

# 'Green Ship of the Future'



## 'Green Ship of the Future'

### A Presentation

Piraeus, Greece 23 June 2009

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FORCE Technology



# 'Green Ship of the Future'



'Green Ship of the Future' is a Danish joint industry project aiming at developing and demonstrating technologies and methods for reduction of air emissions from shipping.

The aim of the project is to provide the necessary technologies and operational means to reduce emissions as follows for newbuildings:

- 30 % reduction of CO<sub>2</sub> emissions
- 90 % reduction of NO<sub>x</sub> emissions
- 90 % reduction of SO<sub>x</sub> emissions

*The base case is the emission level of the average global fleet in 2007 with a time frame of 10 years.*

# Green Ship of the Future Partners



# How to Join . . .



Green Ship of the Future is a joint industry project aiming at developing or demonstrating technologies and methods for reduction of air emissions from shipping. The project is open for all companies and organisations with a project meeting the following conditions:

- The project must aim at demonstration of a technology for reduction of air emissions - either of CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>x</sub> or particles
- One of the partners must be Danish or must have a Danish affiliated company
- The project partners must be willing to join and cooperate with the Green Ship working group (i.e. the group of GSF partners) in order to meet the overall goal for reduction of emissions from ships.



# Network Partners



Green Ship of the Future has established a Network partnership agreement with the following Danish maritime organisations:

- Danish Maritime Authority
- Danish Shipowners
- Danish Maritime
- Danish Marine Group

The role of the Network Partners is to provide a network and to communicate events and project results to their respective members.



# 'Green Ship of the Future'



To meet the reduction targets, the following four groups are considered:

- Machinery;
- Propulsion;
- Operations;
- Logistics;

The project is coordinated by the Danish Centre for Maritime Technology (DCMT). DCMT is a partnership between the Technical University of Denmark (DTU) and FORCE Technology

The coordination is funded by the Danish Maritime Foundation

# Projects: 'Machinery'



## **Dual / Multi MCR Certification**

Development of main engines with dual or multi certification for easy change of MCR rating for any trade route or speed

## **Turbo charging with variable nozzle rings**

Turbo charging with variable nozzle rings result in high efficiency in a wider load range compared to traditional turbochargers, especially at low engine loads, i.e. low speeds.

## **EGR systems**

Development of an Exhaust Gas Recirculation (EGR) system for reduction of NOx emissions on two stroke engines

## **Waste Heat Recovery Systems**

Further development of Waste Heat Recovery (WHR) systems for reduction of energy consumption

## **Auxiliary Systems**

Optimisation of pump and auxiliary systems on a containership and optimisation of pump and cooling water systems on a 34,000 DWT Bulk Carrier Design:

# Projects: 'Machinery'



## **Automated Engine Monitoring**

Optimisation of engine settings by automated monitoring and information system

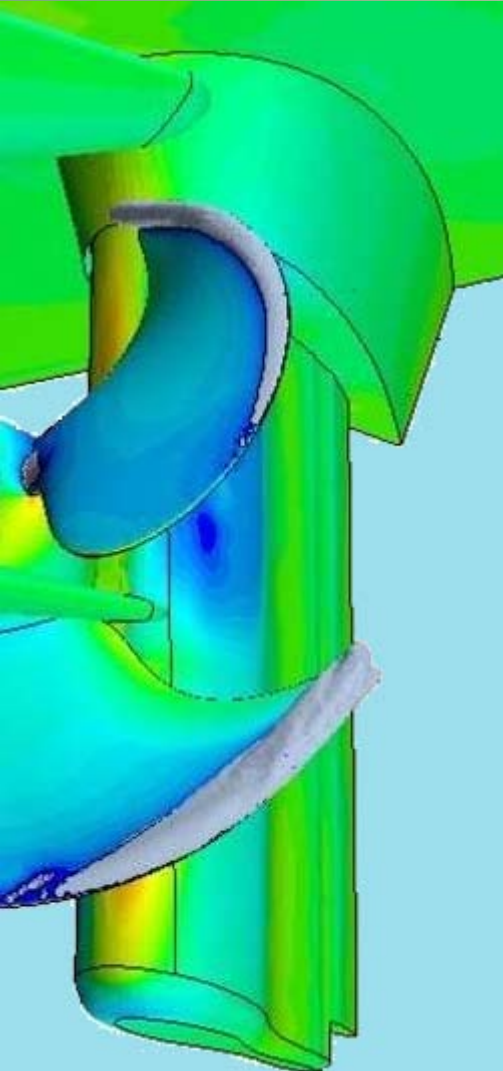
## **Scrubber Systems**

Development of scrubber systems for removal of sulphur and particles

## **Optimised Control for Ship Cooling**

Optimised Control for Energy Optimisation of Ship Cooling Systems

# Projects: 'Propulsion'



## **Air Cavity Systems**

Development and verification of Air Cavitation Systems (ACS) for reduction of frictional resistance

## **Innovative Propeller Design**

New innovative Propeller design with twin blades

# Projects: 'Operation'



## **Forum of Ship Officer Students**

The forum consists of a number of SIMAC students writing their final project. The students study different topics related to on-board applications, challenges or procedures of green ship technologies.

## **Performance Monitoring of Silicone Anti-Fouling**

Documentation of Effect of Silicone Paints based on performance monitoring of sailing ships

# Dual / Multi MCR Certification



## Partners:



MAN Diesel



Development of main engines with dual or multi certification for easy change of MCR rating for any trade route or speed



- Optimal running conditions for different ship speeds eg Turbocharger cut-out, Variable Turbine Area, fuel system equipment, engine settings etc.
- MCR ratings based on current needs & future expectations
- **Potential: 3% reduction in CO<sub>2</sub>**

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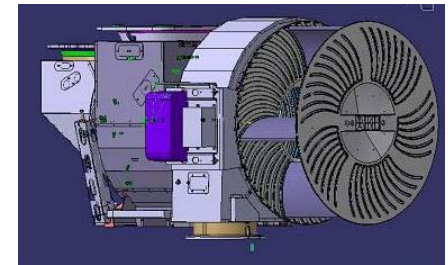
# Turbo Charging & Variable Nozzle Ring

## Partners:



## Variable Nozzle Rings

- Turbo charging with variable nozzle rings result in high efficiency in a wider load range compared to traditional turbochargers, especially at low engine loads, i.e. low speeds.
- Together with APM-M ABB will install the new A100 VTG turbo charger with variable nozzle onboard Alexander Maersk.
- Next stage for turbo-charging is with two-stage turbo charging, which is currently being developed by ABB.



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# Waste Heat Recovery Systems



## Partners:



MAN Diesel



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## Further development of Waste Heat Recovery (WHR) systems

- Optimisation of WHR system in close cooperation with partners
- Determination of vessel operation profile and optimisation of engine for improved exhaust gas data.
- Installation of new exhaust gas fired boiler, turbo generator (steam/gas turbine and generator)
- Optimisation of WHR system given the available space constraints
- **Potential: 20% reduction in CO<sub>2</sub> combined with other emission reduction methods**



# EGR Systems

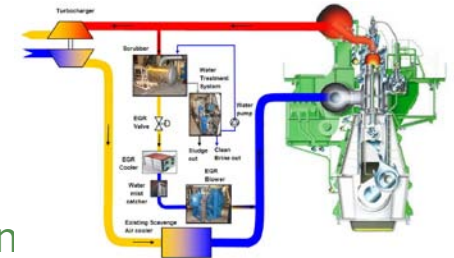


## Partners:



## Development of an Exhaust Gas Recirculation (EGR) system

- Specification and design of an EGR system, including system integration with engine room and aux. systems
- Installation and verification test onboard, incl. EGR system optimisation
- EGR scrubber selection and specification
- Alexander Maersk identified as ship for the first EGR installation
- EGR Installation planned to be ready for testing early 2010
- A prototype EGR system has been set up on the test engine in Copenhagen, with very positive results
- **Potential: NOx reduction by 50%**



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# Pump & Auxiliary Systems

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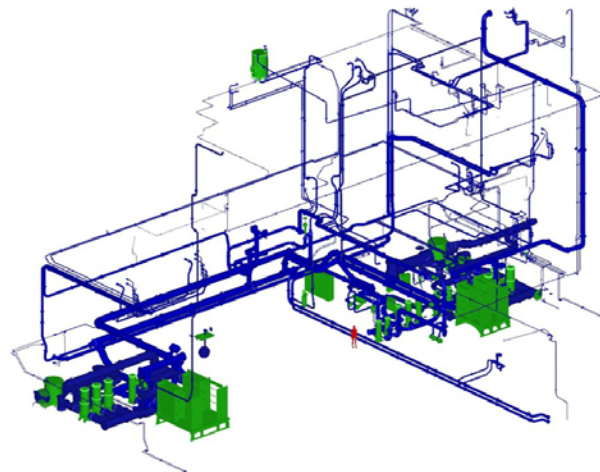
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## Optimisation of pump and auxiliary systems

- Re-design pump & auxiliary systems with a focus on power consumption
- Introduce automated systems that continuously control the power demand
- **Potential: 1% CO<sub>2</sub> reduction for a large container ship**



# Pump- and cooling water systems



## Partners:



## Optimisation of pump and cooling water systems on a 34,000 DWT Bulk Carrier:

- Overall vessel CO<sub>2</sub> emission reduction of 1.5%.
- Corresponding to 20% of the daily auxiliary generated power
- **Potential: 1,5% CO<sub>2</sub> reduction**



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# Automated Engine Monitoring

## Partners:



## Optimisation of engine settings by automated monitoring and information system

- Introduce an automated control system that monitors engine operating parameters and adjusts engine settings for optimal fuel consumption
- Auto-tuning algorithms successfully being verified at full scale field test (electronically controlled engines).
- System design outline in progress
- System requirement specification & project planning initiated
- Full scale test on APM demonstrator vessels (MC engines) prior to December 2009



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# Air Lubrication System (ACS)

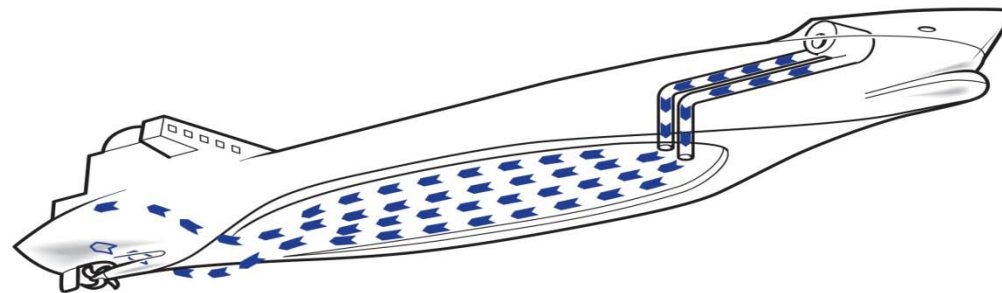
## Partners:



## Development and verification of Air Lubrication System (ACS):



- Up to 15% fuel reduction with ACS stand alone design
- Ship is build and sea trial performed. Service test in progress
- Pay-back time 2-4 years
- **Potential up to 15 % CO2 reduction**



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# Scrubber Systems



## Partners:



MAN Diesel



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## Development of scrubber systems for removal of SO<sub>x</sub> and particles

- Investigate and utilise exhaust gas scrubber technology to clean the exhaust gas
- Full design, development, and installation of the scrubber
- Removal of particulate matter, SO<sub>x</sub>, HC, and heavy metals
- In June 2009 a scrubber will be installed and tested on a DFDS vessel
- **Potential 90% SO<sub>x</sub> reduction and at least 90% reduction in particulate matter**



# Innovative Propeller



## Partners:



## New innovative Propeller design with twin blades

The aim of the propeller project is to increase the velocity and expand the water flow area on the propeller blades, by implementing the Injector effect on each propeller blade . The Injector channels will make the whole area of each single propeller blade to generate thrust due to the Injector.



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# SIMAC GSF Student Forum

## Partners:



**SIMAC will establish a Student Forum with focus on Green Ship technologies**

The forum will consist of a number of SIMAC students writing their final project. The students will study different topics related to on-board applications, problems or procedures of green ship technologies.

FORCE will arrange contact between the students and relevant partners in the GSF if needed.



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# Optimised Control for Ship Cooling



## Partners:

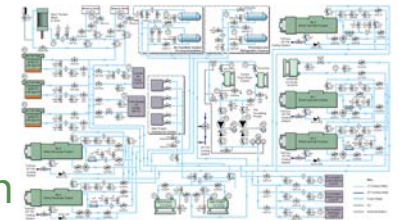


## Optimised Control for Energy Optimisation of Ship Cooling Systems

In two projects, optimised control algorithms for Reefer systems (joint project with Lodam A/S), and for general High Temperature (HT) and low temperature (LT) onboard refrigeration systems are being developed by Aalborg University.

The latter system is designed for an APM-M newbuilding, and the effect is documented by means of advanced simulations.

**Potential:** The project is still at an early stage, but preliminary results indicate significant energy savings, possibly as much as 45% (rough estimate).



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# Performance Monitoring - SeaTrend



## Partners:



## Documentation of Effect of Silicone Paints

HEMPEL and FORCE Technology has made an official agreement to monitor all new applications of HEMPASIL X3 with the SeaTrend performance monitoring software

Currently a number of vessels have been applied with both X3 paint and SeaTrend software.

Based on the experience from the project the effect of the newest generation of silicone paints will be documented.



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# Invitation ...



Alle companies, Organisations and R&D Institutes are invited to join  
'Green Ship of the Future'

## Contacts

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More information on



[www.greenship.org](http://www.greenship.org)