A RETROFIT FOR THE NEXT GENERATION PROPULSION AND STEERING OF SHIPS (GATERS)					F	hase	1									Phase	s-2									Pf	hase-3				
	Work packages & Tasks	M1	M2	M3	M4 P	MS M	6 M	7 M	8 MS	) M10	M11	M12	M13	M14 M1	5 M16	M17	M18 N	(19 M	20 M	21 M2	2 M2	3 M24	4 M25	M26	M27	M28 M	29 M3	0 M31	M32	M33 M	34 M35	M36
																							_				$\equiv$	$\pm$	$\pm$			
<b>WP 7</b>	COMMUNICATION, DISSEMINATION AND EXPLOITATION ACTIVITIES																															
T7.1	Strategic planning, coordination and organisation																		Т													
T7.2	Project communication activities																															
T7.3	Project dissemination activities																															
T 7.3	Project exploitation activities																															
WP8	PROJECT ADMINISTRATION AND MANAGEMENT																															
T8.1	Administrative and financial management																		Т													
T8.2	Scientific and technological management																															
MS	PROJECT MILESTONES								$\top$			MS1		MS2			MS3	М	IS4			T						T	MS5		$\top$	MS6
GATE	RUDDER SYSTEM AS A RETROFIT FOR THE NEXT GENERATION PROPULSION AND STEERING OF SHIPS (GATERS)	M1	M2	M3	M4 N	И5 M	6 M	7 M	8 M9	M10	M11	M12	M13	M14 M1	M16	M17	M18 N	119 M	20 M	21 M2	2 M2	3 M24	M25	M26	M27	M28 M	29 M3	0 M31	M32	M33 M	34 M35	M36



# **GATERS – Management structure**









# GATERS – Management, Communication, Dissemination & Exploitation Activities Support Boards

#### **GATERS - Innovation and IP Management Board (IPMB)**

Project Members	ME HYD	SMP	TWI	UoS
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#### **GATERS - Communication, Dissemination and Exploitation Board (CDEB)**

Project Members	CAPA	GME	HYD	SMP	TWI	UNEW	UoS
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### **GATERS - Industry Advisory Board (IAB) and representatives**

Member Institution / Company	Royal Caribbean Cruise Ltd	Wartsila Netherlands BV	Hellenic Tankers Co Ltd	Oscar Propulsion Ltd	Kuribayashi Steam Co Ltd	Shell Int'l Trad & Shipping Co Ltd
Member's	Dr Tor E	Dr Elias	Dr Christos	Mr David	Mr Hirohisa	Mr James
Representative	Svensen	Boletis	Vervenitos	Taylor	Inada	Cocks







## **Project fund**

Total Project Fund [EUR]	<b>EU Contribution</b> [EUR]	Industry Contribution [EUR]
5,878,364.25	4,999,509.98	878,854.27

## Project cost breakdown

Personal cost	Travel, Equipment & Other cost	Indirect cost (25% Flat rate)	Total cost	
[EUR]	[EUR]	[EUR]	[EUR]	
3,131,085.40	1,571,606.00	1,175,672.85	5,878,364.25	

## **Project time and effort**

Project elapsed duration [months]	Project person efforts [months]	
36	694	

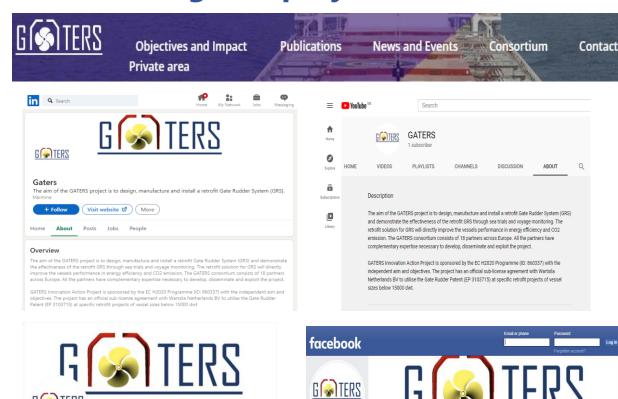


# **Progress on GATERS Project so far**



- Project was officially started in February 2021 with a kick-off meeting held on 24<sup>th</sup> of February
- Project website was launched as well as other CDE activities have been underway including social media interfaces
- WP1 (Preliminary Gate Rudder Design; Model testing and CFD modelling procedure development tasks); WP2 (Target Vessel Trials and Monitoring System installation and data collection task); WP7 (Communication, Dissemination and Exploitation activities tasks); WP8 (Day-to-day management tasks) are underway
- First two critical milestones (MS1 and MS2) are to complete the model tests and confirm the design of the GRS for MV ERGE on M12 and 14, respectively.

# www.gatersproject.com



@gatersprojec

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The aim of the GATERS project is to design, manufacture and install a retrofit Gate

Rudder System (GRS) and demonstrate the effectiveness of the retrofit GRS.

Joined March 2021

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# THANK YOU

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## on behalf of the GATERS Consortium





































## **GATERS Project - Summary**



- Project number: 860337
- Project Acronym: GATERS
- **Project title**: GATE Rudder System as a Retrofit for the Next Generation Propulsion and Steering of Ships
- Call (part) ID: H2020-MG-2019-Two-Stages
- **Topic**: LC-MG-1-8-2019 (Retrofit Solutions and Next Generation Propulsion for Waterborne Transport)
- Fixed EC Keywords: Maritime, Low emission technology in transport
- Free keywords: Novel propulsion and manoeuvring system; Retrofit technology; Short sea shipping operations; Oceangoing shipping operations; Generic and flexible propulsion system; IMO requirements for Emission
- Starting Date: 1 February 2021
- **Duration**: 36M
- **Funding:** 5.894,822.5 M EUR (total); 4,999,510.0M ER (EU requested)
- Call (part) ID: H2020-MG-2019-TwoStages
- Partners no: 18 (11 Industry + 4 Research Institutes + 3 Universities)
- Country no: 9
- Partners: UoS(UK); HSVA(DE); BV(FR); GME(GR); CNR(I); HYD(TR); ITU (TR); TWI (UK); NAS (MT); CAPA(TR); SINTEF(NO); DANAOS(CYP); SMP(UK); GURD(TR); UNEW(UK); STARB(CYP); LLI(UK); CETENA(I)
- Coordinator: University of Strathclyde (UoS); Prof Mehmet Atlar (<u>mehmet.atlar@strath.ac.uk</u>); Tel: +447900890228