C-ENERGY Technologies AB

HYDRAULIX system

– Hydraulically operated Fuel Injectors

C-ENERGY Technologies AB

Introduction

- founded 2020 in Gothenburg
- engineering experts focusing on the maritime and stationary energy transition

- the C-ENERGY **HYDRAULIX** system is a proven design
- providing emission compliance for existing Diesel engines
- robust and reliable fuel and emission saving solution
- verified functionality, performance and durability

- C-ENERGY Technologies provides also an **E.G.R.** system for reducing NO_x and can be installed on any possible marine or stationary application
- both **HYDRAULIX** and the **E.G.R.** system from C-ENERGY can be combined together

Description of the HYDRAULIX system

- when the engine is running and the HYDRAULIX system is installed, a constant hydraulic oil pressure is being applied to the fuel injector in order to avoid the spring bouncing and fuel dropping into the combustion chamber after the fuel pump is closed
- the fuel injector will be modified 1) hydraulic oil supply into the spring chamber and 2) fuel oil leakage opening will be closed; recommended to be done before a scheduled maintenance of the fuel injector
- with the improved function of the fuel valve through the HYDRAULIX system a better combustion is achieved especially outside the optimized MCR range
- the improved combustion is leading to a lower fuel oil consumption, less emissions as well an extended Time Between Overhaul (TBO) and an extended service life on engine parts
- works on 2-stroke and 4-stroke Diesel engines

HYDRAULIX – WORKING PRINCIPLE & TECHNICAL SETUP

Hydraulic Pump Unit (HPU)

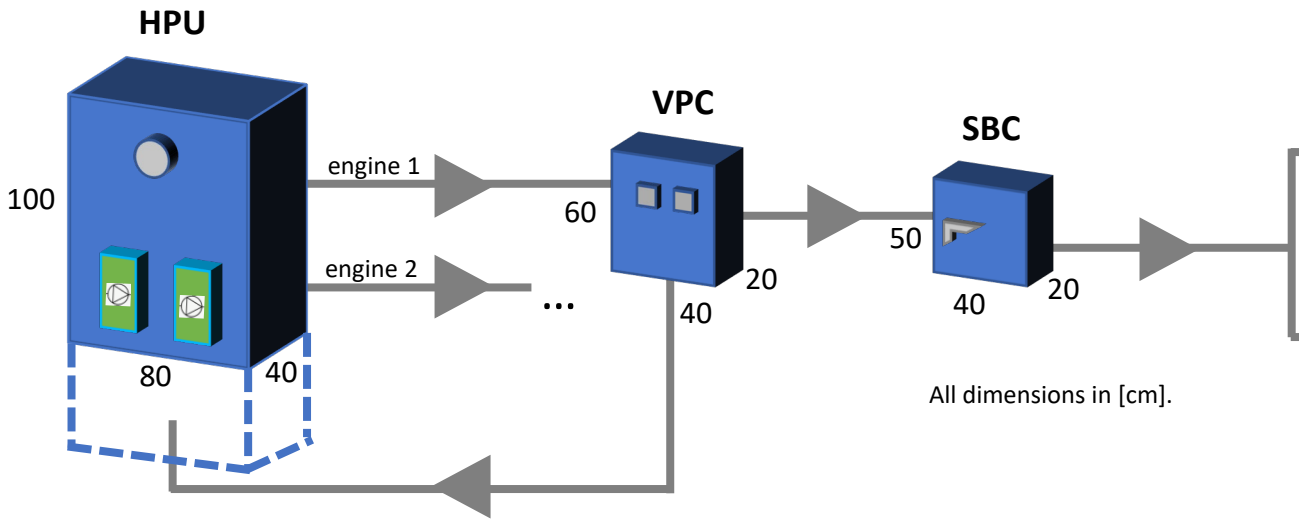
- including oil tank underneath, operating and standby pump for redundancy, all electrical equipment; oil is the same as engine lubrication oil
- pump capacity can be chosen for multiple engine application if required

Variable Pressure Controller (VPC)

- this pressure control unit consists of a distribution block, proportionality valve and a current calculator
- calculation give the signal for the right pressure

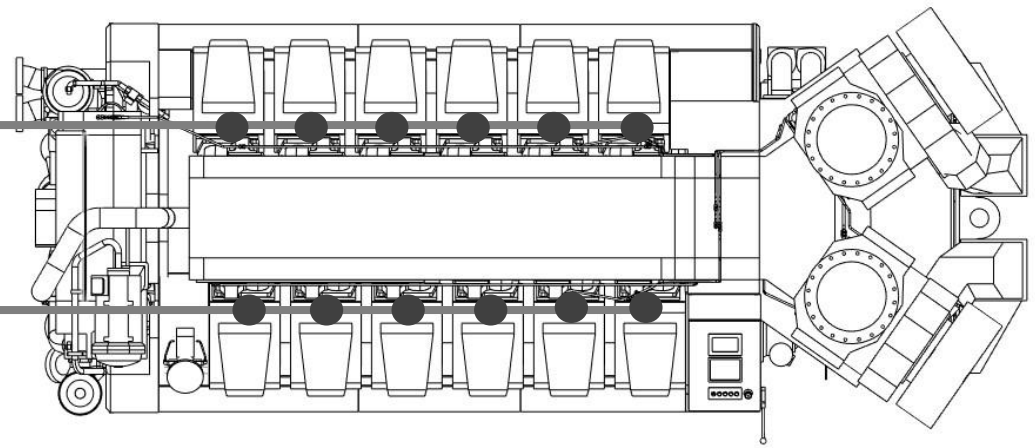
Separation Block Cabinet (SBC)

- this cabinet needs to be installed as close as possible to the engine
- main task is to act as a shut-off device and a monitoring unit for the pressures



All dimensions in [cm].

typical V-type Diesel engine (top view) as example



high pressure distribution pipes
(single-walled or double-walled available)

modified fuel injector (details are not shown)

ARGUMENTS FOR C-ENERGY HYDRAULIX SYSTEM (1/4)

- a Standard Fuel Valve is designed to work at a fixed MCR around 85-100% depending on the application
- when running the engine in partial load, the poorer atomization of the fuel results in drips, coating and deposits of coke leading to a bad combustion
- this results in a high fuel consumption and worse emission values

=> Installing the C-ENERGY HYDRAULIX system will solve this problems

ARGUMENTS FOR C-ENERGY HYDRAULIX SYSTEM (2/4)

DNV

C-ENERGY TECHNOLOGIES
Fiskebäcks Hamn 34
426 58 Västra Frölunda
Sweden

DNV Ship Classification
Engines & Pressurized Equipment
Brooktorkai 18
20457 Hamburg
Germany

Date:	Our reference:	Your reference:
2023-03-22	10701727-2	Email dated 2023-01-17

Technical evaluation of the C-ENERGY HYDRAULIX system for Diesel engines

Dear Sir,

We have received your above-mentioned request to check and validate your product HYDRAULIX for safety on Diesel engines.

The aim of the product, accordingly to your information, is to save fuel and reduce the CO_2 emissions. We have received your Sales Presentation as well as a further confidential technical drawing regarding the modification in the fuel injector as data basis for review.

Due to the wide range of Marine engines and applications, DNV can at this stage not comprehensively check and validate this product but has in principle no objections against an installation of the HYDRAULIX system on Diesel Engines.

We would like to point out that, each modification of class relevant components on board a vessel is subject of a case-by-case approval.

Sincerely
for DNV

Digitally Signed By: Neddenien, Sven
Location: DNV Hamburg, Germany
Signing Date: 2023-03-22

Sven Neddenien

Mobile: +49 173 6141968
sven.neddenien@dnv.com

DNV Headquarters, Veritasveien 1, P.O.Box 300, 1322 Høvik, Norway. Tel: +47 67 57 99 00. www.dnv.com

C-ENERGY TECHNOLOGIES

- DNV has issued a “Letter of No Objection” in principle for our HYDRAULIX system on Diesel engines
- no class relevant components will be changed or modified
- our customers will always be supported is case of any Class questions

ARGUMENTS FOR C-ENERGY HYDRAULIX SYSTEM (3/4)

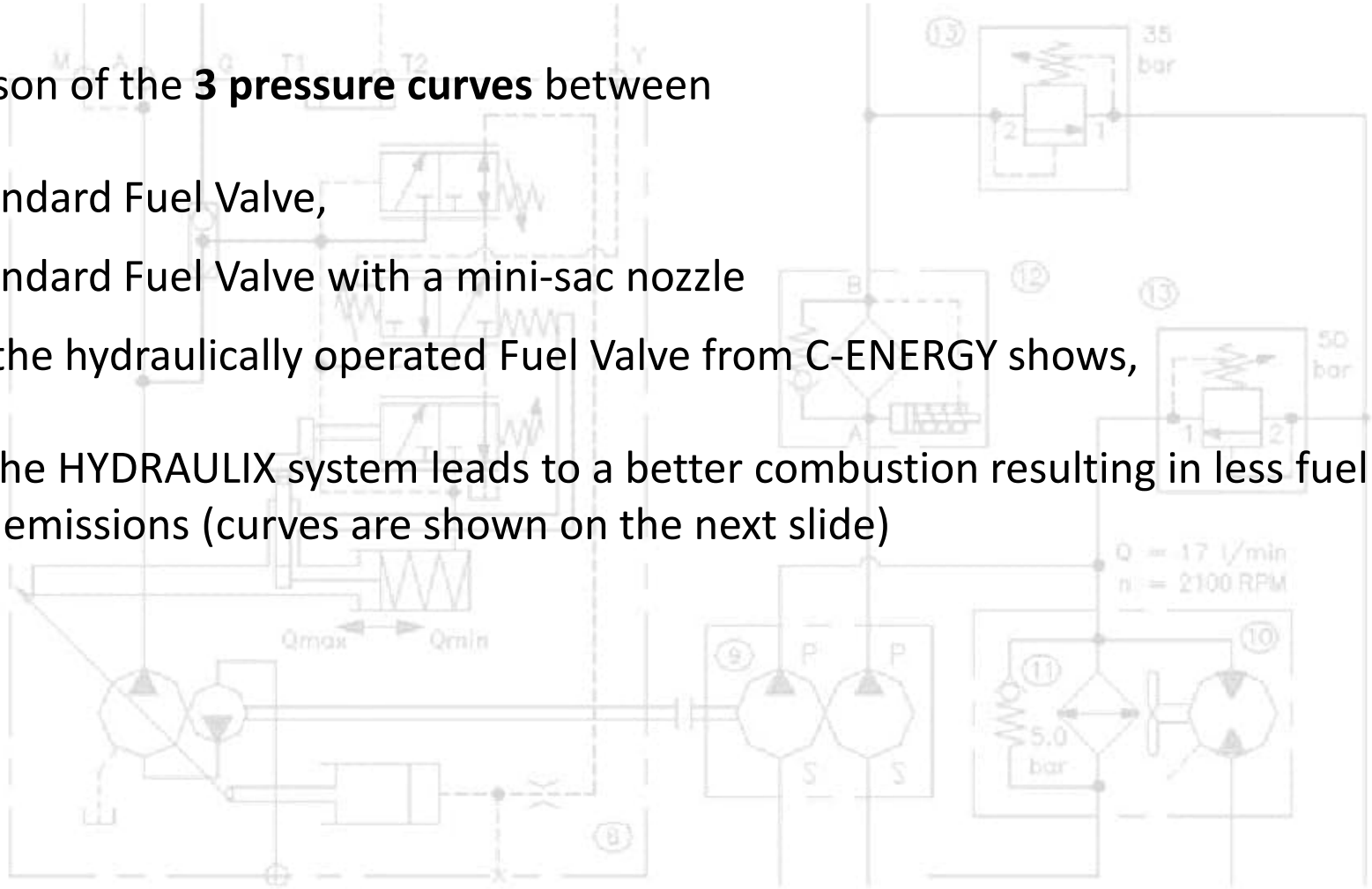
- a comparison of the **3 pressure curves** between

  a Standard Fuel Valve,

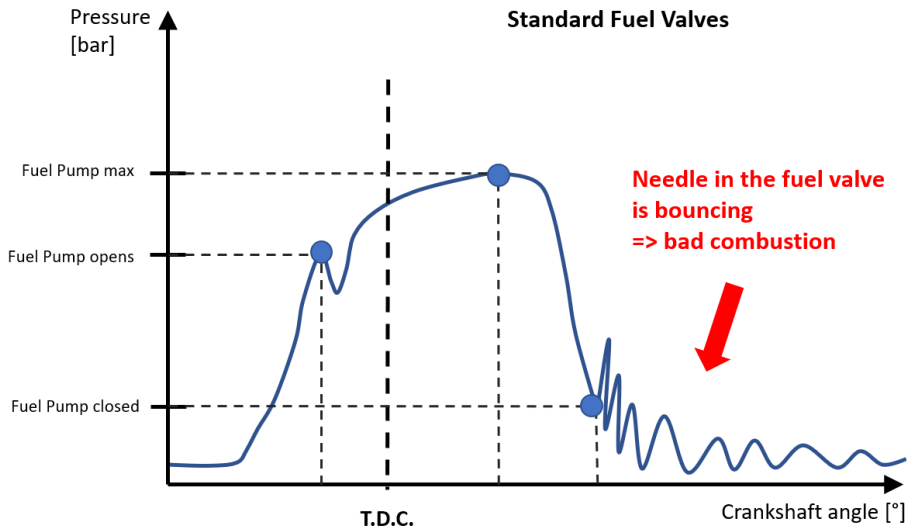
  a Standard Fuel Valve with a mini-sac nozzle

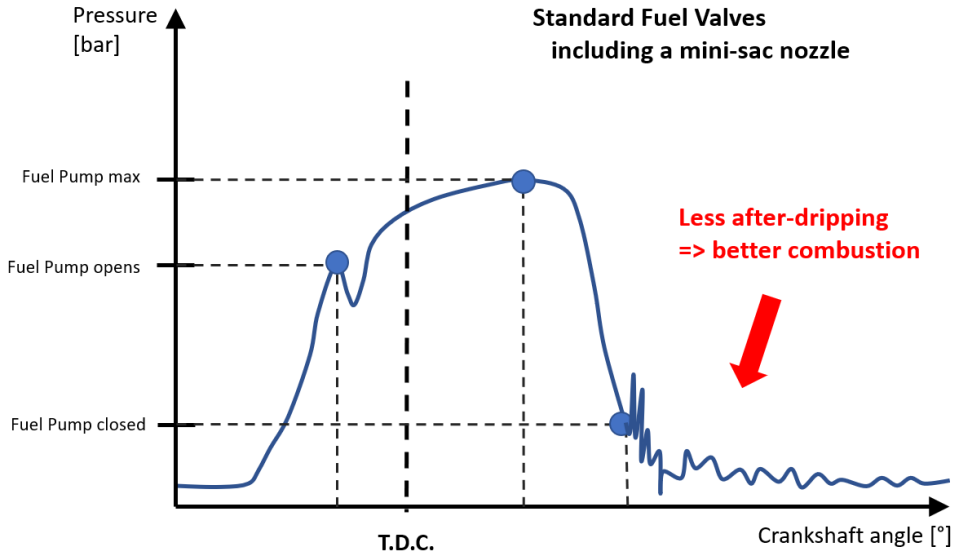
  and the hydraulically operated Fuel Valve from C-ENERGY shows,

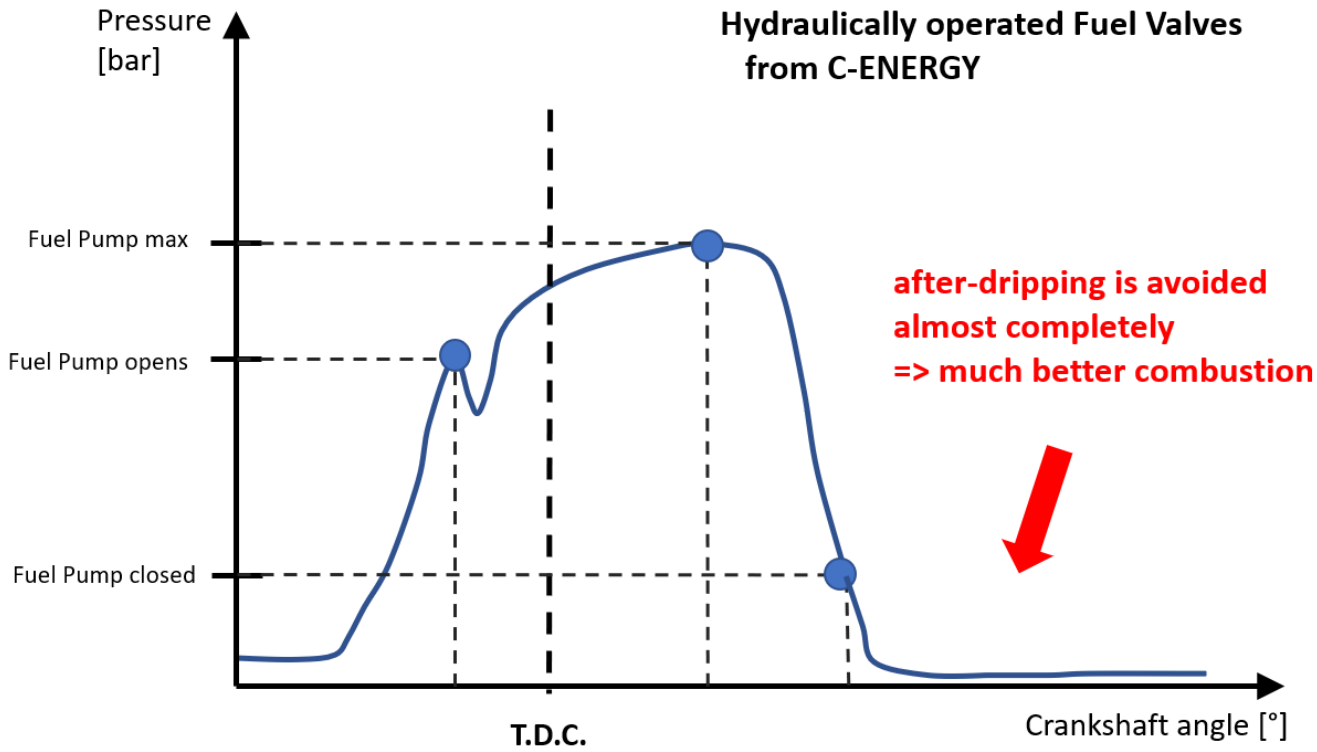
  that only the HYDRAULIX system leads to a better combustion resulting in less fuel consumption and lower emissions (curves are shown on the next slide)



ARGUMENTS FOR C-ENERGY HYDRAULIX SYSTEM (4/4)





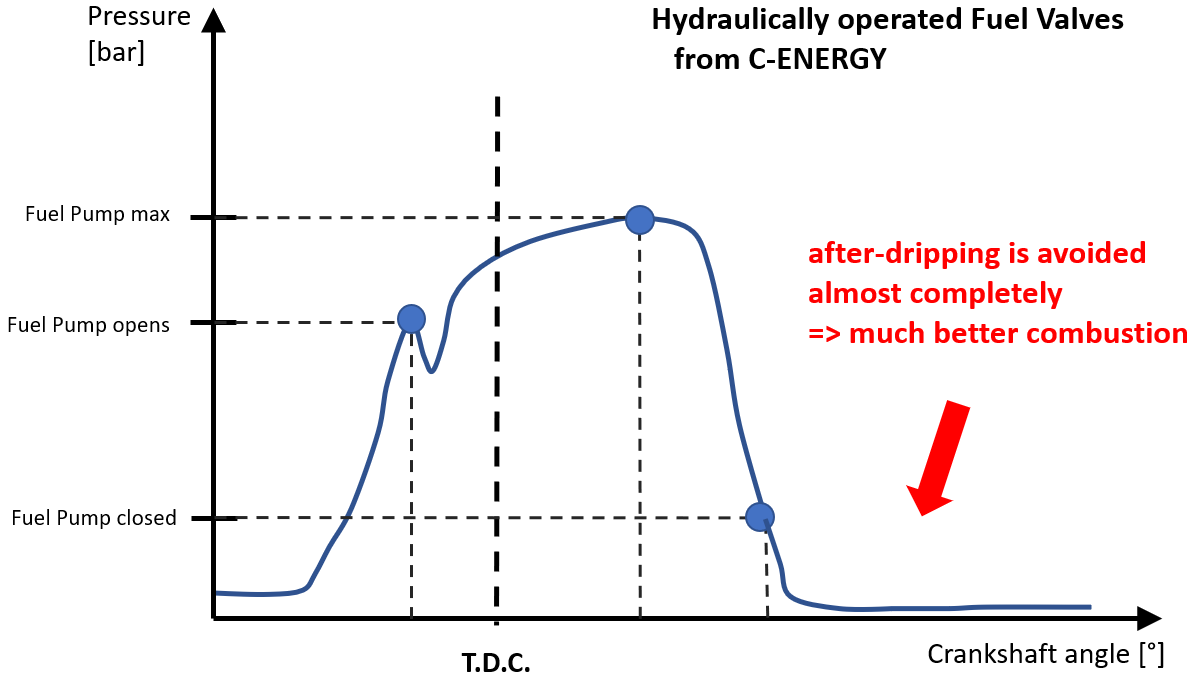


Experience with this technology
1/3

Roll-On/Roll-Off cargo ship with 2x Pielstick 12V PC2.5 main engines
(Diesel-Mechanic application)

Performance of the HYDRAULIX:

- High Fuel savings
- CO_2 reduction according to Fuel savings
- particles visibly reduced



Experience with this technology
2/3

C-ENERGY

C-ENERGY **HYDRAULIX** **Business Case calculation with Fuel Savings** (not considered: reduced need for maintenance & spare parts)	**Unit**	**CONTAINER SHIP 812 TEU ME 1x MaK 9M43 8.4 MW, 4-stroke, 75%, 5.540 rh, North and Baltic Sea**	**CONTAINER SHIP 862 TEU ME 1x MaK 9M43C 8.5 MW, 4-stroke, 85%, 4.315 rh, North Sea**	**CONTAINER SHIP 2.272 TEU ME 3x Götaverken 58 MW, 2-stroke, xx%, 7.000 rh, world wide**	**COASTAL TANKER ME 1x 6 MW, 4-stroke, xx%, 5.000 rh, North and Baltic Sea**	**RO-RO FERRY ME 2x Pielstick PC 2.5 12 MW, 4-stroke, xx%, 4.600 rh, North and Baltic Sea**
Input						
Date	[-]	**24.02.2022**	**24.02.2022**	**24.02.2022**	**24.02.2022**	**24.02.2022**
	comment	last 12 months average values	last 12 months average values	last 12 months average values	last 12 months average values	last 12 months average values
Fuel price / Bunker price Rotterdam for MGO 0,1% S [2]	[USD / metric t]	**622,50**	**622,50**	**622,50**	**622,50**	**622,50**
Exchange rate USD to EUR [3 & 4]	[-]	**0,8548**	**0,8548**	**0,8548**	**0,8548**	**0,8548**
Fuel consumption per year	[t / year]	**5.652**	**5.590**	**70.000**	**4.320**	**5.621**
Fuel savings [1]	[%]	**6**	**5**	**2**	**4**	**8**
Investment for Fuel Saving product incl. Parts & Service (budget price)	[Euro]	**160.000**	**160.000**	**485.000**	**155.000**	**330.000**
Output						
Fuel price / Bunker price	[Euro / metric t]	**532,11**	**532,11**	**532,11**	**532,11**	**532,11**
Fuel costs per year	[Euro / year]	**3.007.503**	**2.974.512**	**37.247.910**	**2.298.728**	**2.991.114**
Fuel savings per year	[t / year]	**339**	**280**	**1.400**	**173**	**450**
Fuel costs savings per year	[Euro / year]	**180.450**	**148.726**	**744.958**	**91.949**	**239.289**
Payback / ROI	[years]	**0,89**	**1,08**	**0,65**	**1,69**	**1,38**

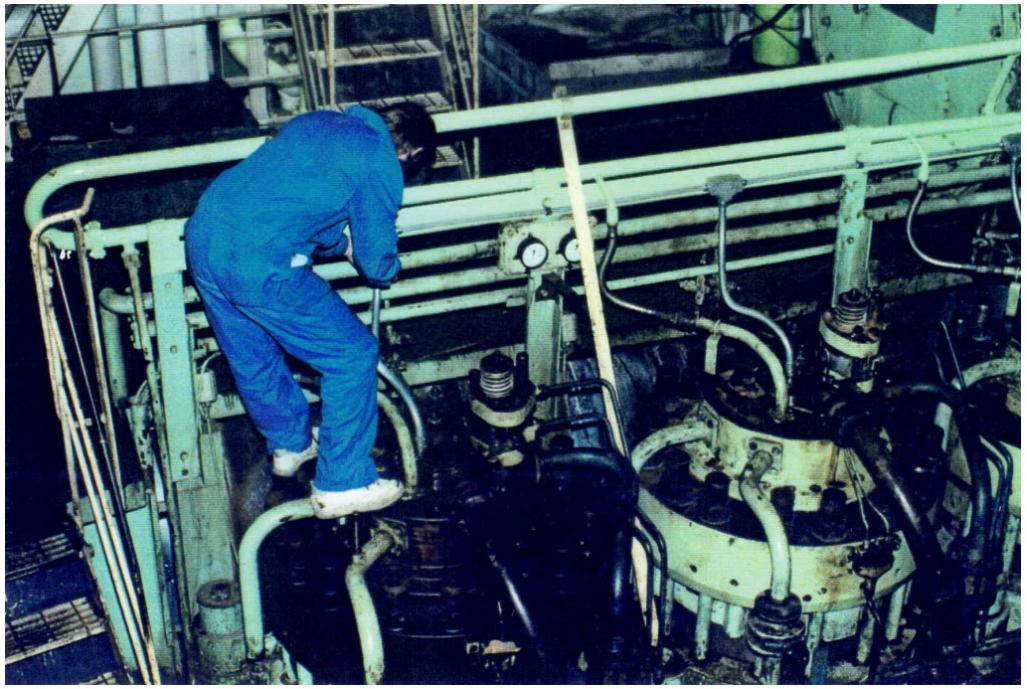
[1] Depending one engine maker and setup; for more detailed information please fill out our Customer Data Sheet.

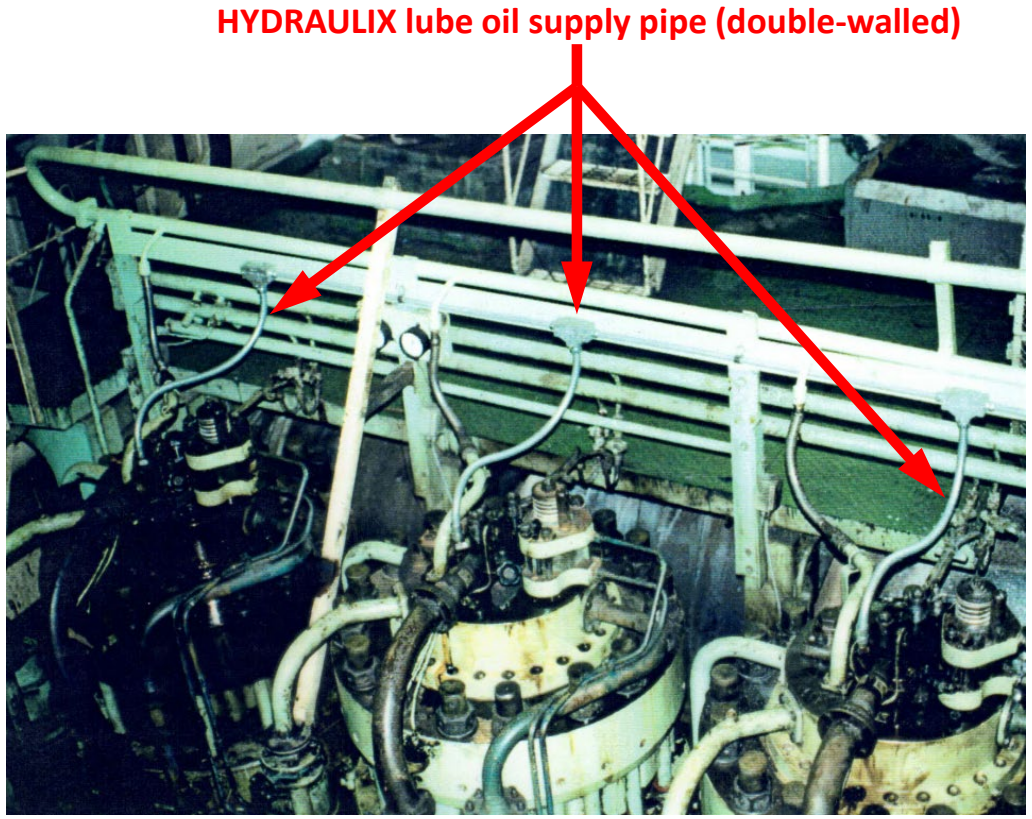
[2] Source: https://shipandbunker.com/

[3] Source: https://www.oanda.com/currency-converter/de/?from=USD&to=EUR&amount=1

[4] Source: https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-usd.en.html

Experience with this technology
3/3





HYDRAULIX installation on a 2-stroke Sulzer RND90 Diesel engine

Reference List
1/2

Why are all our references from the 1990s?

The original technical principle of the HYDRAULIX system was installed on **45 engines** from 1989 to 1995 where C-ENERGY founder Claes Jakobsson was testing and operating that product on several Pielstick marine engines at the time.

From 1996 this system was outsourced to a bigger company and they have installed around 80 systems. In total, more than 120 HYDRAULIX systems have been installed on different Diesel engines in the field. Due to competing interest with the OEM spare part sales, the system was shelved in 2001.

C-ENERGY has recognized the demand from the market to reduce fuel consumption due to upcoming emission regulations in 2021 and started with a technically upgraded HYDRAULIX system in order to save fuel and reduce emissions even for newer engine types.

Reference List
2/2

Project No.	Type	Company	Country	Name	Engines		Fuel type	Installation date
					Amount	Type		
1	Marine	Frigomaris GmbH	Germany	SNOW DRIFT	1	Sulzer 8RND90	IF360	1989
2	Marine	Stena Marine Management AB	Sweden	STENA FREIGHTER	2	Pielstick 12PC2.5V	IF180	1990
3	Marine	Nordstrom & Thulin	Sweden	GRAIP	2	Pielstick 12PC2.5V	IF180	1991
4	Marine	Wallenius Lines AB	Sweden	ANIARA	2	Pielstick 16PC2.5V	IF180	1991
5	Stationary	Gotlands Energieverk K. S. V.	Sweden	Power Plant	2	Pielstick 8PC4 .2V	IF180	1991
6	Marine	Northern Marine Managemenf Ltd.	UK	KYOWA	1	Sulzer 6RND68M	IF360	1991
7	Marine	Scandi Line A/S	Norway	SANDEFJORD	2	Pielstick 12PC2.0V	IF180	1992
8	Marine	Stena Marine Management AB	Sweden	STENA CARRIER	2	Pielstick 12PC2.5V	IF180	1992
9	Marine	Stena Marine Management AB	Sweden	STENA NORDICA	4	Pielstick 12PC2.5V	IF180	1992
10	Marine	DFDS A/S	Denmark	PRINCE of SCANDINAVIA	4	Pielstick 12PC3.0V	IF360	1992
11	Marine	Star Cruise	Malaysia	STAR AQUARIUS	2	Sulzer 9ZAL40S	IF180	1992
12	Marine	Ferm Int. Ship Management	Sweden	UNITED STAR	2	Wichman 9AXAG	IF180	1992
13	Marine	The National Swedish Adm. of Shipping & Navigation	Sweden	SCANDIA	2	Hedemora Vl 6A/l 2	MDO	1993
14	Stationary	Bermuda Electric Co, Ltd	Bermuda	Power Plant	1	Pielstick 18PC3. OV	Hago	1993
15	Stationary	PT Indocement Tungal Prakarssa	Indonesia	Power Plant	9	Pielstick 18PC4.0V	IF180	1993
16	Marine	Barber Ship Management A/S	Norway	TAPIOLA	1	Sulzer 9RND90M	IF360	1993
17	Marine	Mediterranean Shipping Company	Italy	MSC CARLA	3	Götaverken 850/1700 VGS	IF360	1994
18	Marine	Leif Hoegh & Co. A/S	Norway	HOEGH CAIRN	1	MAN 8KSZ70/125	IF360	1994
19	Marine	DFDS A/S	Denmark	HAMBURG	2	Stork 20TM410	IF360	1995
					45			

C-ENERGY SOLUTIONS IN A NUTSHELL

The C-ENERGY Technologies HYDRAULIX system helps …

• **better combustion**	➔ to achieve a better and cleaner combustion
• **reduction of fuel consumption**	➔ for a short amortization and fuel cost savings
• **emission improvements**	➔ for unrestricted/unlimited operation performance
• **reduced costs for spare parts**	➔ extended service life of spare parts and engine
• **reduced service hours at maintenance**	➔ due to extended maintenance intervals

C-ENERGYS MISSION STATEMENT

“Preserving the viability of the planet is the task and responsibility of the generation acting responsibly now. Our customers benefit from our advanced HYDRAULIX system and can provide their individual contribution to the necessary energy transition within the shipping industry.”

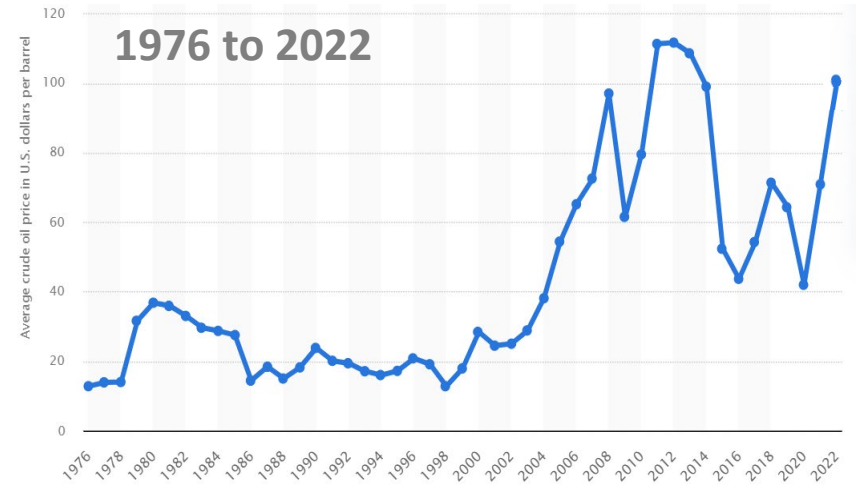
“Its time to act!”

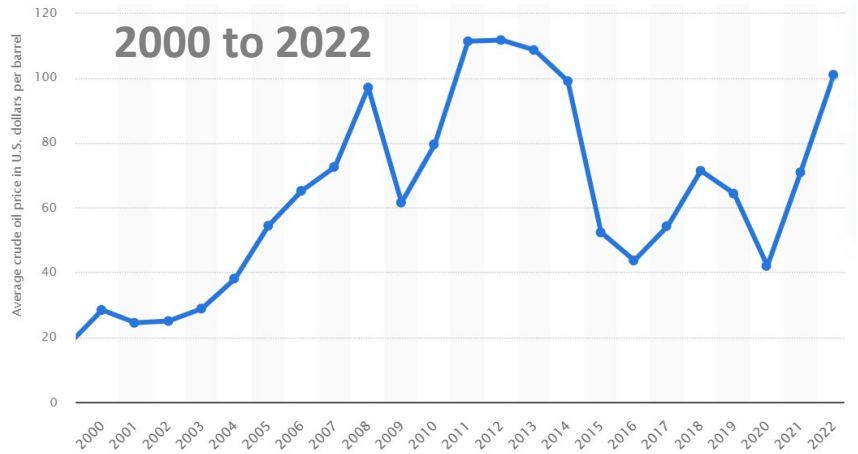
BACKUP

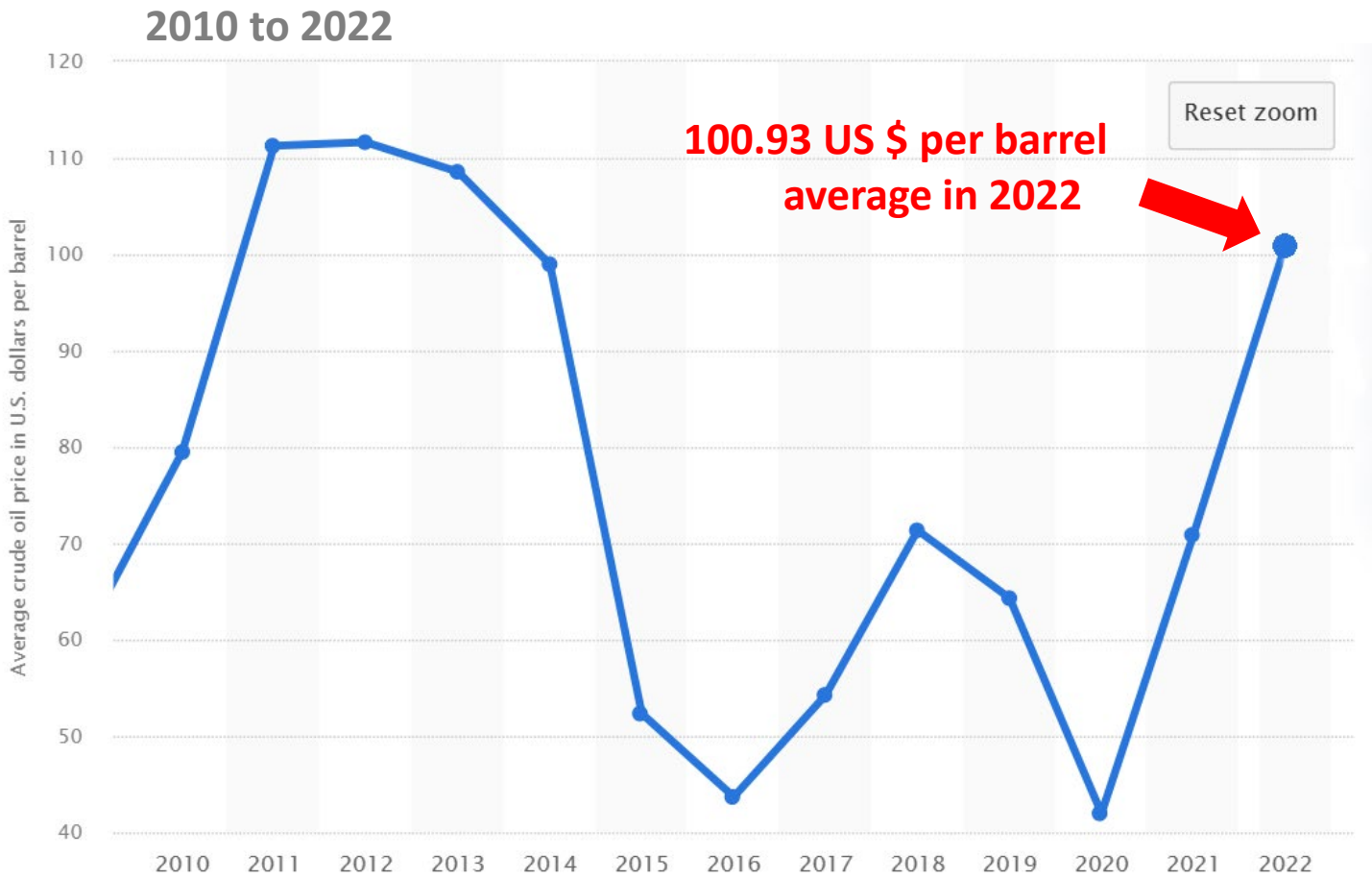
Average annual Brent crude oil price

© Statista 2023

(in U.S. dollars per barrel)

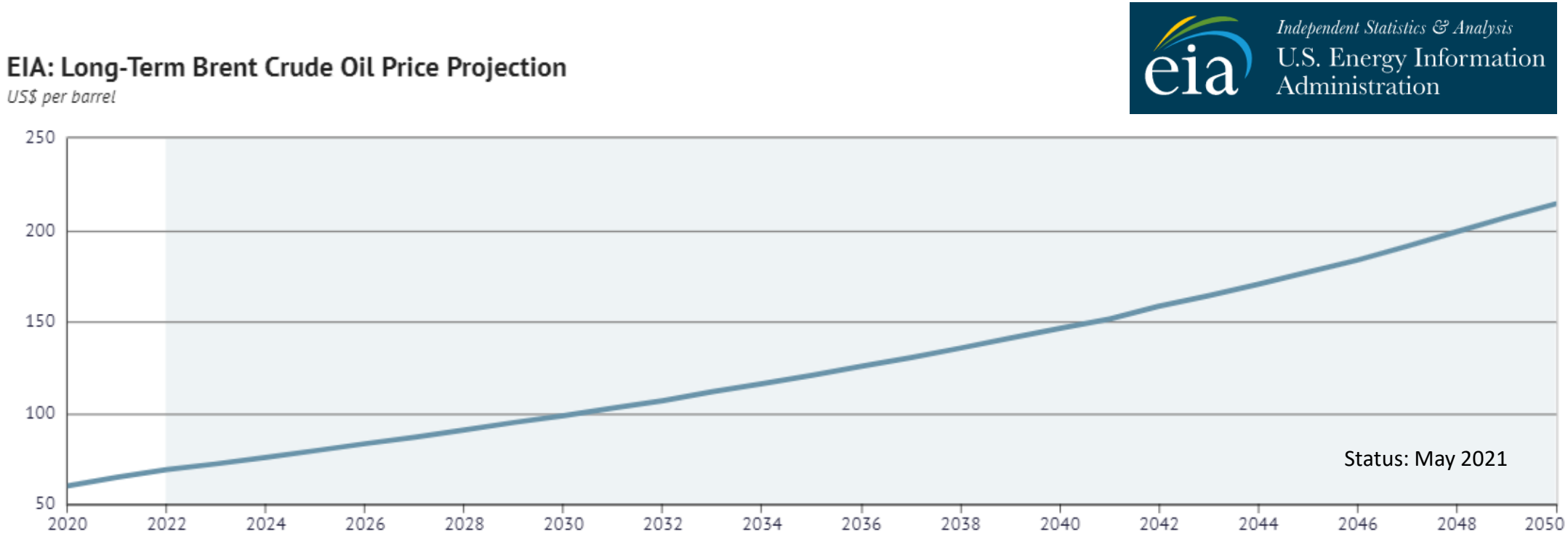




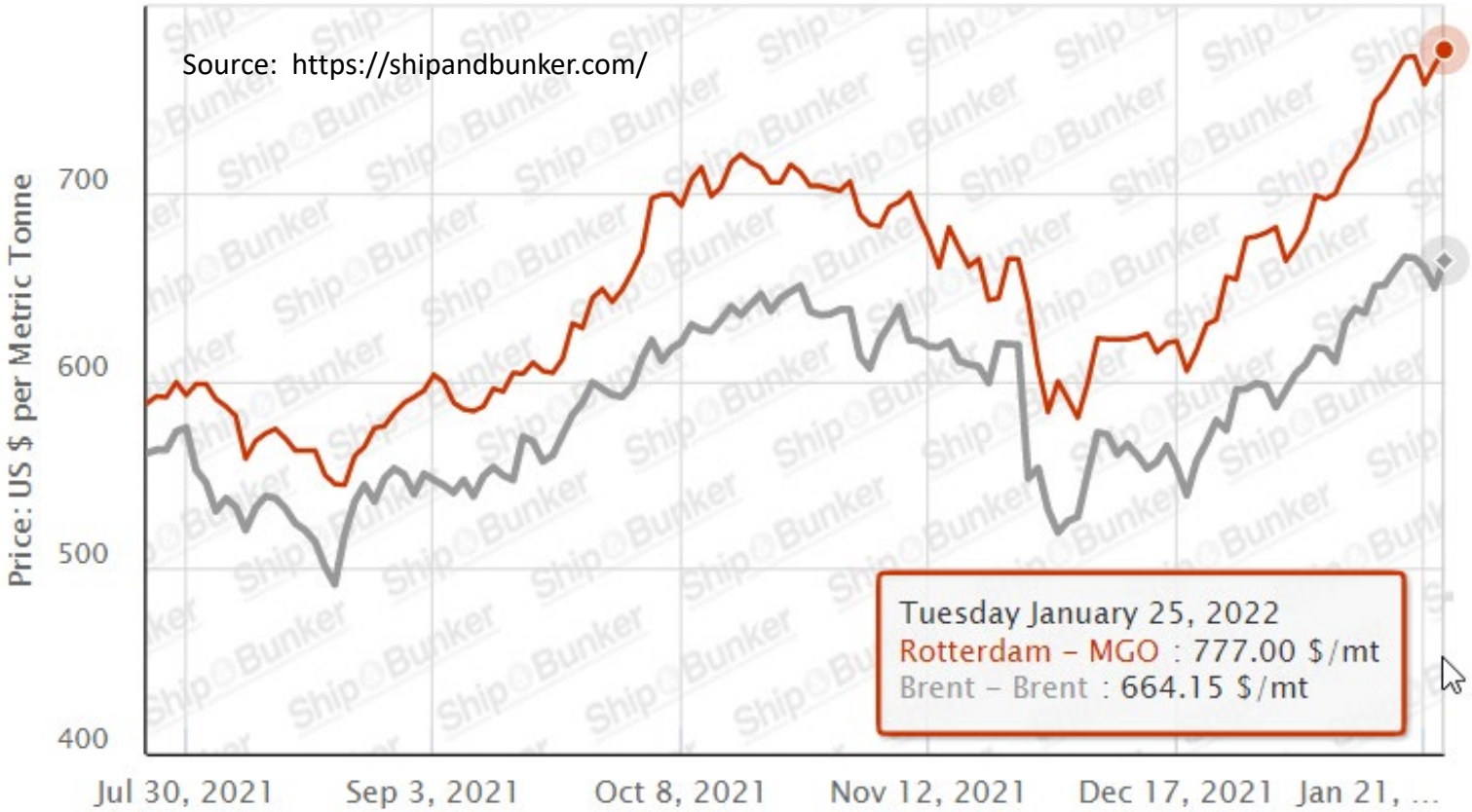


What is the future price of Brent crude oil?

The current EIA forecast that Brent crude oil prices will average **74.95 US $ / barrel** in 2022.
Oil prices are rising due to an increase in demand and a decrease in supply.



What is the price of MGO in Rotterdam?



Rotterdam MGO

October 2021:	690 $/t	610 €/t
November 2021:	700 $/t	603 €/t
December 2021:	620 $/t	540 €/t
January 2022:	770 $/t	680 €/t
January 2023:	890 $/t	817 €/t

C-ENERGY Technologies AB

What is the average fuel price over the last year in Rotterdam?

HFO 380 (max. 3.5% S)

	High	Low	Average
Global 20 Ports	$597.00	$381.00	$458.50
Rotterdam	$559.00	$353.00	$423.50
Brent	$746.07	$457.75	$567.50

VLSFO (max. 0,5% S)

	High	Low	Average
Global 20 Ports	$774.00	$493.50	$578.50
Rotterdam	$731.50	$454.50	$542.50
Brent	$746.07	$457.75	$567.50

MDO (max. 0,1% S)

	High	Low	Average
Global 20 Ports	$904.50	$556.00	$670.00
Rotterdam	$866.00	$490.00	$622.50
Brent	$746.07	$457.75	$567.50

Source: https://shipandbunker.com/

CONTACT

Manufacturer

C-ENERGY Technologies AB

Claes Jakobsson
Gothenburg, Sweden

Promotion, Sales and Tendering

Alternative Energy Solutions

AES by DTS
Dr. Thomas Spindler
Augsburg, Germany

Email: aes_infos@gmx.de / aes_sales@gmx.de
Web: www.aes-dts.de / www.aes-dts.com

Disclaimer

All data provided by C-ENERGY in this document is non-binding. This data serves informational purposes only and is especially not guaranteed in any way. Depending on the subsequent specific individual projects, the relevant data may be subject to changes and will be assessed and determined individually for each project. This will depend on the particular characteristics of each individual project, especially specific site and operational conditions.