



LOGISTICS & MARITIME FORUM  
European trends and regional perspectives

15-16 February 2017, Piacenza Expo

## Scenario Analysis for the Use of LNG as Marine Fuel in the Western Mediterranean. The Case of the GAINN Key Pilot Projects

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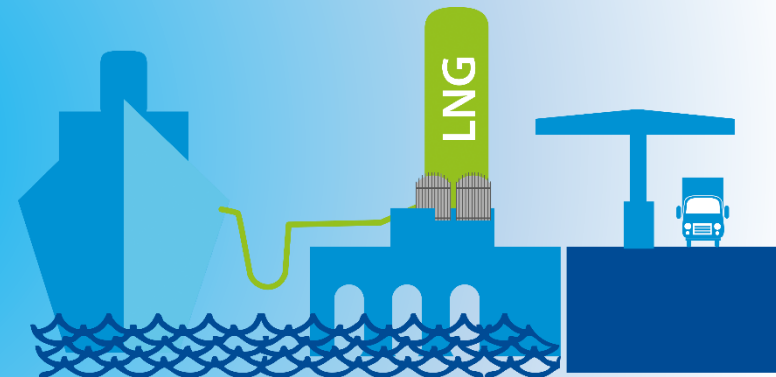
# LOW-SULPHUR MARINE FUELS WITHIN THE EU

DIRECTIVE 2012/33/EU – DIRECTIVE 2016/802/EU

## 0.5% Sulphur limit 2020

# LNG BUNKERING STATIONS AT CORE PORTS

DIRECTIVE 2014/94/EU







**Financial feasibility analysis of the best option to comply with international environmental regulations of the entire Mediterranean short-sea fleet**



**171 business cases analysed individually**



**LNG maximum bunkering demand potential in m<sup>3</sup> / year for each Mediterranean core port**



**Savings, reduction of emissions, investments required and profitability indicators for each ship in the Med SSS fleet**

**PORTUGAL, SPAIN AND ITALY**

No. of ports of study 56

No. of total destination ports 167



No. of lines 116

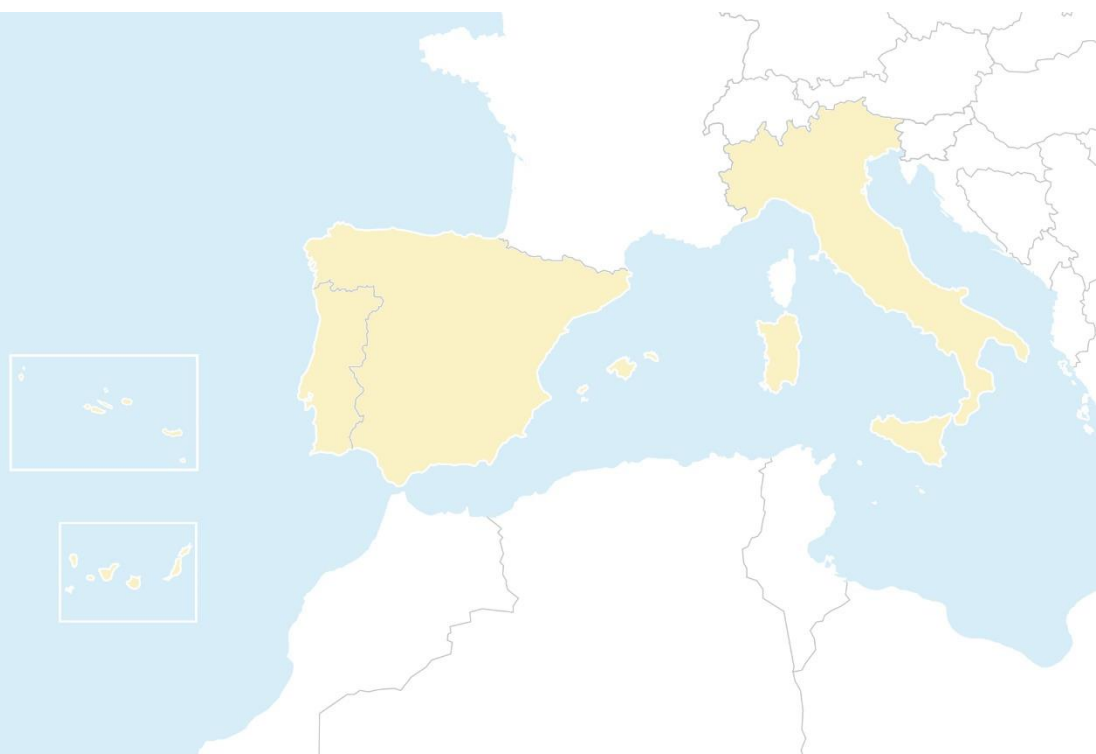
No. of shared lines 6

No. of ports by line 3

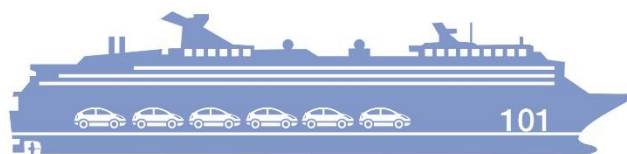
Weekly frequency 19



No. of sea carriers 24







39



31

**171**  
**vessels**

RO-PAX RO-RO PAX



GT	20,215.2
DWT	4,051.8
Speed	23.9
Engine power (kW)	22,686.1
Fuel consumption (tonnes/day)	84.6
Age in 2020	22.2



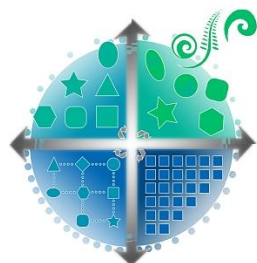
GT	24,001.3
DWT	10,170.2
Speed	20.0
Engine power (kW)	16,550.9
Fuel consumption (tonnes/day)	59.2
Age in 2020	16.4



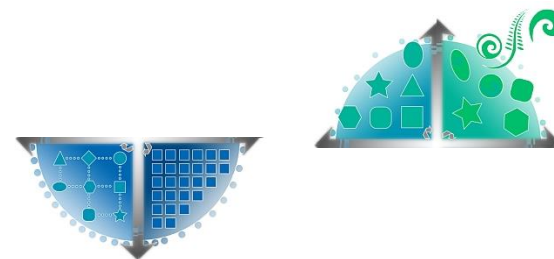
GT	499.2
DWT	61.0
Speed	23.0
Engine power (kW)	2,857.7
Fuel consumption (tonnes/day)	12.4
Age in 2020	20.8



Scenarios



## TWO SCENARIOS



INPUT FACTOR	LOW BRENT	HIGH BRENT
HFO Price (Euros / tonne)	236	539
MDO Price (Euros / tonne)	461	1,053
MGO Price (Euros / tonne)	501	1,144
LNG Price (Euros / tonne)	354	528
Discount rate	12%	15%
Inflation rate	2%	3%
Gap in LNG – HFO price (% annual change)	0.00%	0.50%
Gap in LNG – MGO price (% annual change)	0.00%	0.50%



# Savings in Environmental Emissions



## ANNUAL SAVINGS IN ENVIRONMENTAL EMISSIONS

### PORTUGAL, SPAIN AND ITALY



#### FUEL CONSUMPTION

	LOW BRENT SCENARIO	HIGH BRENT SCENARIO
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CURRENT CONSUMPTION	408,357,058	932,645,993
LNG CONSUMPTION	454,100,366	677,493,623
MGO CONSUMPTION	737,695,646	1,684,821,835



#### SAVINGS / EXTRA COSTS DUE TO FUEL CHANGE

	LOW BRENT SCENARIO	HIGH BRENT SCENARIO
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SAVINGS LNG vs. HFO	- 45,743,308	255,152,370
SAVINGS LNG vs. MGO	283,595,280	1,007,328,212

### PORTUGAL, SPAIN AND ITALY

#### TOTAL EMISSIONS ( tonnes/ year)

TOTAL CO <sub>2</sub> EMISSIONS	4,926,732
TOTAL NO <sub>x</sub> EMISSIONS	109,263
TOTAL SO <sub>x</sub> EMISSIONS	100,617
TOTAL PM <sub>x</sub> EMISSIONS	13,704



#### TOTAL AVERAGE ANNUAL REDUCTIONS (€)

REDUCTIONS CO <sub>2</sub> IN 2016	10,599,595
REDUCTIONS CO <sub>2</sub> IN 2025	32,433,658



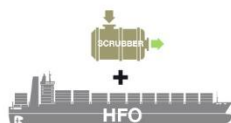


Feasibility of LNG as a Fuel for the Mediterranean SSS Fleet: Profitability, Facts and Figures

**INVESTMENTS AND FINANCIAL FEASIBILITY ANALYSES**



## AVERAGE INVESTMENTS IN 2017

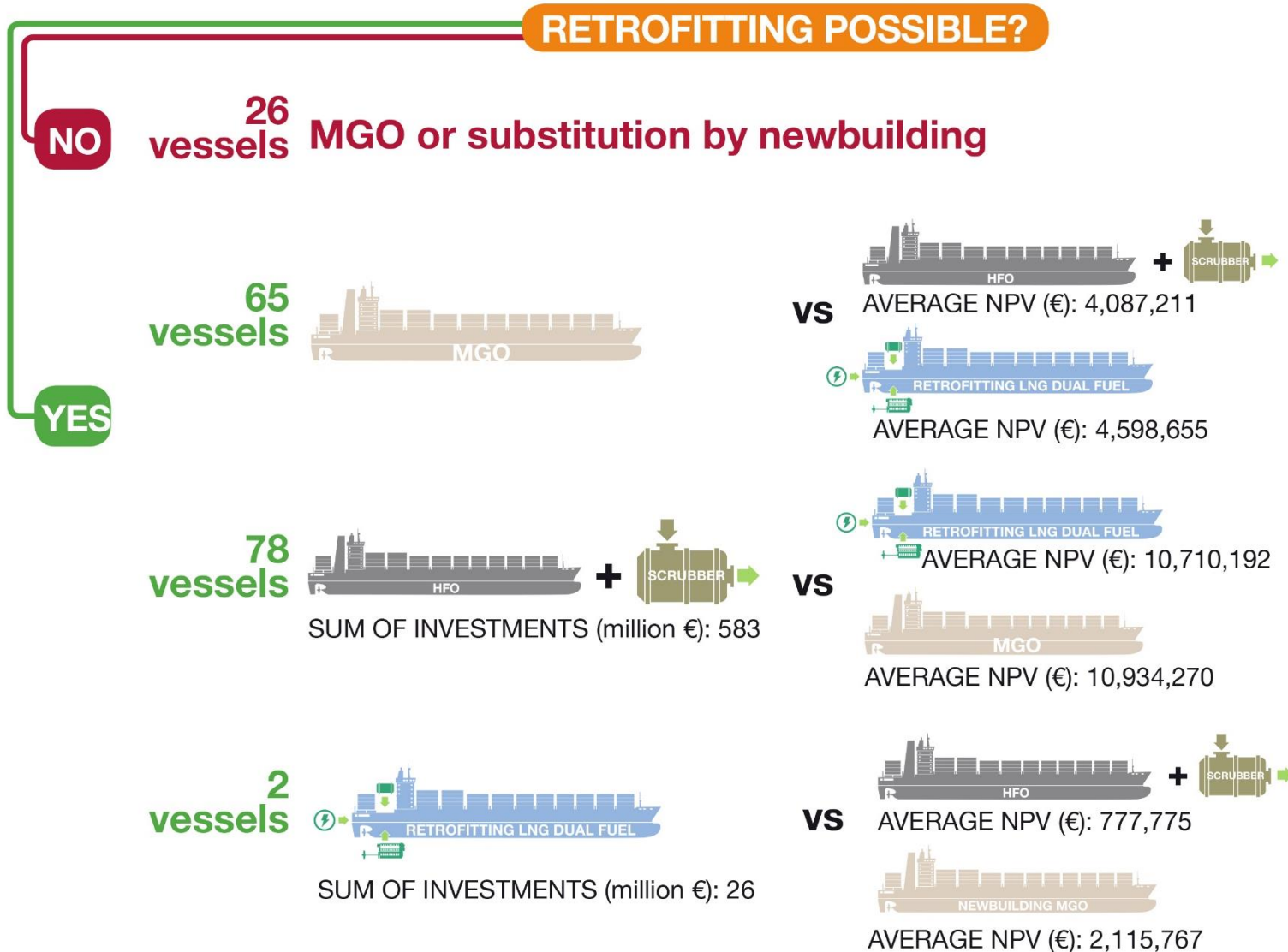


HSC	* NP	15,960,585	16,545,068	* NP	15,960,585
HSC1	* NP	6,833,722	7,087,499	* NP	6,833,722
RO-PAX0	3,200,784	3,971,035	3,498,693	4,950,130	1,749,346
RO-PAX1A	2,977,474	9,980,943	8,075,551	6,698,404	3,720,930
RO-PAX1B	4,904,268	10,897,779	10,125,116	10,324,233	5,419,964
RO-PAX2	5,731,637	14,617,874	14,463,421	12,911,413	7,179,777
RO-PAX3	8,723,998	17,360,339	19,514,748	19,121,209	10,397,211
RO-PAX4	11,463,236	28,196,038	28,548,318	24,452,073	13,742,591
HSC1	* NP	*NP	1,738,098	* NP	1,675,864
PAX	* NP	1,919,966	1,390,614	* NP	725,918
RO-RO1A	2,754,163	2,326,395	1,648,905	3,463,641	709,478
RO-RO1B	3,538,716	4,669,394	4,014,885	5,224,092	1,685,376
RO-RO2	5,731,637	13,313,930	12,976,759	11,225,606	5,493,969
RO-RO3	5,731,637	8,945,897	12,931,152	10,926,463	5,194,826

\* NP: Retrofitting this type of vessel is not possible due to excessive dimensions and weight of existing engines



## BEST OPTION FROM A FINANCIAL PERSPECTIVE – LOW BRENT SCENARIO





## Uncertainty →



### HIGH BRENT SCENARIO:

89 vessels to be LNG retrofitted, 25 scrubbers installations and 57 would use MGO as marine fuel

Investments: 157 million Euros installing scrubbers and 1.3 billion Euros retrofitting to LNG dual fuel

Annual LNG bunkering needs: 2.1 million m<sup>3</sup>

### LOW BRENT SCENARIO:

Only 2 vessels to be LNG retrofitted, 78 scrubbers installations and 91 would use MGO as marine fuel

Investments: 26 million Euros in LNG retrofitting and 583 million Euros in installing scrubbers

Annual LNG bunkering needs: 51,428 m<sup>3</sup>

A green road sign with the word "Uncertainty" in white, set against a blue sky with clouds. The sign is tilted and mounted on two wooden posts. The word "Uncertainty" is written in a large, white, sans-serif font. The background is a bright blue sky with scattered white clouds. The sign has a white border and is mounted on two wooden posts.

Uncertainty

## MAIN RISK FACTORS →

- ① **Gap between HFO, MGO and LNG prices**
- ① **Logistic costs of distributing LNG**
- ① **Investments required once the LNG engines reach an industrial manufacturing stage**
- ① **International and EU regulation**
- ① **Sufficient bunkering stations for all routes**

○ DOWNS ↓ DE: Many risk factors → UNCERTAINTY PREVAILS

○ UPS ↑ DE:



**RISK**



**FUTURE INVESTMENTS**



Action Number: **2014-EU-TM-0698-M**



Action Number: **2014-EU-TM-0700-S**



**January/2015 – September/2019**

European Union, Connecting Europe Facility Transport Call for Proposals, 2014



Co-financed by the European Union  
Connecting Europe Facility



## GAINN4MOS GENERAL OVERVIEW



**6 EU  
COUNTRIES**



**16 PORTS**



**6 SEA CARRIERS**



**19 PARTNERS**



## GAINN4MoS Partners:



## MIT Implementing Bodies in GAINN4MoS Action:







## 4 Ship Prototypes and Engineering Studies



### **SPABUNKER CUARENTA (Valencia)**

Type of Vessel: Bunkering Barge

Overall Length: 73.79 m

DWT: 4,200 Tn

Total Capacity of Tanks: 12,623.7 m<sup>3</sup>

**Challenge:** Maintaining capacity to supply conventional fuels whilst ensuring safety of operations with different fuels.



### **TUGBOAT (Leixoes)**

Type of vessel: Tractor

Propulsion: Azimuthal

**Challenge:** Finding space to position the LNG tanks and complying with safe ventilation distances.



### **Engineering study of ropax MV LOBO MARINHO (Madeira)**



### **Engineering study of the containership MV FUNCHALENSE 5 (Madeira)**



### **MV CORVO (Açores)**

Type of vessel: General Cargo Ship

Overall Length: 119.80 m

DWT: 8,893 Tn

Total Cargo Capacity: 610 TEUs

**Challenge:** Maintaining the ship's autonomy. Several LNG storage alternatives will be explored, including ISO tanks on board.



### **PAX/ROPAX PROTOTYPE (Italy)**

Type of vessel: Passenger/Ropax Ship

Total Cargo Capacity aprox.: + 1,000 passengers + 600 linear meters

**Challenge:** Lack of LNG bunkering services in Southern Italy and Sicily.



### **Three engineering studies of pax or ropax vessels (Italy)**



**LNG technologies and innovation for maritime transport for the promotion of sustainability, multimodality and efficiency of the network**

**Action Number: 2014-ES-TM-0593-S**



**Co-financed by the European Union**  
Connecting Europe Facility



**Action Number: 2014-ES-TM-0593-S**



**January/2015 – December/2018**



# LNG dual-fuel

## retrofitted ropax high-speed craft

1<sup>st</sup>  
in the World



ga.lnn  
4Ship Innovation



Co-financed by the European Union  
Connecting Europe Facility

FV  
FUNDACIÓN  
valenciaport

FRED. OLSEN  
Express

valenciaport  
autoridad Portuaria de Valencia

GOBIERNO DE ESPAÑA  
MINISTERIO DE FOMENTO

CIMNE



## Bencomo Express: An LNG dual-fuel retrofitted ropax HSC

TENERIFE

Santa Cruz de Tenerife

Agaete

GRAN CANARIA

Distance: 36 nm

Transit time: 1 hour

Round trips: 3/day

Year of construction: 1999

Speed: 38 Knots

Capacity



871 passengers 330 line metres

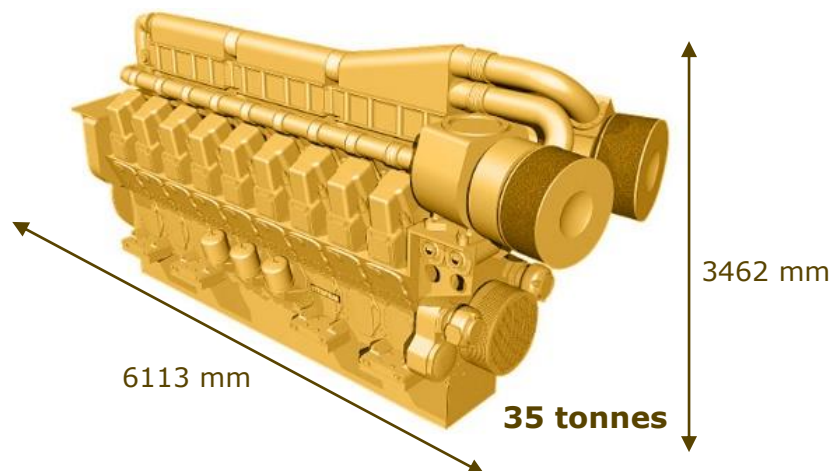


**Main engines: 4 x CAT 3618**

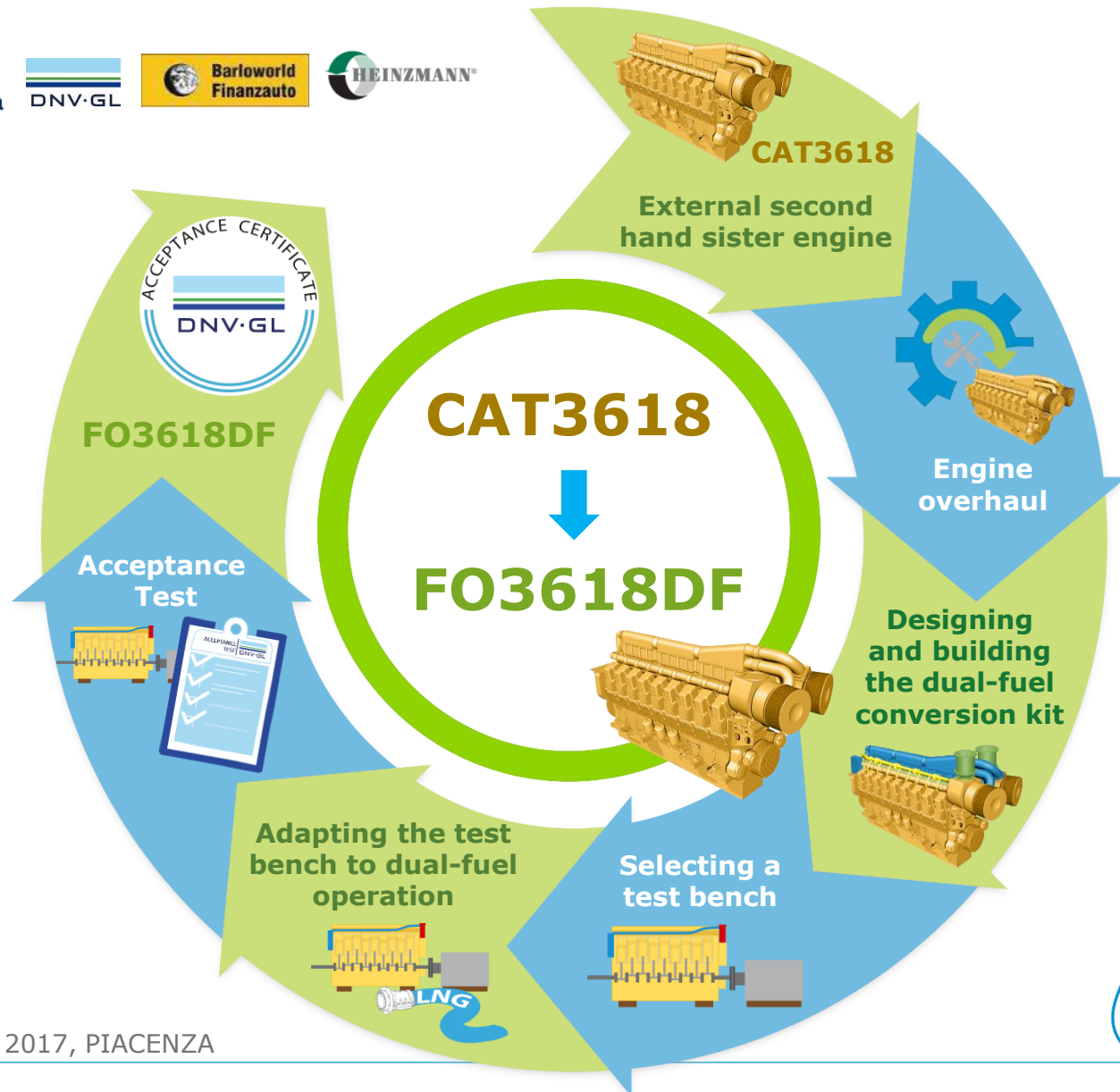
(4 x 7200 kW)

Auxiliary engines: 4 x CAT 3406

Waterjets: 4 x Wartsila LIPS LJ 150D

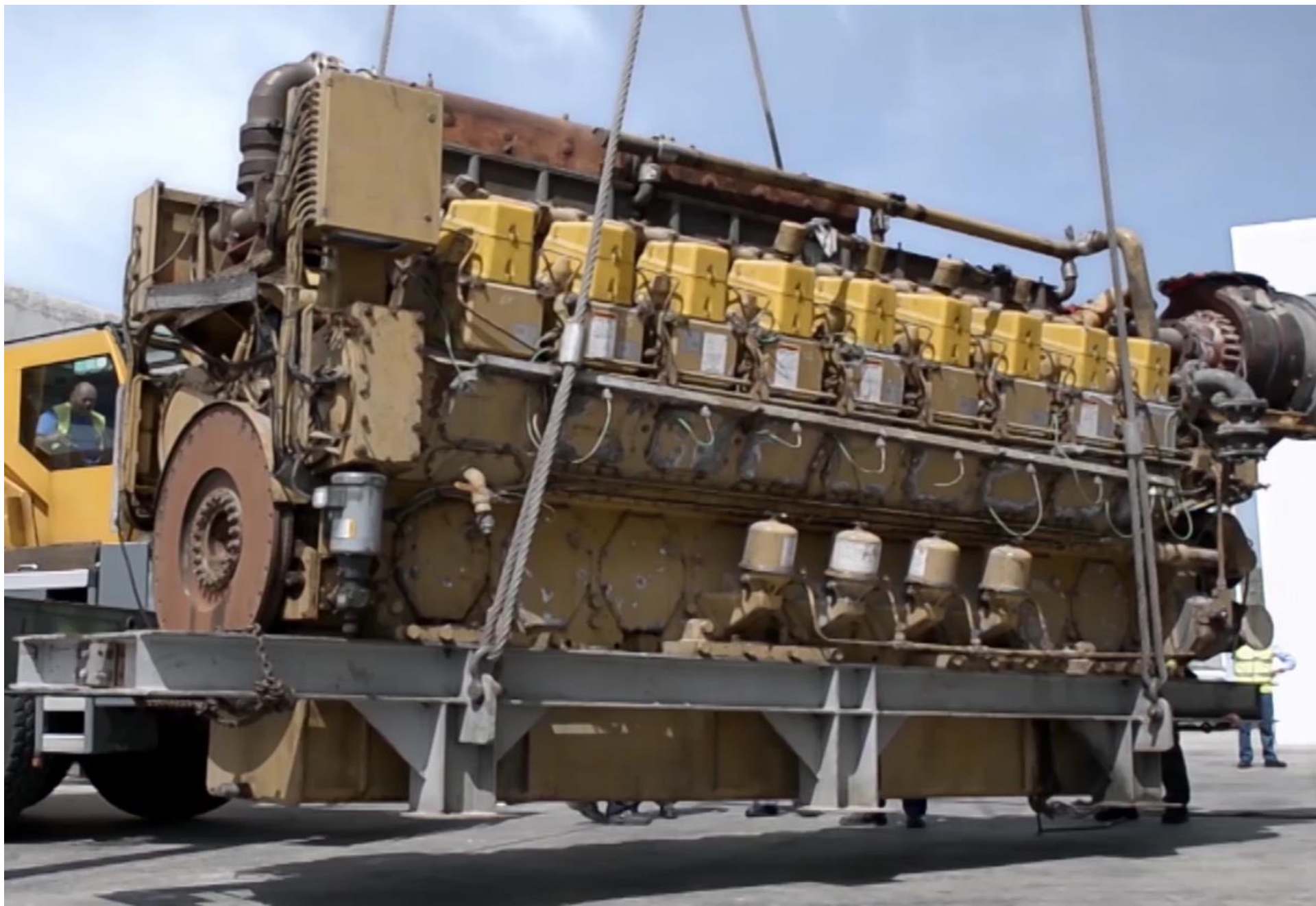


# Step 1. Adapt an external engine to run on dual fuel

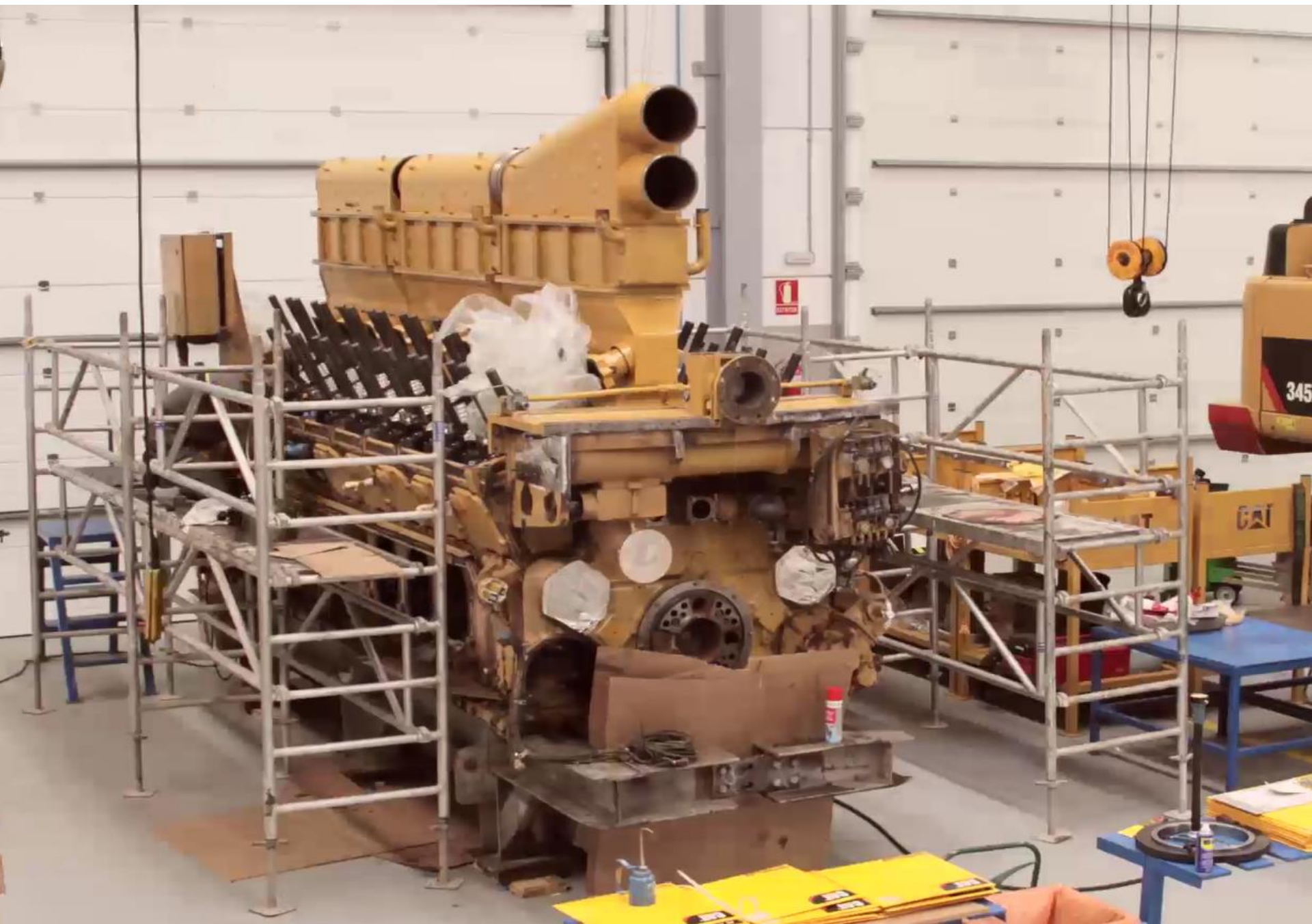




# External second hand sister engine

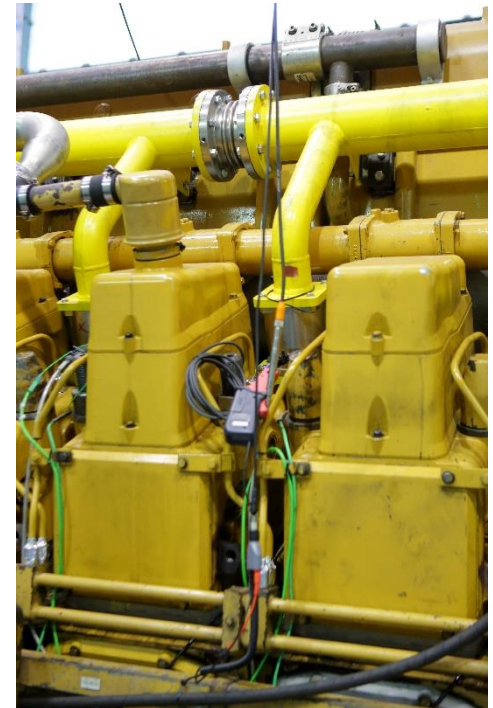
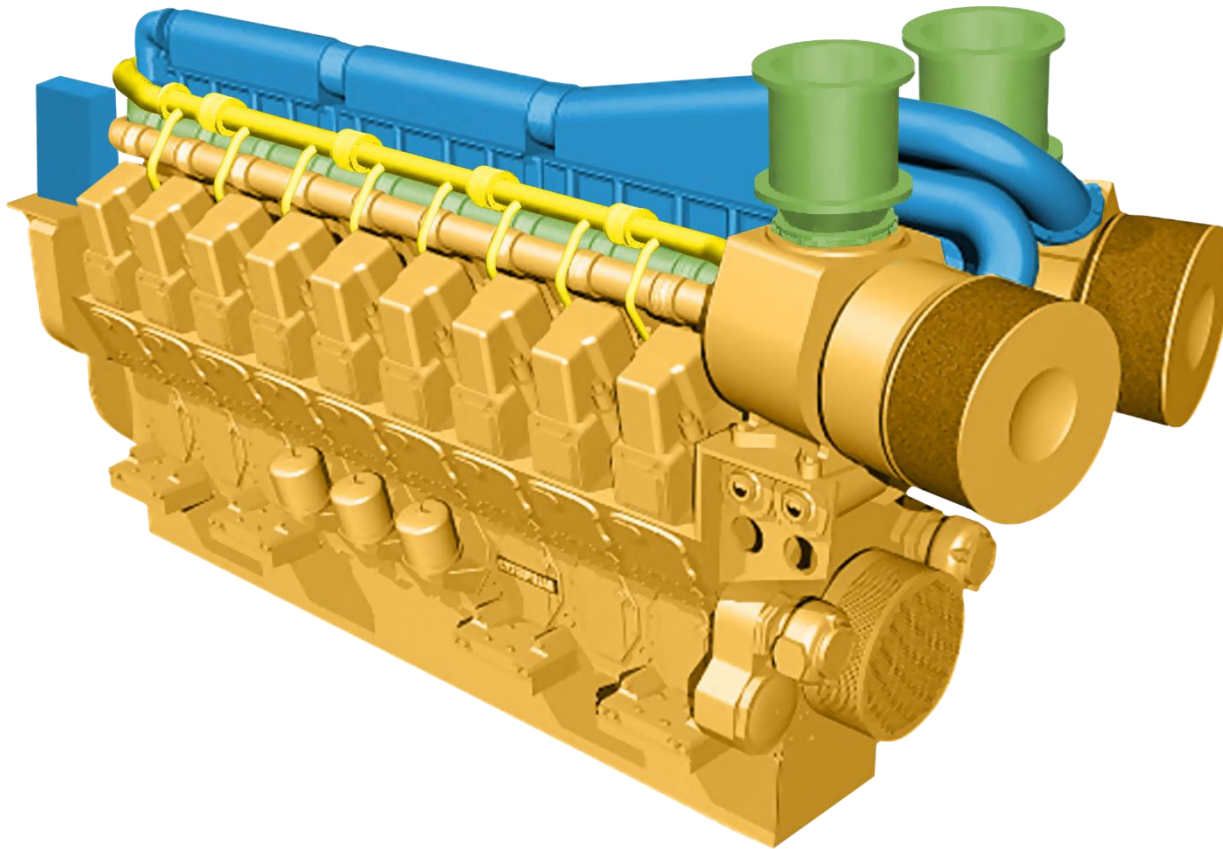


# Engine overhaul

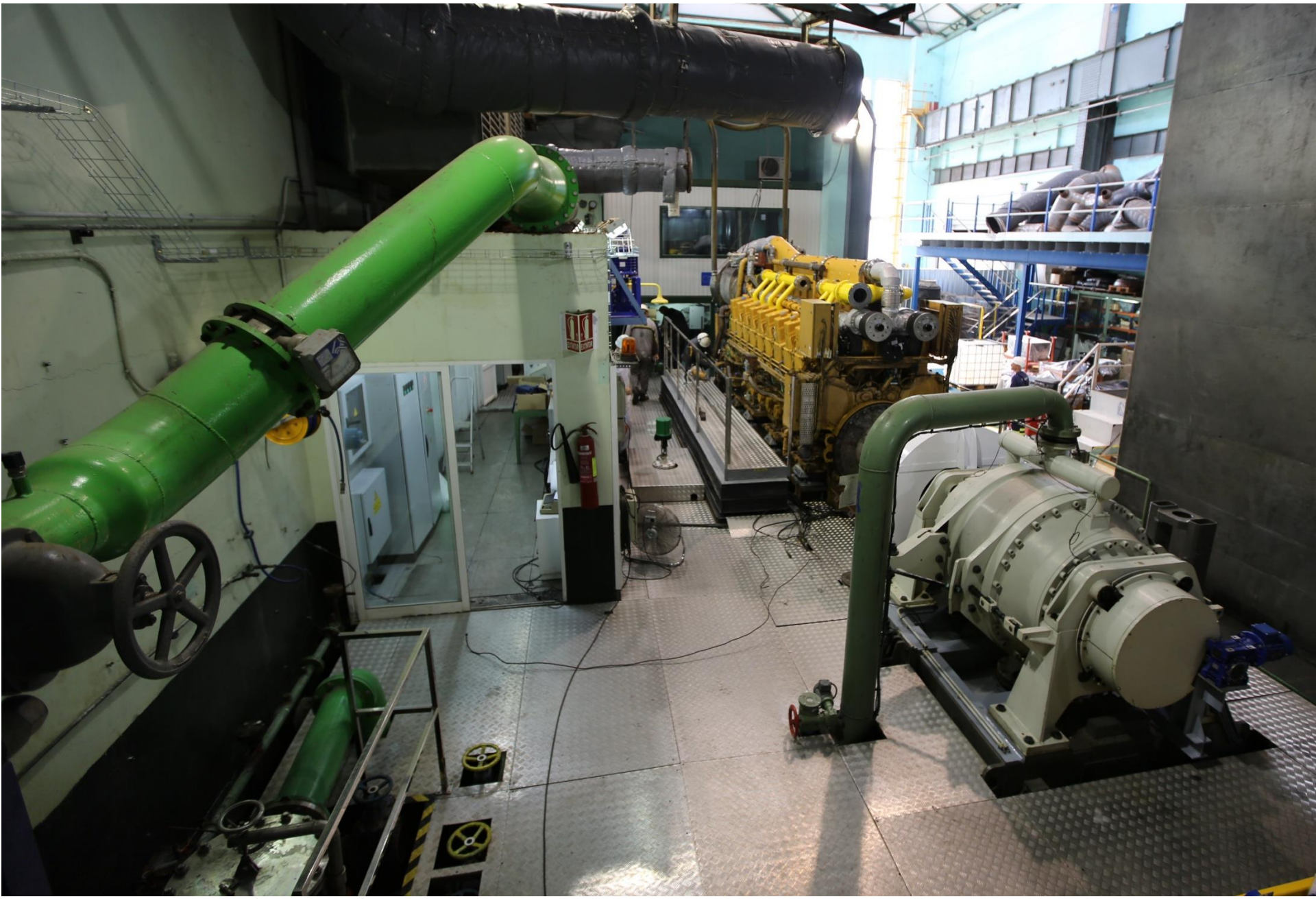




# Designing and building the dual-fuel conversion kit



# Test bench







## Adapting the test bench to dual-fuel operation

# LNG





GAINN4SHIP INNOVATION: Event at Shipyard



Co-financed by the European Union  
Connecting Europe Facility

October  
27  
2016

GAINN4SHIP INNOVATION

Acceptance Test for the **Dual-Fuel engine FO3618DF**  
to retrofit the high-speed ropax vessel  
**Bencomo Express**

Location: NAVANTIA (Cartagena - Murcia, Spain)



# Retrofitting ropax HSC

## STEP1

TO ADAPT  
AN **EXTERNAL  
ENGINE TO RUN  
ON LNG**



## STEP2

TO CONVERT THE  
**FOUR ENGINES AND  
VESSEL'S SYSTEMS**



## STEP3

REAL LIFE  
TRIALS





## JOIN OUR SOCIAL NETWORKS!



[\*www.gainnprojects.eu\*](http://www.gainnprojects.eu)



[GAINN: LNG Ship Retrofitting & Bunkering Station Pilots](#)



[@GAINNprojects](#)



# Thanks for your attention!

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