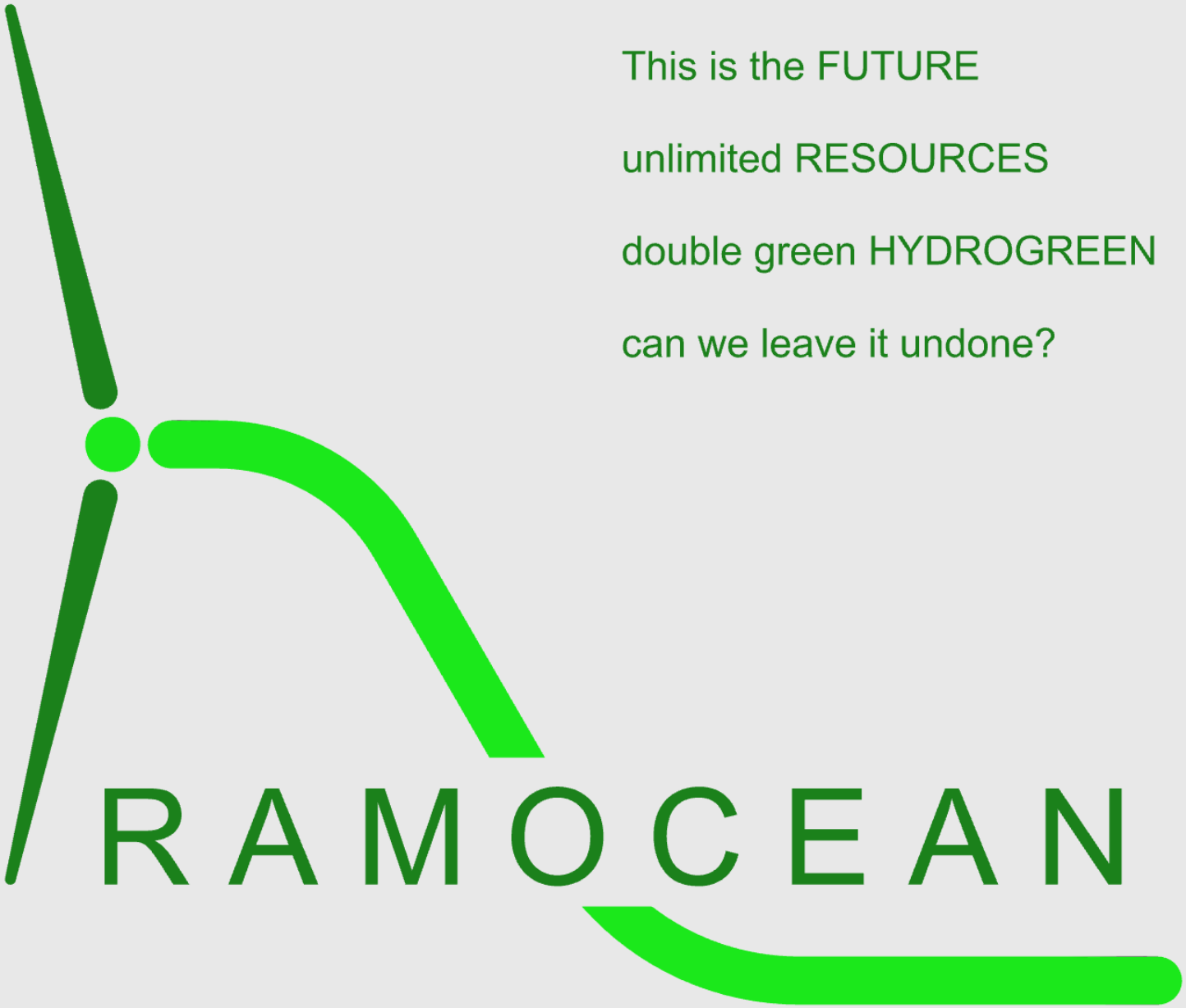


This is the FUTURE

unlimited RESOURCES

double green HYDROGREEN

can we leave it undone?

INTRODUCTION TO AN OFFSHORE PLATFORM FOR PRODUCTION

OF

LIQUEFIED HYDROGEN FROM SEAWATER AND WIND WITHOUT FOOTPRINTS

FUTURE DESIGN
SELF-CONTAINED
AUTONOMOUS
HIGH SEAS HIGH WINDS
DIRECT SALES TO CONSUMER
INVESTORS DREAM:
MOVABEL, NEGOTIABLE ASSET
NO DECOMMISSIONING

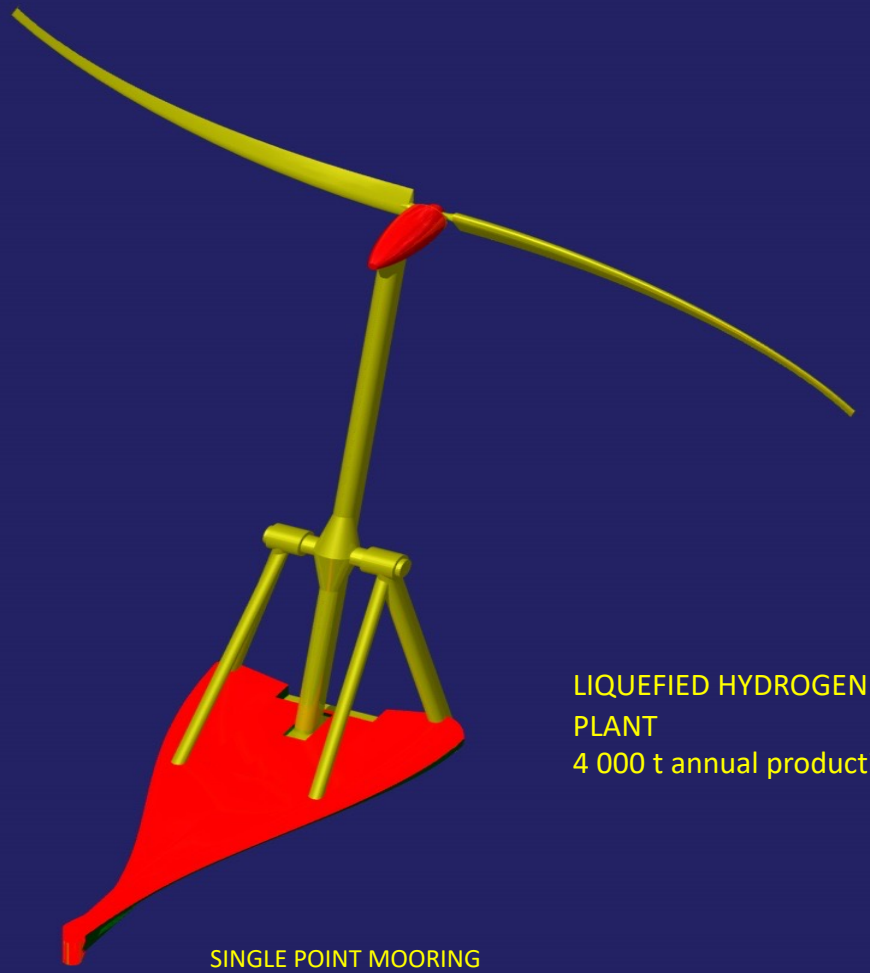
RAMOCEAN AS
NORWAY

THE QUANTUM LEAP

LIQUEFIED HYDROGEN PRODUCTION AT SEA

SEABED FOOTPRINT = 0
LANDSCAPE FOOTPRINT = 0
DOUBLE-GREEN PRODUCT = WIND + SEAWATER

LENGTH = 180 m
BEAM = 90 m
HEIGHT = 419 m



LIQUEFIED HYDROGEN PLANT
4 000 t annual production

SINGLE POINT MOORING

50 MW RAMFORM FLOATER

Negotiable Asset
Movable

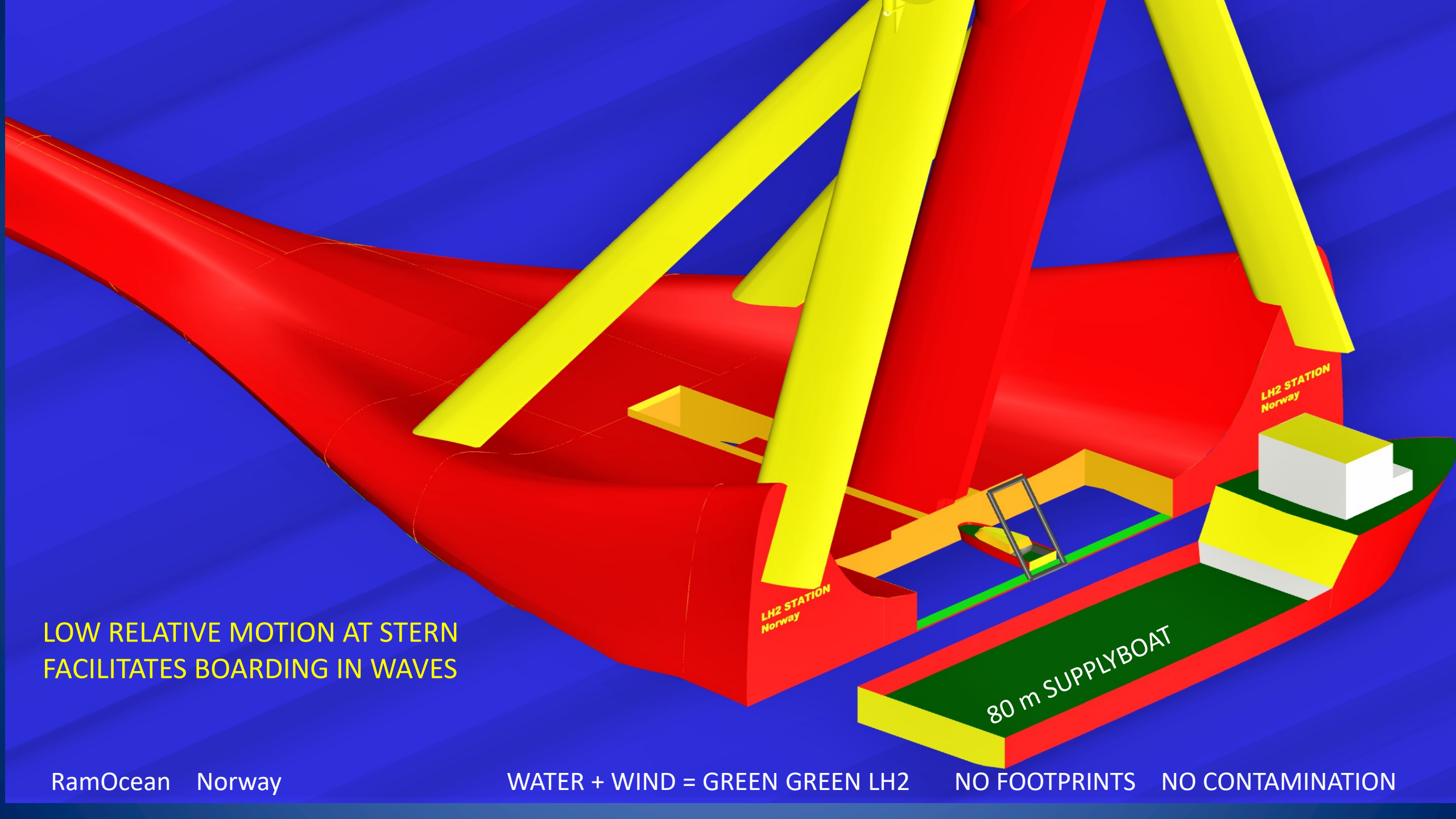
RamOcean Norway

WATER + WIND = GREEN GREEN LH2 NO FOOTPRINTS NO CONTAMINATION

ARRANGEMENT ON FREEBOARD DECK

RamOcean Norway

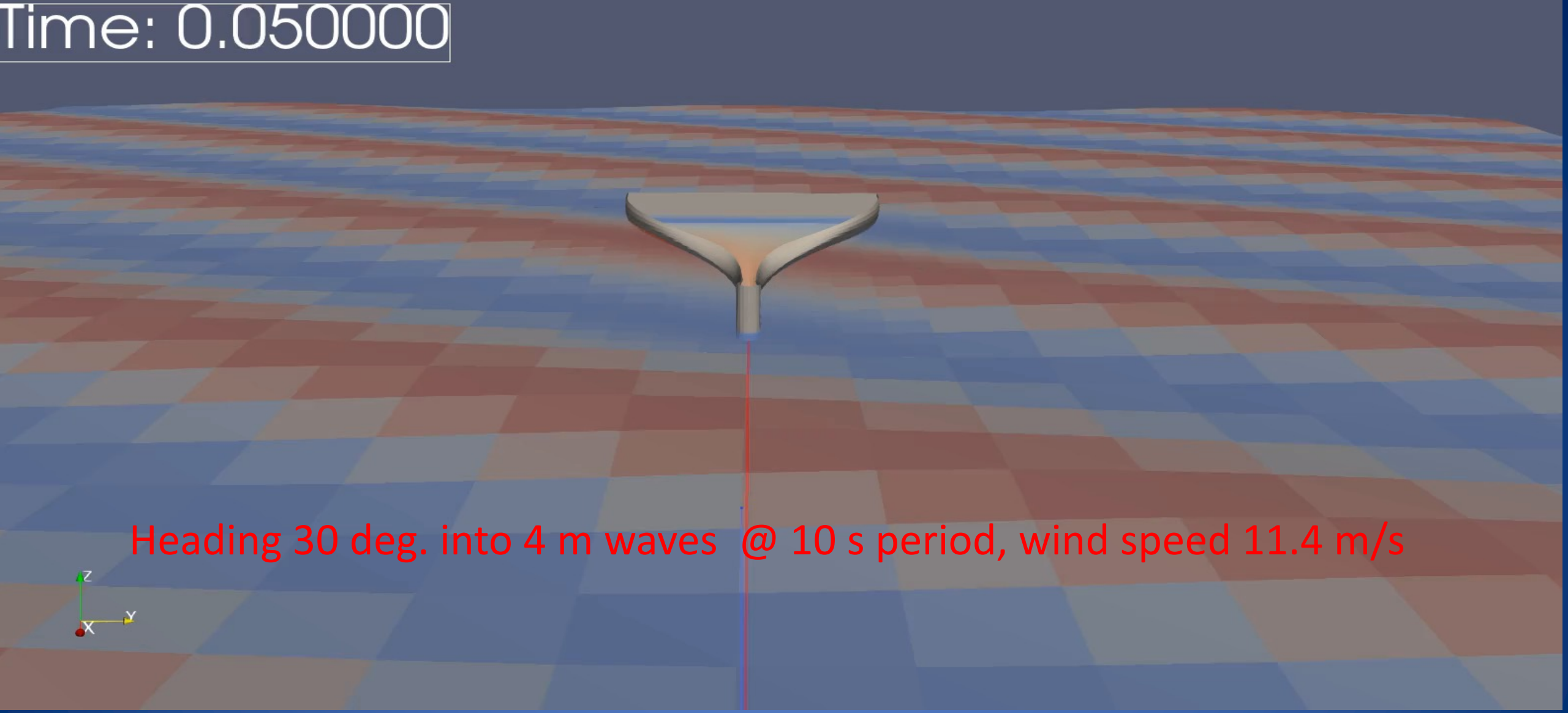
WATER + WIND = GREEN GREEN LH2 NO FOOTPRINTS NO CONTAMINATION

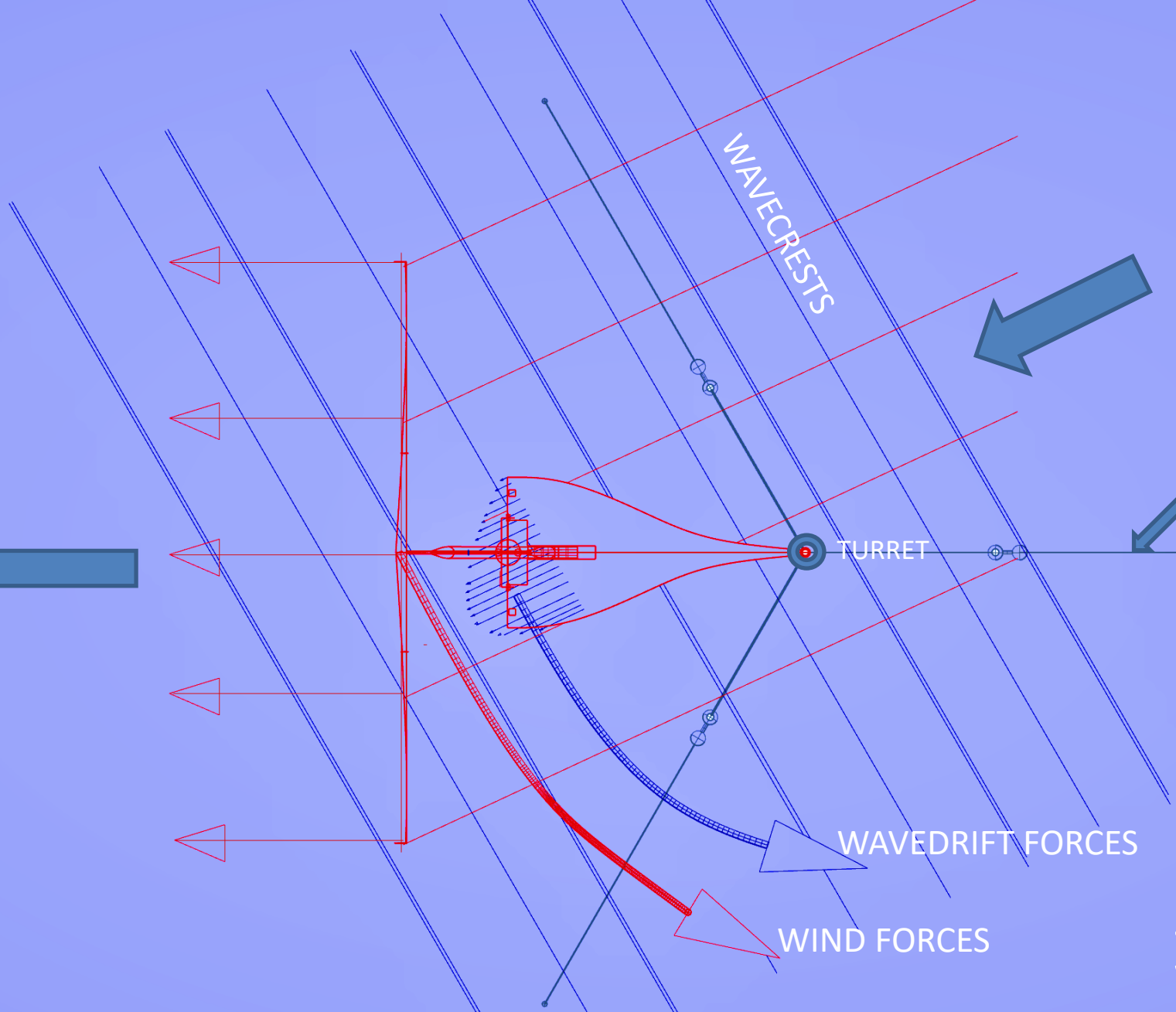


LOW RELATIVE MOTION AT STERN
FACILITATES BOARDING IN WAVES

RamOcean Norway

WATER + WIND = GREEN GREEN LH2 NO FOOTPRINTS NO CONTAMINATION


Time: 0.050000
Heading 30 deg. into 4 m waves @ 10 s period, wind speed 11.4 m/s
Z
Y
X



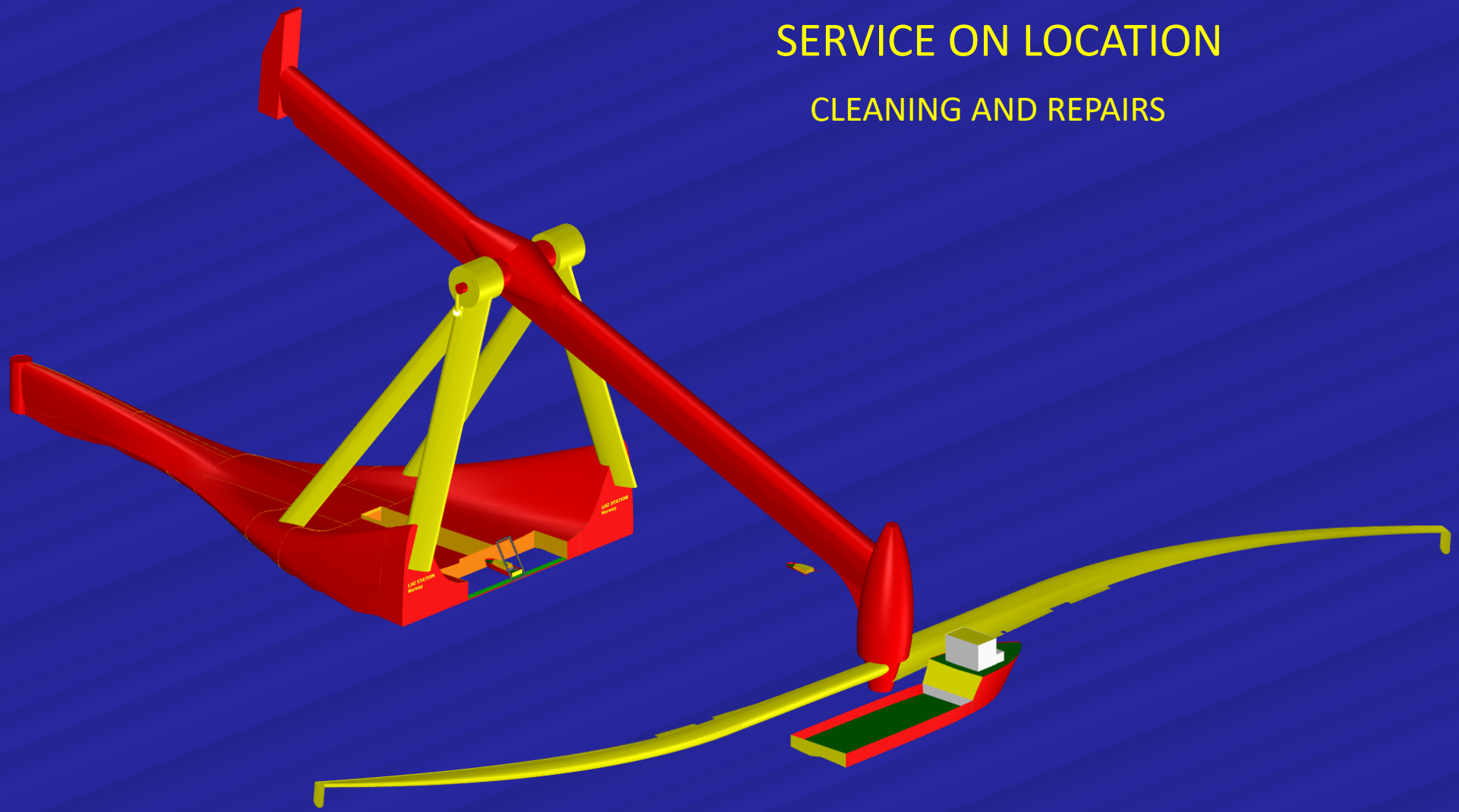
SELF ALIGNING INTO
WIND & WAVES

RamOcean Norway

WATER + WIND = GREEN GREEN LH2 NO FOOTPRINTS NO CONTAMINATION

SERVICE ON LOCATION

CLEANING AND REPAIRS



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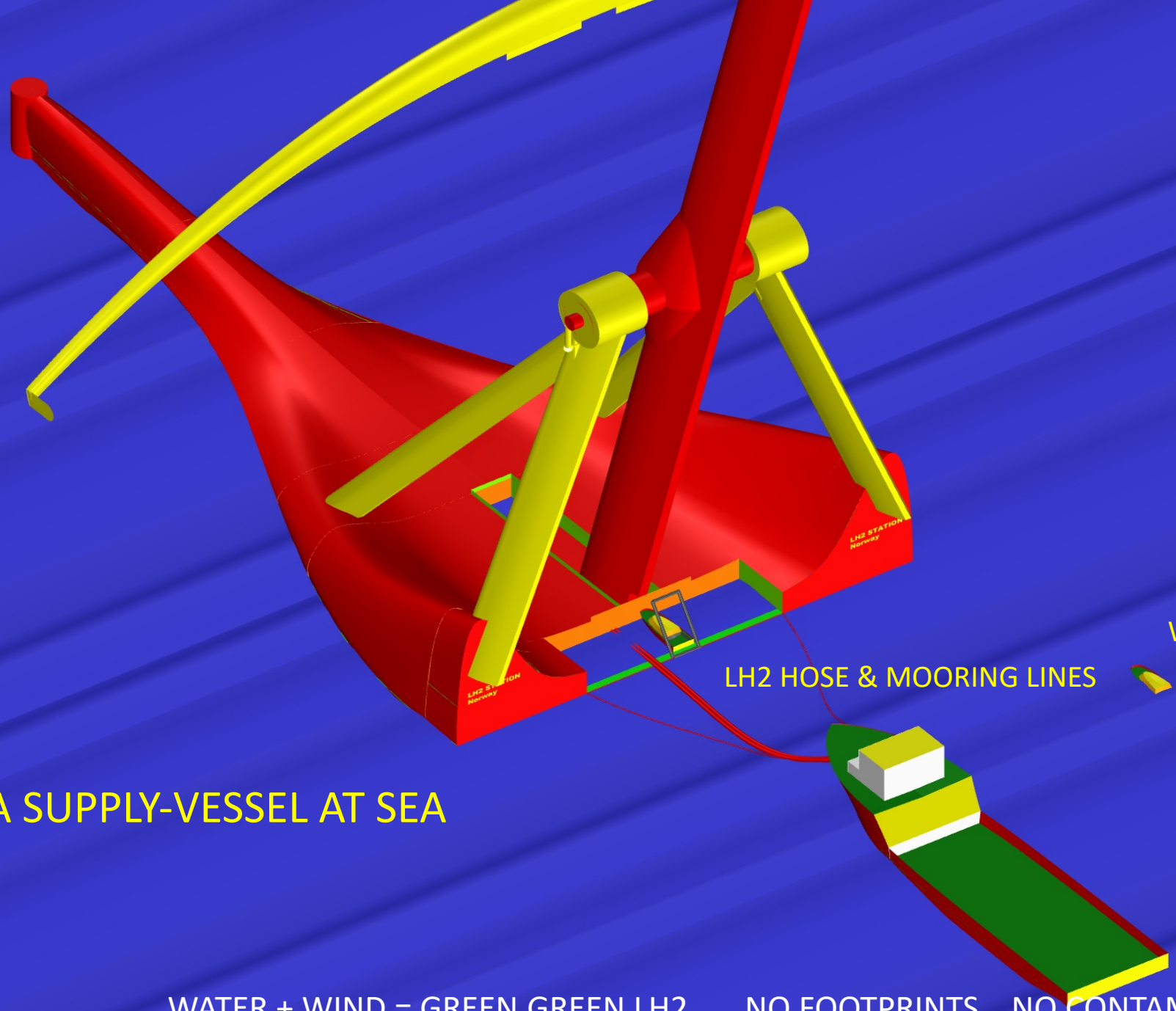
WATER + WIND = GREEN GREEN LH2 NO FOOTPRINTS NO CONTAMINATION



WORK BOAT

LH2 HOSE & MOORING LINES

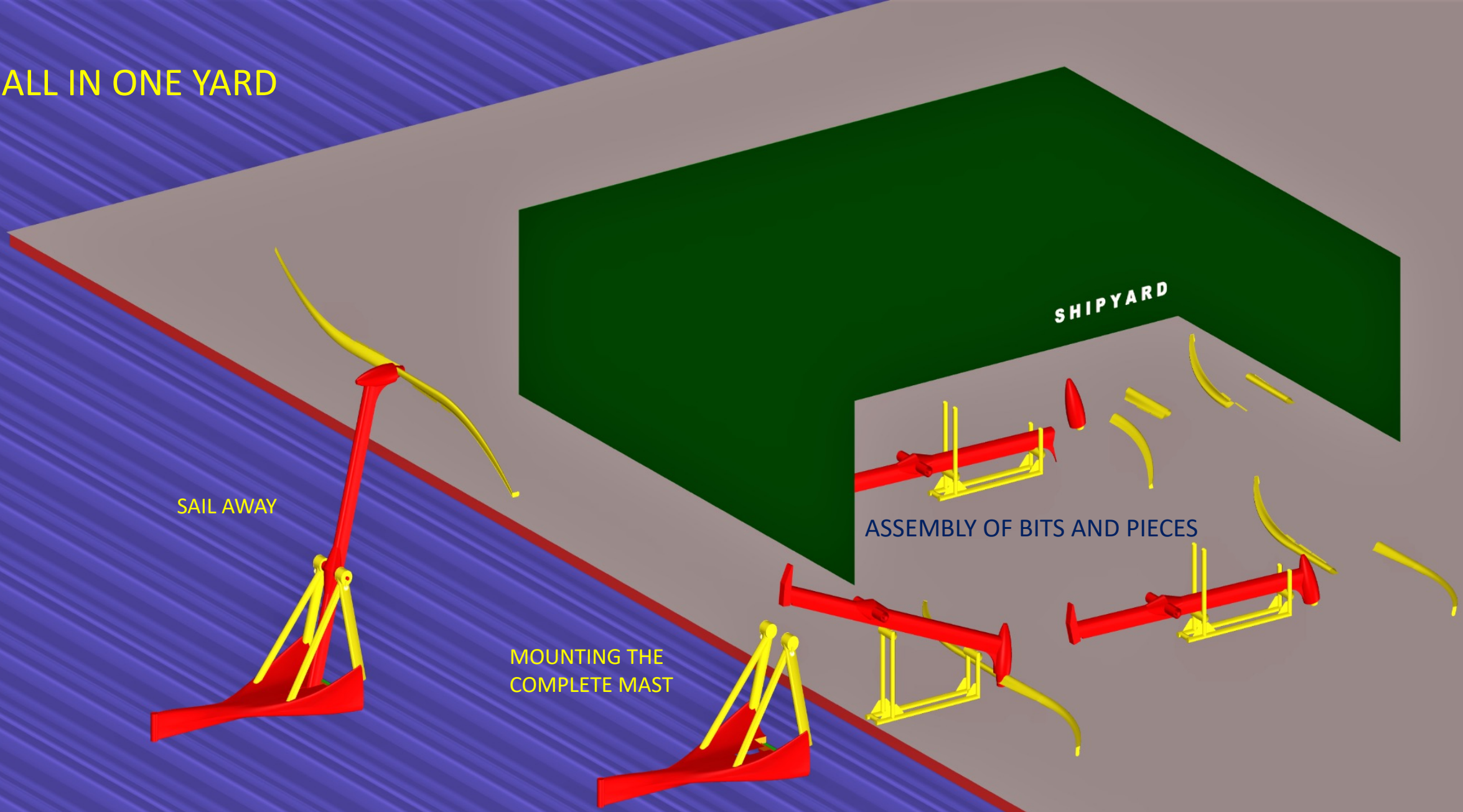
EXAMPLE:

BUNKERING A SUPPLY-VESSEL AT SEA

RamOcean Norway

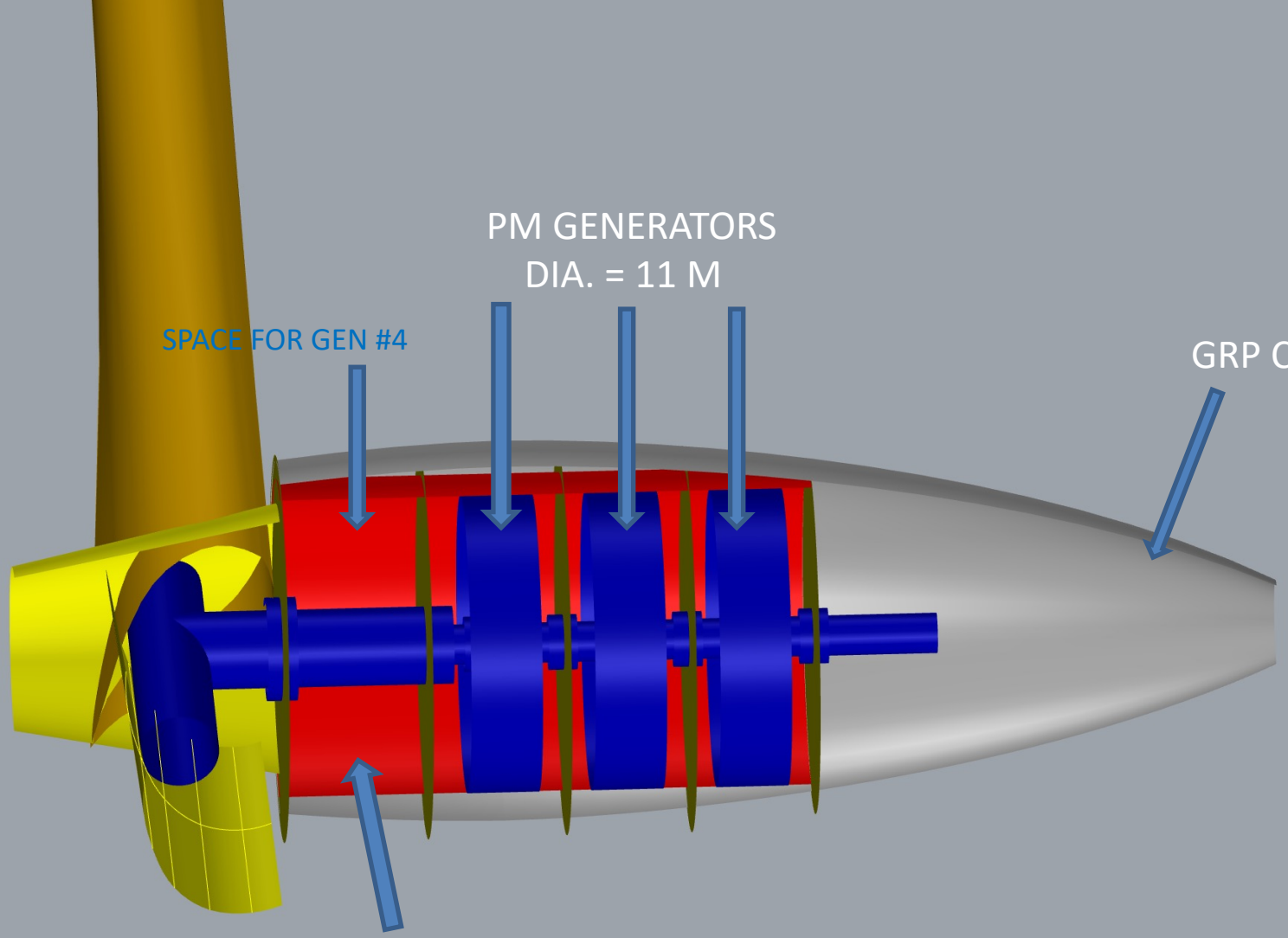
WATER + WIND = GREEN GREEN LH2 NO FOOTPRINTS NO CONTAMINATION

ALL IN ONE YARD



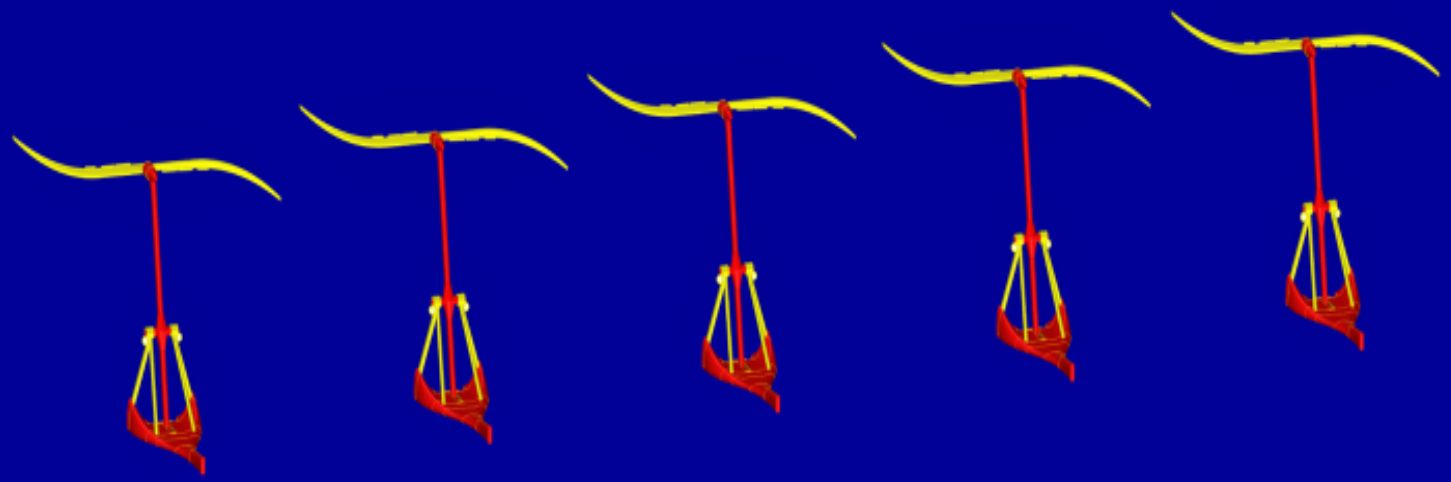
RamOcean Norway

WATER + WIND = GREEN GREEN LH2 NO FOOTPRINTS NO CONTAMINATION



TURBINE ASSEMBLY

RAMOCEAN



20 000 TONNES OF LIQUEFIED HYDROGEN PER ANNUM

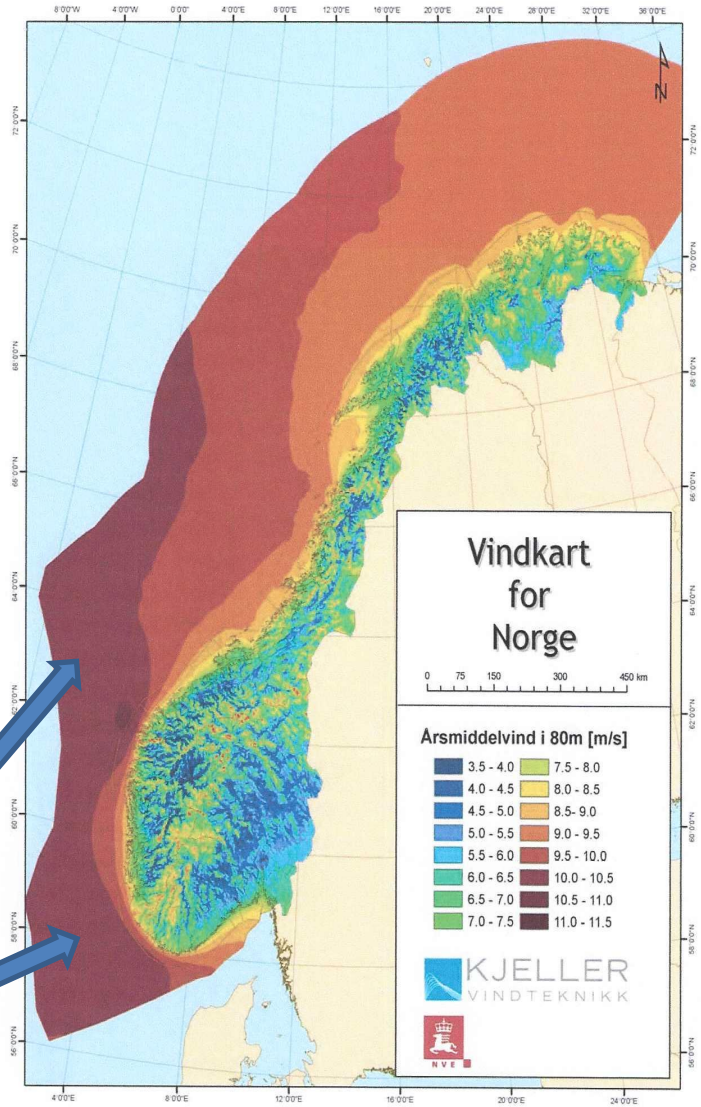
RamOcean Norway

WATER + WIND = GREEN GREEN LH2 NO FOOTPRINTS NO CONTAMINATION

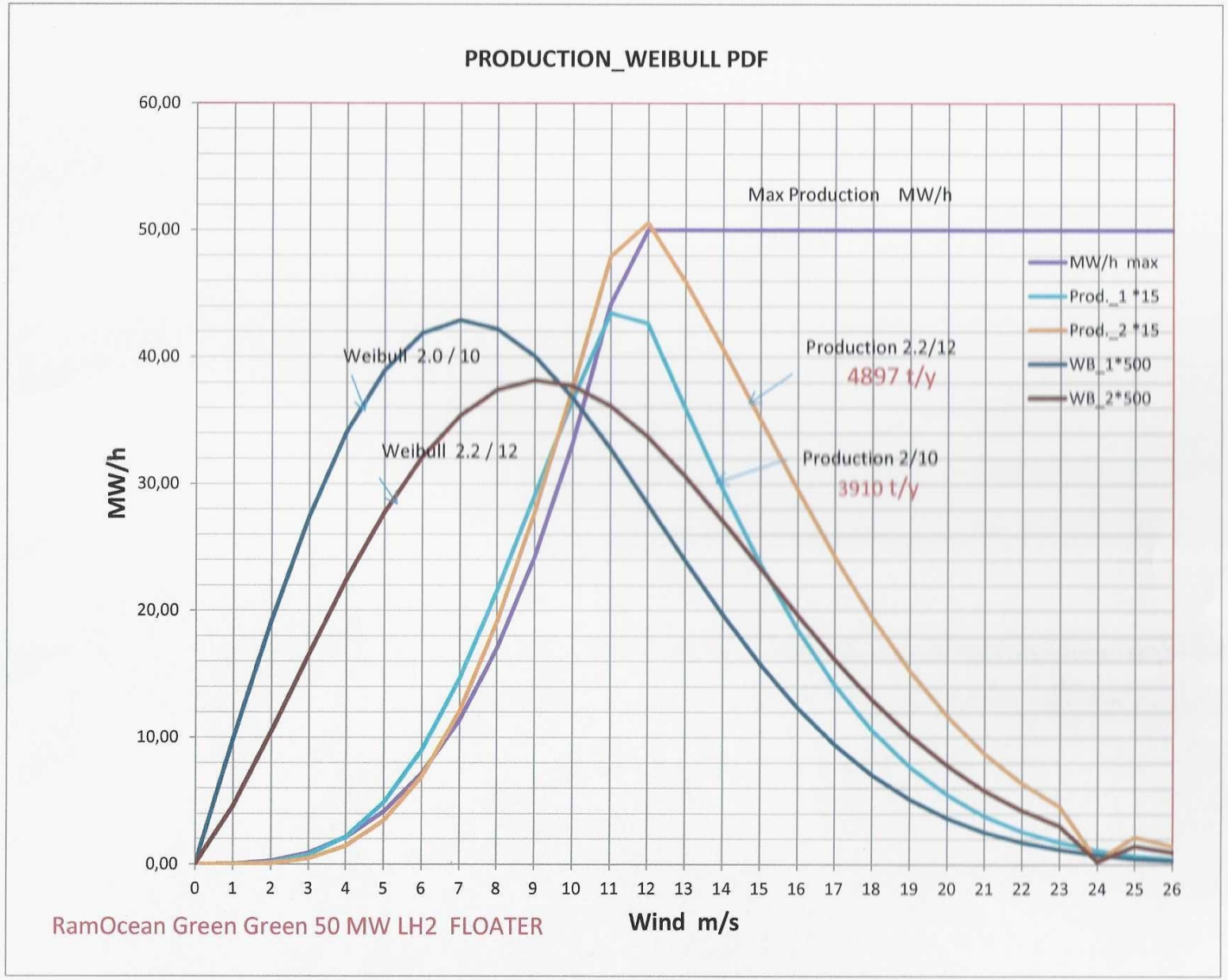
WIND SPEED 10.0 – 10.5 M/S

ANNUAL AVERAGE WIND (m/s) at 80 m

KJELLER VINDTEKNIKK



Figur 1: Normalårskorrigert middelvind i 80m høyde.

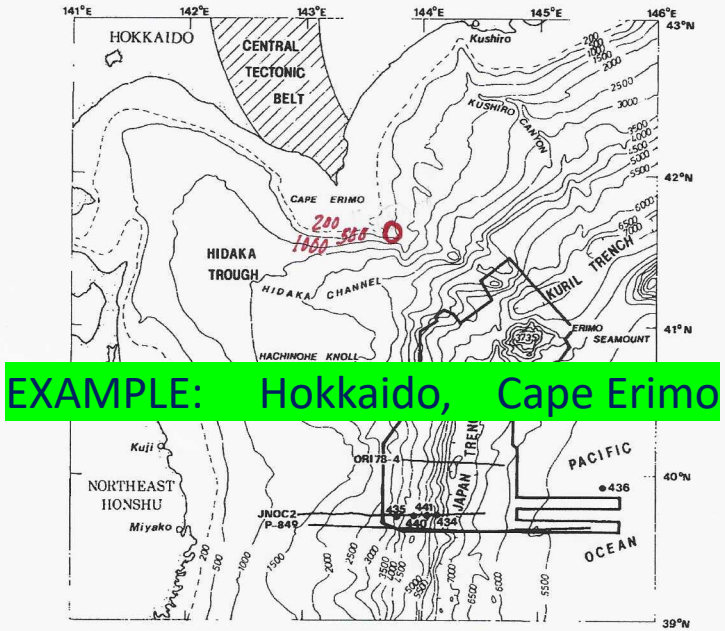

PRODUCTION_WEIBULL PDF
60,00
50,00
40,00
30,00
20,00
10,00
0,00
MW/h
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Wind m/s
Max Production MW/h
Weibull 2.0 / 10
Weibull 2.2 / 12
Production 2.2/12
4897 t/y
Production 2/10
3910 t/y
MW/h max
Prod._1 *15
Prod._2 *15
WB_1*500
WB_2*500
RamOcean Green Green 50 MW LH2 FLOATER

1. Introduction

During Leg 3 of the French-Japanese Kaiko project using R/V "Jean Charcot", we surveyed the Japan Trench subduction zone [1] which is associated with the modern seismicity of the northern Honshu island. The detailed survey covers about 18,000 square kilometers along the trench with Seabeam bathymetry and simultaneous observations of the magnetic and gravity fields. Single-channel seismic records were also obtained. All these data were recorded continuously along the tracks. Navigation in a Loran-C net provided continuous position information nominally precise to about 100 m, and onboard computer and plotting facilities enabled us to make real-time interpretations. Here we summarize mainly these on board interpretations and preliminary post cruise studies as well.

1.1. The objectives of the survey

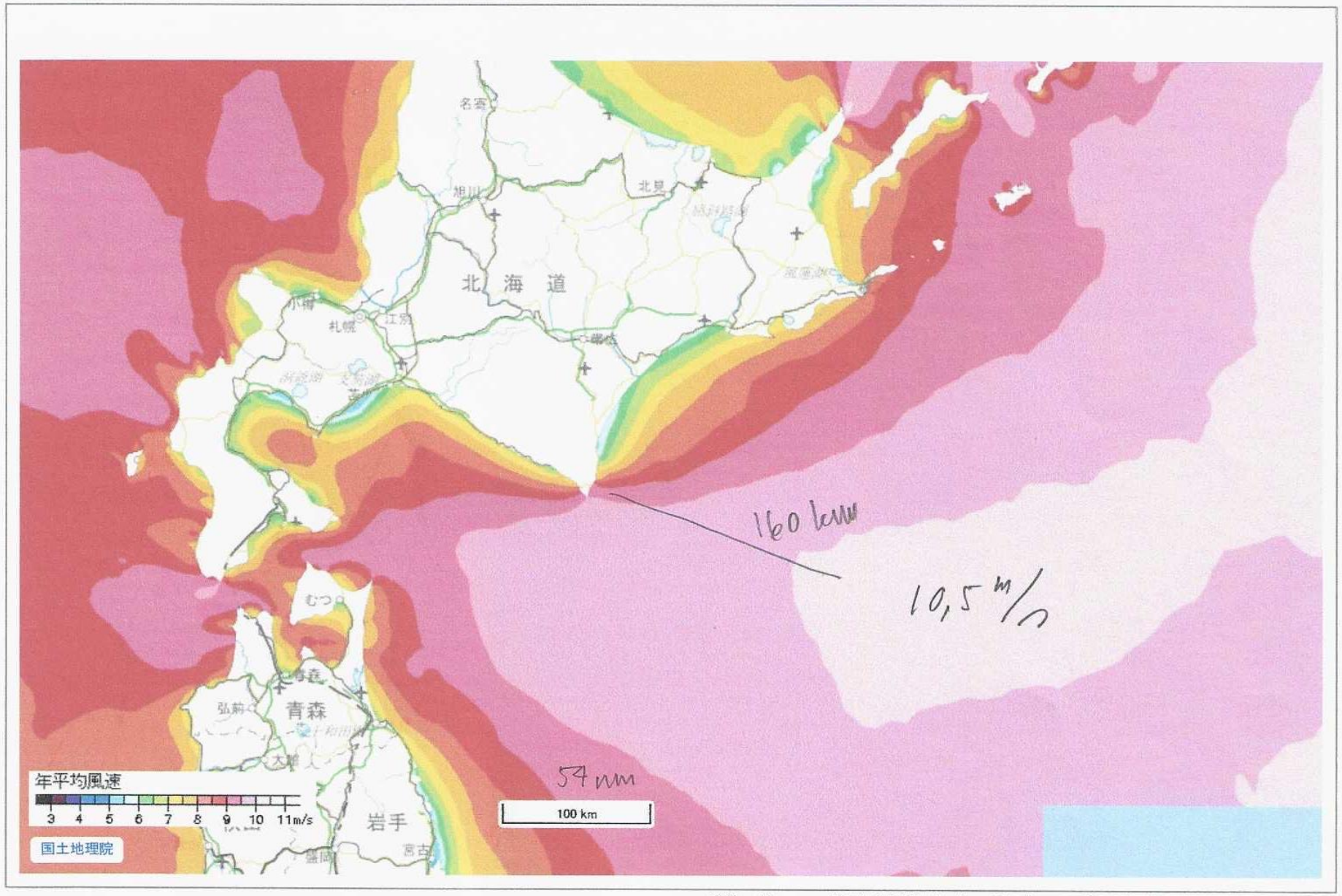
The area we surveyed during the later part of Kaiko Leg 3 (July 19-29, 1984) includes the northern Japan Trench and its juncture with the Kuril Trench at Erimo Seamount (Fig. 1). The front of the landward slope of the Japan Trench, once considered a typical convergent margin with active accretion, was found from study of the cores recovered during the Deep Sea Drilling Project (DSDP) Legs 56 and 57 to have an unexpected history of massive subsidence and probably landward retreat of the slope. Accretion was limited to



EXAMPLE: Hokkaido, Cape Erimo

Fig. 1. Location of the Kaiko survey (Leg 3, box 1) off northeast Japan in addition to the previous multichannel seismic lines: *JNOC 1, JNOC 2* (Japan National Oil Corporation, 1976), *ORI 78-3, ORI 78-4* (Ocean Research Institute and Japan Petroleum Exploration Company, 1978) and *P-849* (Shell Oil Company, Beck et al. 1976). DSDP sites (Legs 56-57 and 87) were also plotted on this map. Isobaths are derived from the bathymetric chart of the adjacent seas of Nippon No. 6301 (Hydrographic Department, Maritime Safety Agency, Japan, 1966).

NeoWins（洋上風況マップ）



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nel

PROTON® PEM

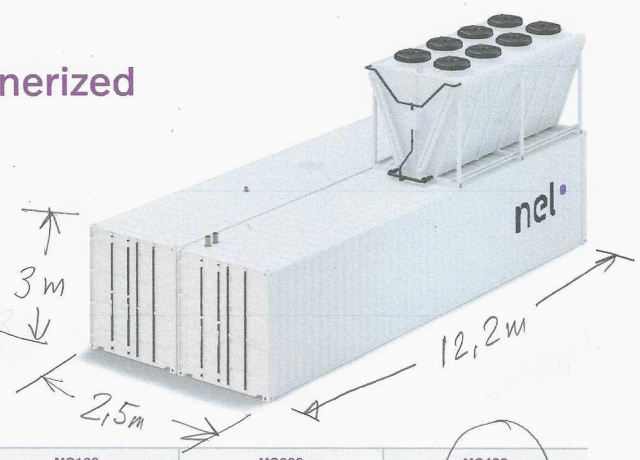
M Series Containerized

Hydrogen Generation Systems

892 kg/d

We need:

$\frac{12000}{892} = 13++?$

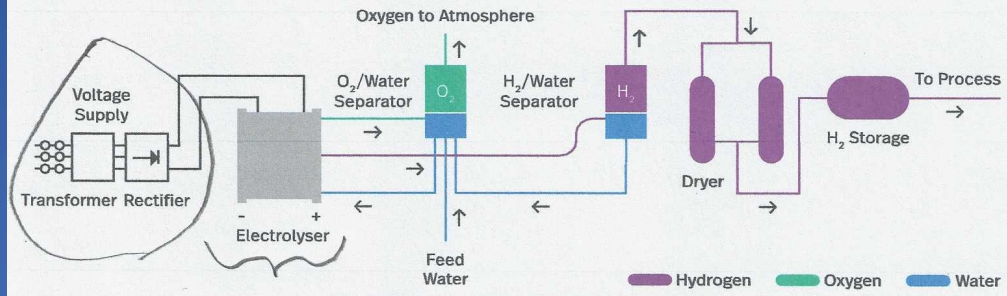


MODEL	MC100	MC200	MC400
Class	0.5 MW	1.0 MW	2.0 MW
Description	Fully-automated MW-class on-site hydrogen generator utilizing a modular skid-based design Tri-mode operation (selectable): • Command-following mode allows operation based on available input power • Load following mode automatically adjusts output 0-100% to match demand • Tank filling mode operates with power-conservation mode during standby		
Electrolyte	Proton Exchange Membrane (PEM) – Caustic-Free		
HYDROGEN PRODUCTION			
Net Production Rate Nm^3/h @ 0°C, 1 bar SCF/h @ 70°F, 1 atm SLPM @ 70°F, 1 atm kg/24 h	 103 Nm^3/h 3,909 SCF/h 1,845 SLPM 222 kg/24 h	 207 Nm^3/h 7,857 SCF/h 3,708 SLPM 446 kg/24 h	 413 Nm^3/h ~~15,714~~ SCF/h 7,416 SLPM 892 kg/24 h
Delivery Pressure – Nominal	30 barg (435 psig); full differential pressure H_2 over O_2		
Average Power Consumption at Stack per Volume of H_2 Gas Produced[1]	4.53 kWh/Nm^3		
Average Power Consumed at Stack per Mass of H_2 Gas[1]	50.33 kWh/kg		
Purity (Concentration of Impurities)	99.9% [H_2O < 500 ppm, N_2 < 2 ppm, O_2 < 1 ppm, all others undetectable]		
Purity (Concentration of Impurities with Optional High Purity Dryer)	ISO 14687-1:1999 Type 1 Grade C / ISO 14687-2:2012 Type 1 Grade D 99.9998% [H_2O < 2 ppm, N_2 < 2 ppm, O_2 < 1 ppm, all others undetectable]		
Start-Up Time (from Off State)	<5 min		
Ramp-Up Time (Minimum to Full Load)	<10 Sec		
Ramp Rate (% of Full-Scale)	≥ 15% per sec (Power Input Mode)		
Turndown Range	10-100% (Input Power Mode); 0-100% (H_2 Demand Mode)		
DI WATER REQUIREMENT			
Consumption Rate at Maximum Production	93 L/h (25 gal/h)	187 L/h (49 gal/h)	373 L/h (99 gal/h)
Temperature	5°C to 40°C (41°F to 104°F)		
Input Water Quality	Required: ASTM Type II Deionized Water, < 1 µS/cm (> 1 MΩ-cm) Preferred: ASTM Type I Deionized Water, < 0.1 µS/cm (> 10 MΩ-cm)		

RamOcean Norway

WATER + WIND = GREEN GREEN LH2 NO FOOTPRINTS NO CONTAMINATION

Electrolysis is the process of splitting the water molecule into hydrogen and oxygen using electricity. The inputs to this process are simply feed water and the current supplied to the electrolyser.



REVERSED OSMOSIS + DEMINERALIZATION

H_2/WATER SEPARATOR

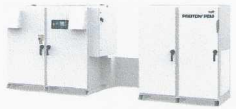
The H_2/Water Separator removes liquid water from the high pressure hydrogen and safely recycles it back to the system water tank.

DRYER

The dryer will dry the gas to reach the suitable dew point. It consists of multiple beds filled with a desiccant to absorb the water.

H_2 STORAGE

The gas storage provides a back-up solution or ensures the hydrogen make-up for batch applications with uneven gas consumption.



C Series

The C Series electrolysers are ideal for a variety of industrial applications. Producing up to 30 Nm^3/h of hydrogen gas at 99.9998% purity, these units replace the need for hydrogen tube trailers or liquid hydrogen storage. They can be containerized, offering facilities flexible siting and reduced operational safety risks associated with delivered hydrogen.

H Series

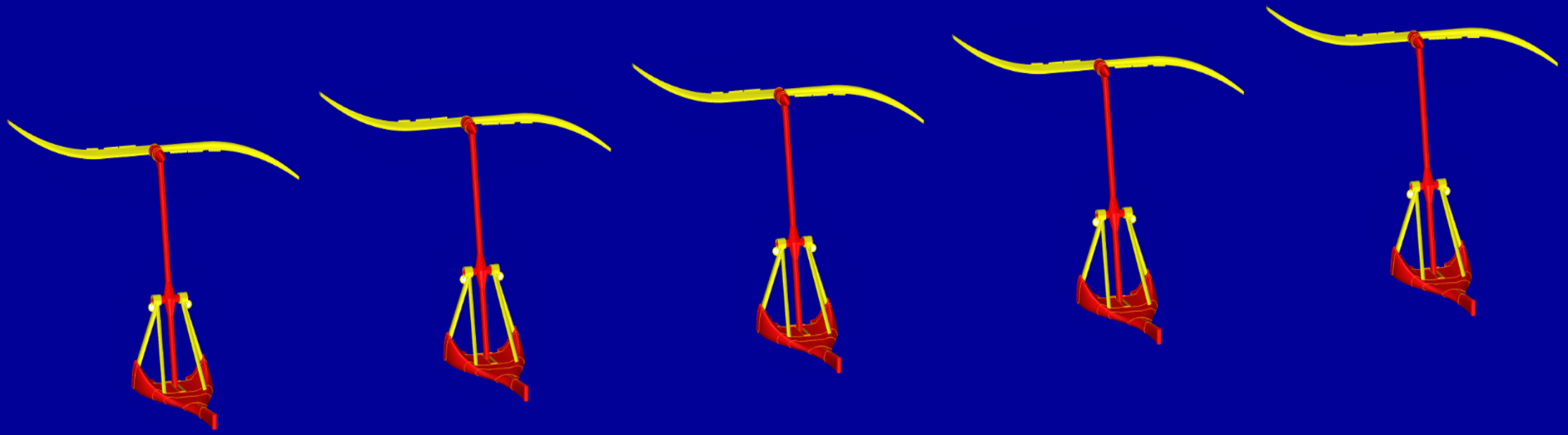
H Series electrolysers offer turnkey solutions for small-scale applications requiring up to 6 Nm^3/h of hydrogen gas at 99.9995% purity. These units make a minimal impact to facility floor space, are easy to maintain and can be installed within hours.

S Series

Producing high purity hydrogen of 99.9995% at up to 1.05 Nm^3/h, S Series electrolysers replace the need for pressurized hydrogen cylinders in a variety of industrial processes. Each unit is low maintenance, compact, quiet, and can be installed within hours virtually anywhere in a facility.

RamOcean Norway WATER + WIND = GREEN GREEN LH2 NO FOOTPRINTS NO CONTAMINATION

RAMOCEAN



20 000 TONNES OF LIQUEFIED HYDROGEN PER ANNUM

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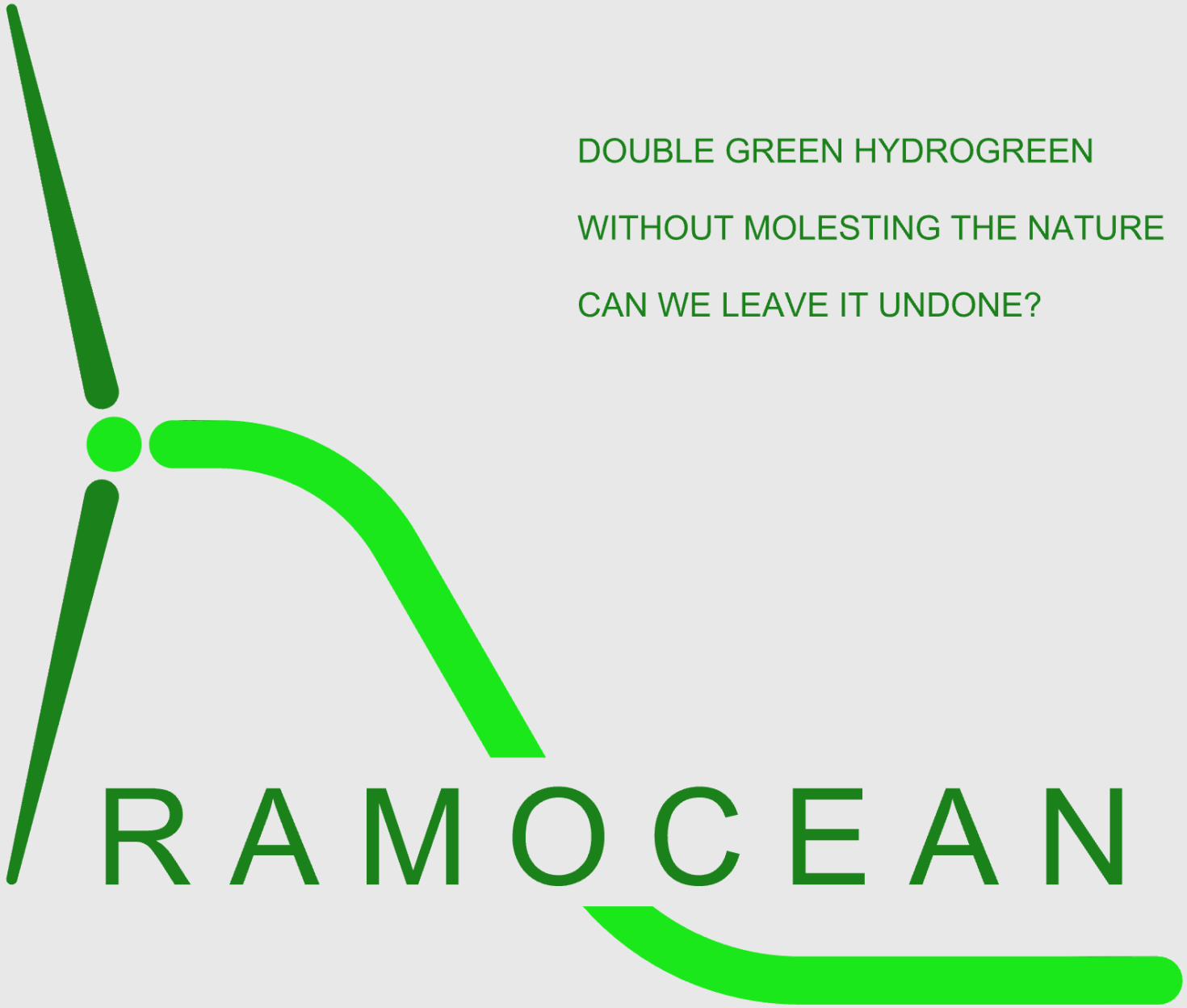

DOUBLE GREEN HYDROGREEN

WITHOUT MOLESTING THE NATURE

CAN WE LEAVE IT UNDONE?