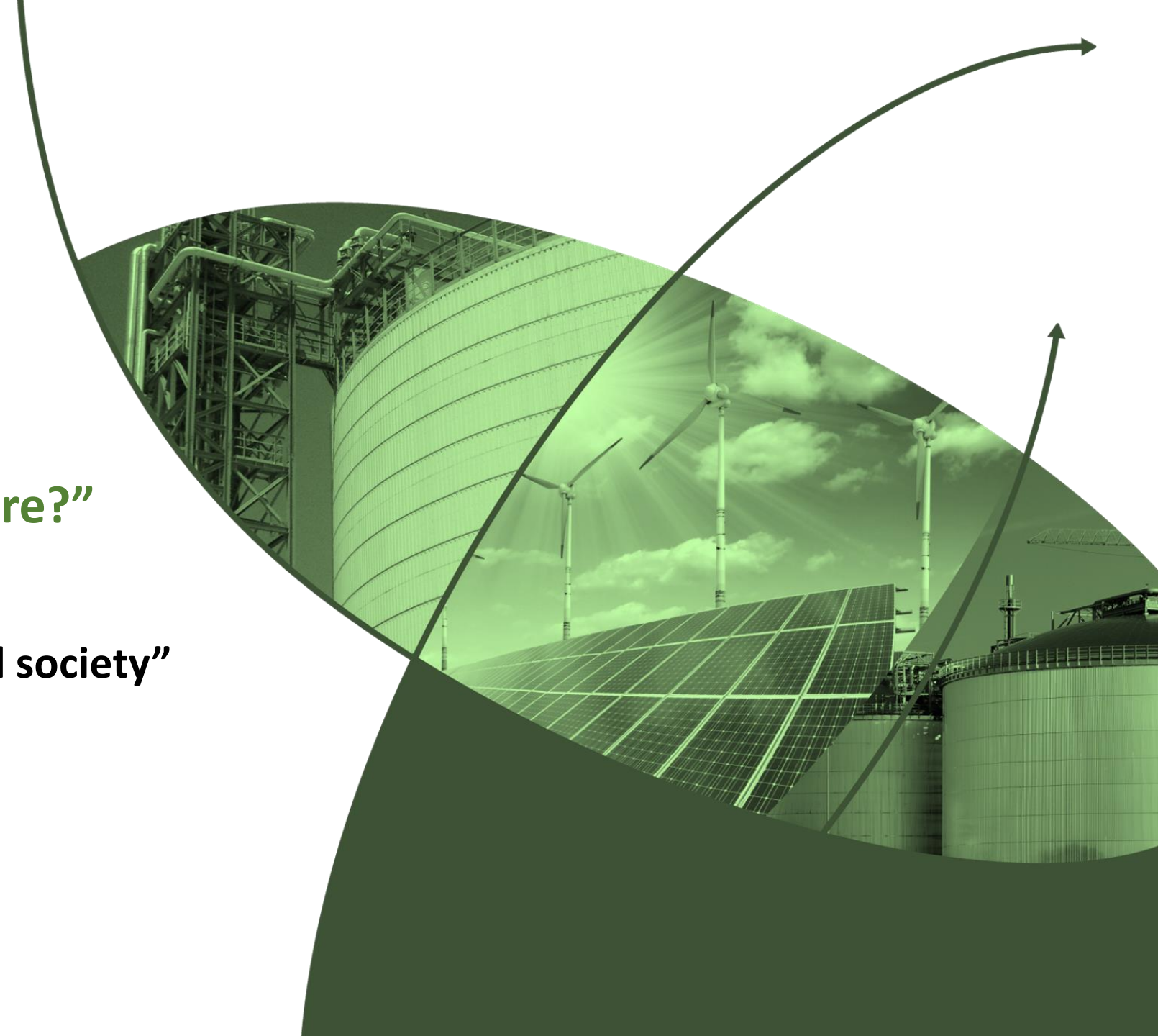
PROTON VENTURES



“Ammonia…..,
…….the Green Oil of the future?”

“Many projects : but let’s not fool society”

Date: 24-8-2021

By: JP Vrijenhoef

Press releases

- https://www.theguardian.com/environment/2021/aug/12/clean-fuel-blue-hydrogen-coal-study?CMP=oth_b-aplnews_d-1
- https://www.landsvirkjun.com/news/mou-for-a-new-green-energy-park-in-reydarfjordur
- https://www.maritime-executive.com/article/waertsilae-reports-progress-targeting-ammonia-blend-engine-this-year
- https://www.rechargenews.com/wind/utility-uniper-joins-deme-in-ambitious-oman-green-hydrogen-plan/2-1-1041767
- https://sea-lng.org/2021/07/understanding-energy-density-of-future-fuels-could-be-key-to-clearer-decarbonisation-decision-making/
- https://koole.com/study-for-commercial-scale-hydrogen-imports/
- https://www.cnbc.com/2021/07/30/renewable-hydrogen-can-travel-through-existing-pipelines-ceo-says-.html
- https://www.offshore-energy.biz/oman-forms-national-hydrogen-alliance-to-push-energy-transition/
- https://ec.europa.eu/commission/presscorner/detail/nl/ip_21_2341

Oil majors are finally following green developments, but want to maintain existing assets

Biden-backed ‘blue’ hydrogen may pollute more than coal, study finds

Infrastructure bill includes $8bn to develop ‘clean hydrogen’ but study finds large emissions from production of ‘blue’ hydrogen

The large infrastructure bill passed by the US Senate and hailed by Joe Biden as a key tool to tackle the climate crisis includes billions of dollars to support a supposedly clean fuel that is potentially even **more** polluting than coal, new research has found.

Source: https://www.theguardian.com/environment/2021/aug/12/clean-fuel-blue-hydrogen-coal-study?CMP=oth_b-aplnews_d-1

Should be : fictive!!

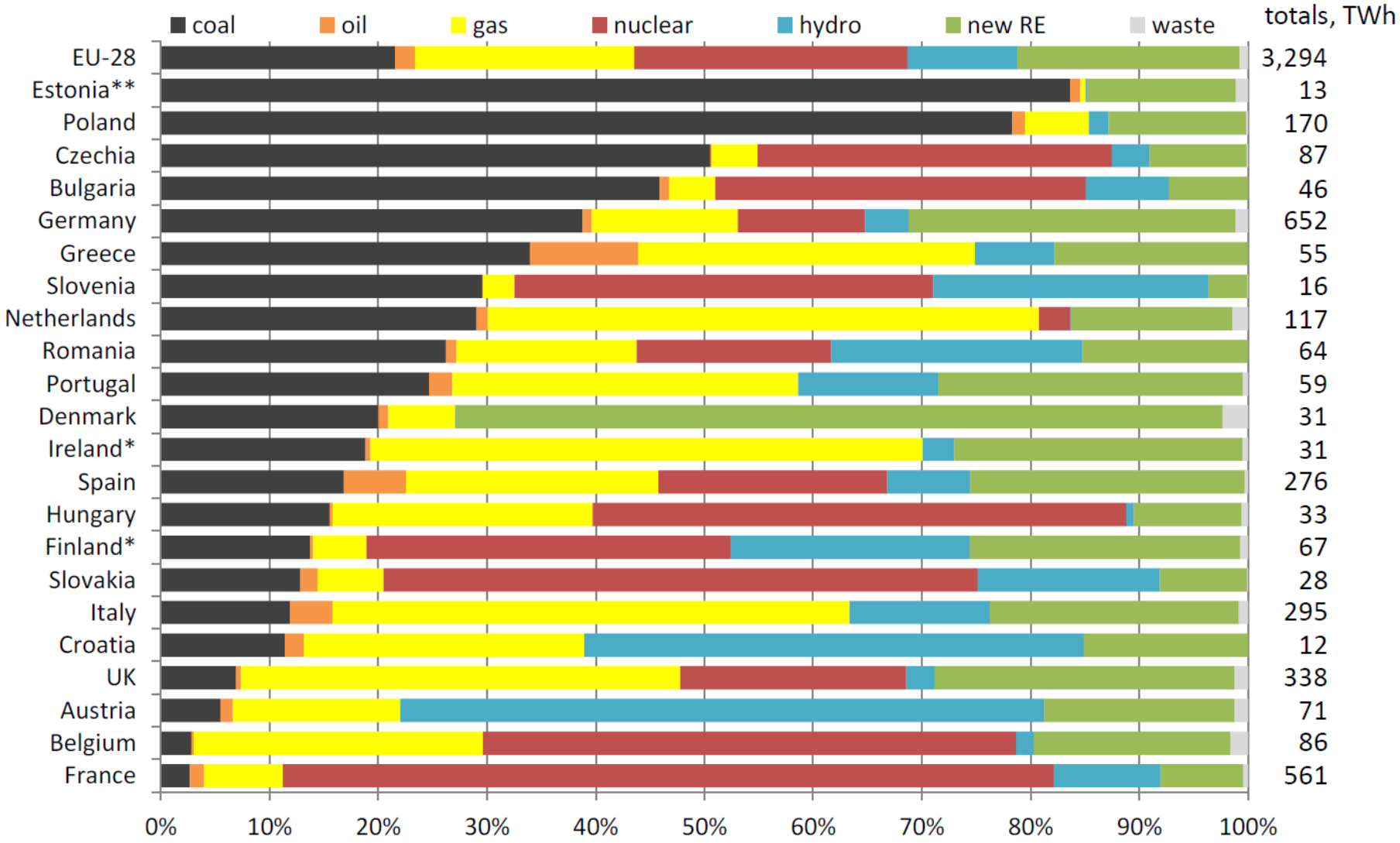
Oil majors are finally following green developments, but want to maintain existing assets

Biden-backed ‘GREEN’ hydrogen pollutes less than coal, study finds.

Infrastructure bill includes $8bn to develop ‘clean hydrogen’

The large infrastructure bill passed by the US Senate and hailed by Joe Biden as a key tool to tackle the climate crisis includes billions of dollars to support a supposedly clean fuel that is potentially even **less** polluting than coal, new research has found.

EU Energy Consumption & Resources Mix (2017): total 3294 TWH



Source: Eurostat database nrg_bal_peh, last update 21.03.2019 (*n.b.* coal includes peat* and oil shale**)

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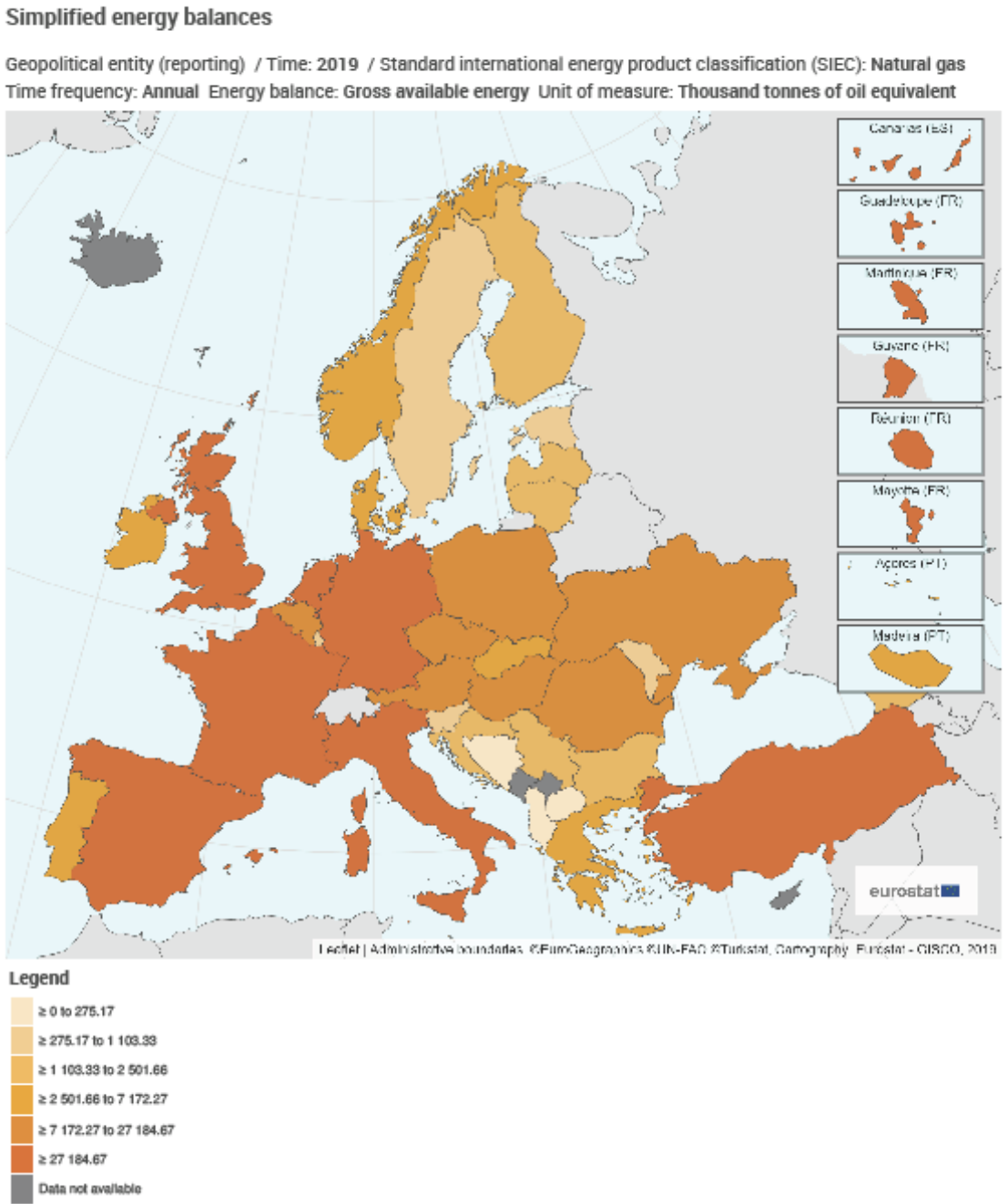
In 2019 was 229 mt oil equivalent sustainable out of total 1497 mt energy used close to 15% only

2030 we expect 50% sustainable

if 10% green ammonia :
70 MT oil equivalent or some 300 Mt ammonia annually

estimated is 20% ammonia /hydrogen by 2030:
600-700 MT/anum

3 times world capacity today



https://ec.europa.eu/eurostat/databrowser/view/NRG_BAL_S__custom_1235096/default/bar?lang=en

PROTON VENTURES

150?

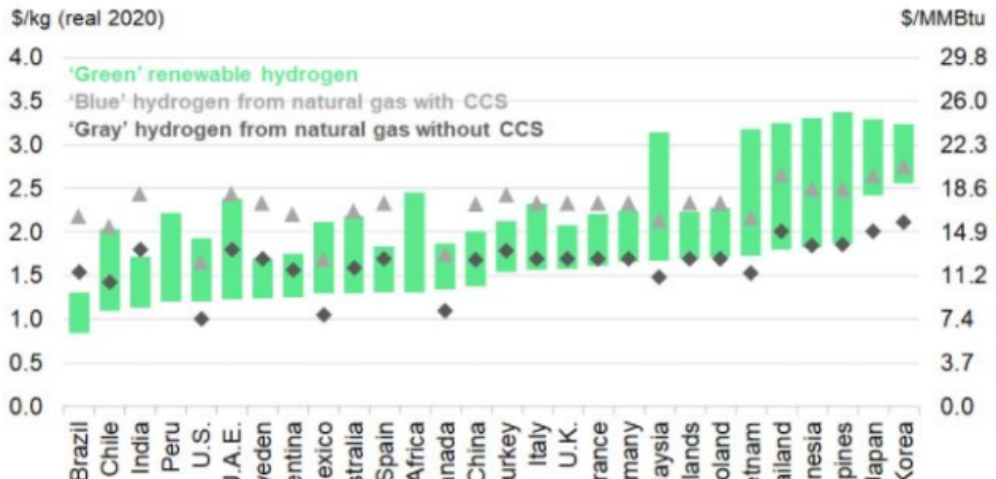
‘Green’ Hydrogen to Outcompete ‘Blue’ Everywhere by 2030

May 5, 2021

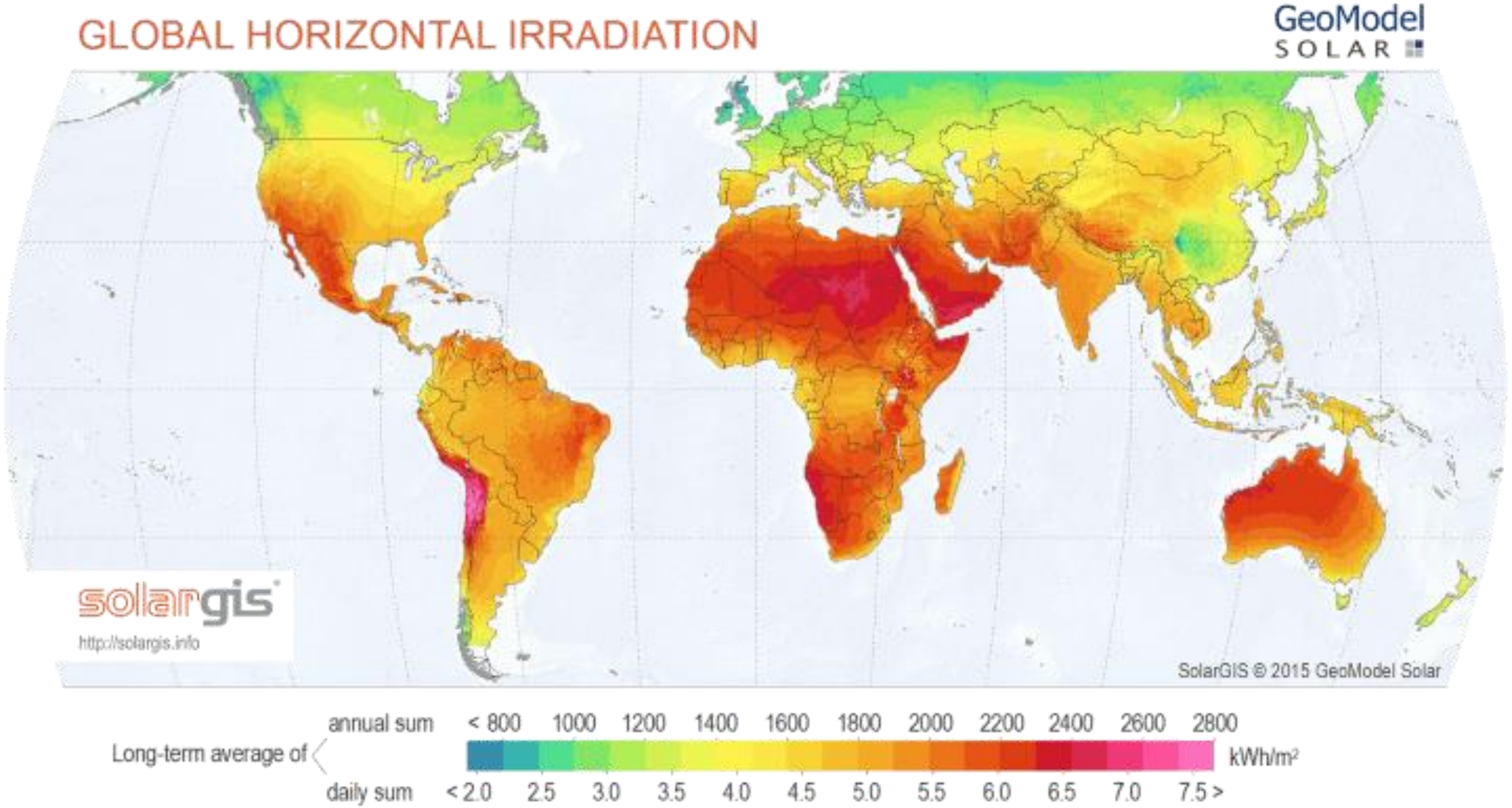
This article first appeared on the BNEF mobile app and the Bloomberg Terminal.

- Fossil hydrogen with CCS currently cheaper than ‘green
- The opposite should be true by 2030 in all major markets

‘Green’ versus ‘blue’ hydrogen costs, 2030



Ammonia, the new oil

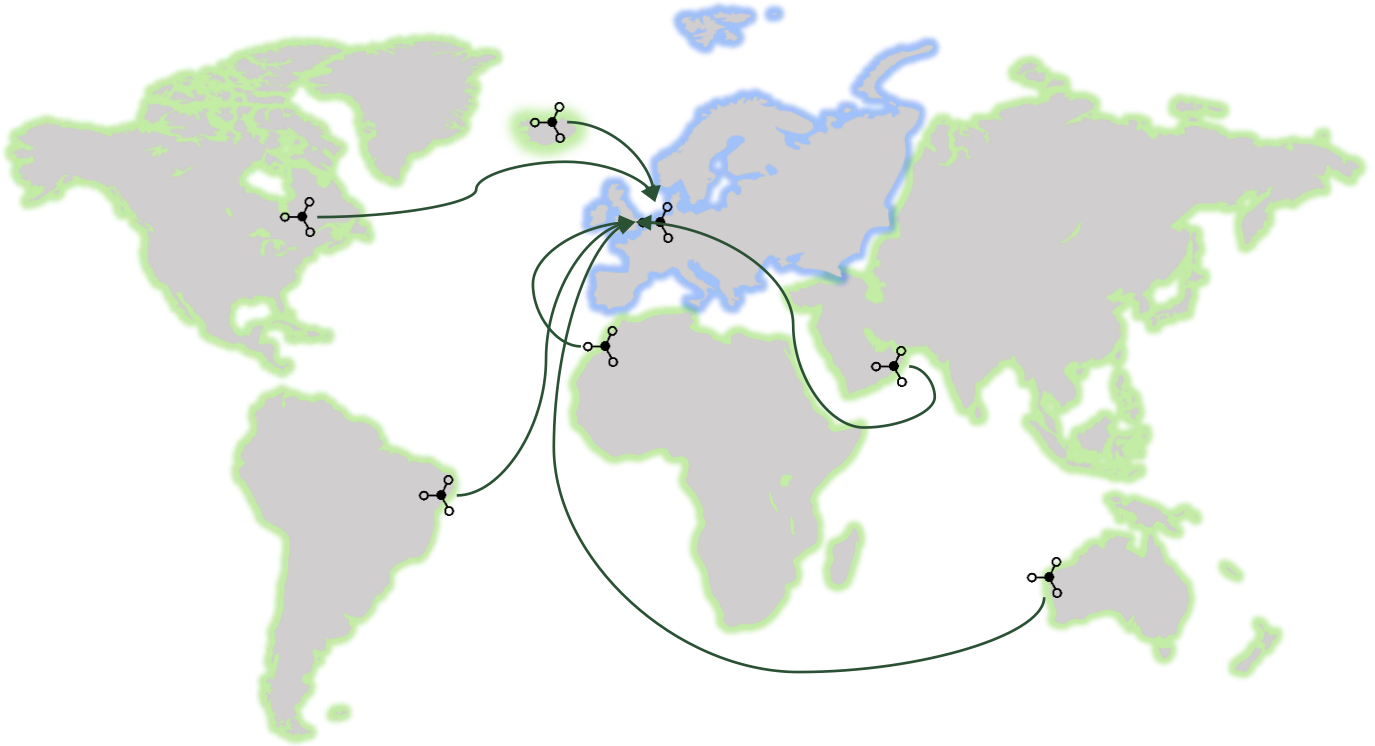


The Objectives / Opportunity

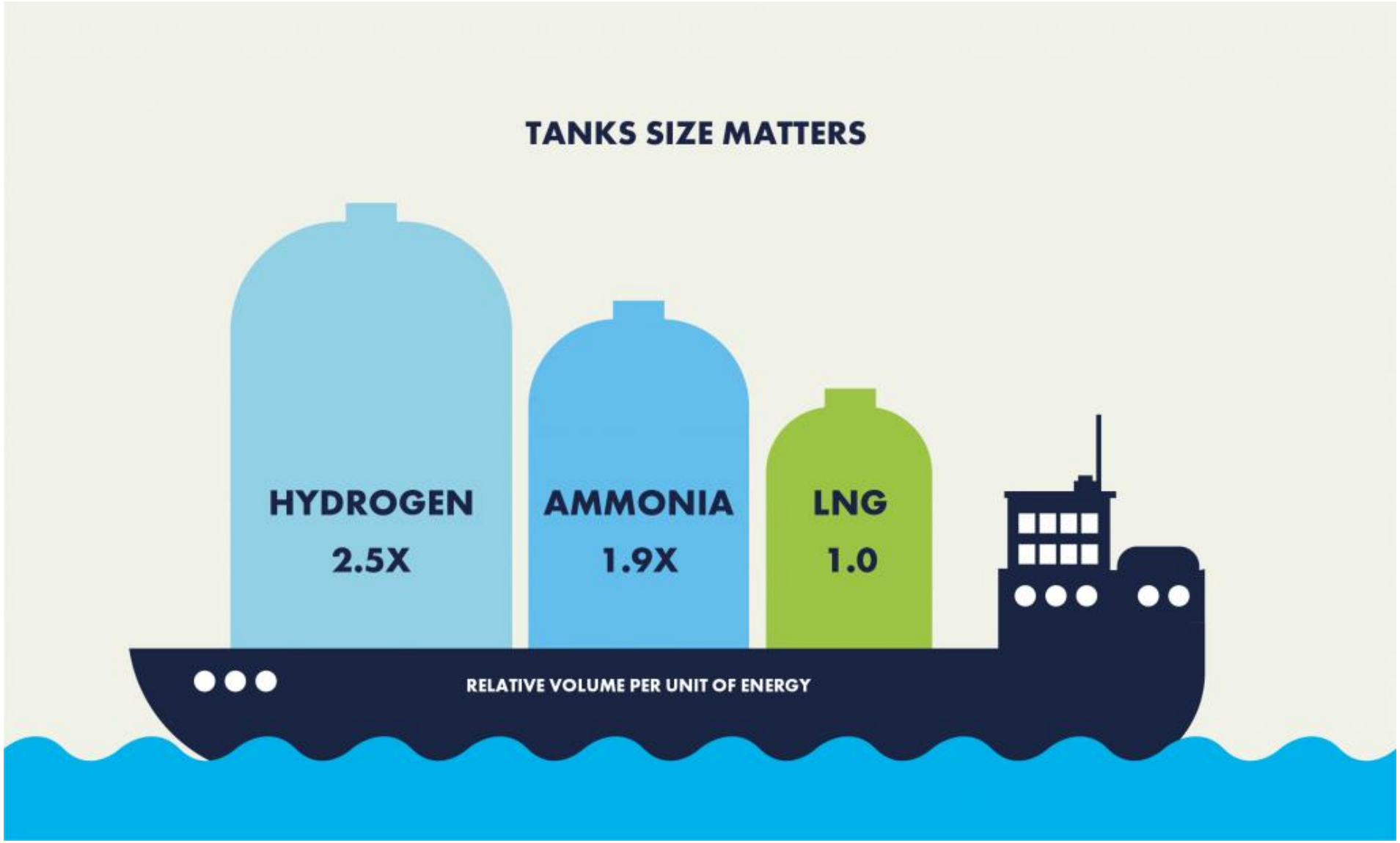
- Through recent political and technological developments there is an opportunity to set up new green energy supply chains between sun- and wind rich countries that bring future supply and demand together.

- The **THA** consortium wants to work together with specially selected partners in specific countries to create a new export industry and all related benefits.

- Thanks to unique technical solutions and the combination of industry experts in each part of supply chain **THA** can start this supply chain within 3 years from today, with large scale up potential.



PROTON VENTURES



Alternative routes to transport Hydrogen (base 2670 ton transport)

NFuel (Ammonia) **2670 ton H2**

- 3 H2 + N2 => 2 NH3 or 1,5 molecule H2 gives 1 molecule NH3 (no loss of H2 in the formation reaction)
- Approx. 178 kg H2 per ton NH3
- Cracking NH3 to H2 takes approx. 20% of initial H2 quantity (why do this and not use directly the NH3 ?)
- **15,000 ton NH3 requires some 22,500 m3 storage volume on ship**

LOHC (Liquid Organic Hydrogen Carrier) **2670 ton H2**

- Thermo-chemical bonding of H2 to organic hydrocarbons (e.g. MCH)
- Approx. 62 kg H2 per ton LOHC
- Thermal energy needed to release H2 from LOHC required, typically 25% energy loss
- Re-use existing infrastructure related to Oil & Petro Chemical Industry
- **45,000 ton LOHC requires some 58,500 m3 storage volume on ship**

LH2 (liquid H2) **2670 ton H2**

- Liquid at -253 °C, requiring some 3.9 (theoretical minimum) up to 16 kWh/kg H2 in energy (12 - 50% of energy value is lost)
- **2,670 ton liquid H2 requires some 38,000 m3 storage volume on ship**
- **Compressed H2 gas at 200 barg would require for the same 2,670 ton of 22,000,000 m3 storage volume on ship**

CH4 – CH3OH (MeOH) **2670 ton H2**

- The formation reaction requires CO2 and generates consumes H2 due to H2O being formed
- 4 H2 + CO2 ⍰ 1 CH4 + 2 H2O (loss is 50% in H2) Equals 200% Capex for solar or wind compared to NFuel/LOHC
- 3 H2 + CO2 ⍰ 1 CH3OH + 1 H2O (loss is 33% in H2) Equals 150% Capex for solar or wind compared to NFuel/LOHC
- But lower transport costs! But also no CO2 available cheap in solar or wind rich areas

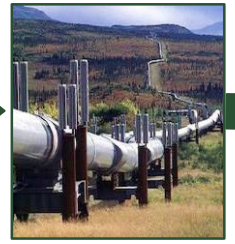
Example: All Supply Chain Roles Covered

Renewable Power	H_2 Production & Conversion	Local gas distribution	Storage & Export	Transport	Storage Design & operation	Local distribution	Decomposition H_2 or NH_3 sales
RE Park developer & operator	GNH_3 plant operator	Gas transport operator	Export Terminal Operator	Fleet Owner / GNH_3 Trader	Import terminal operator	Gas transport operator	Sales & marketing
Local Partner(s)	PROTON VENTURES		GES PROTON VENTURES	Trammo	GES PROTON VENTURES Port of Rotterdam	VARO Port of Rotterdam	Trammo VARO

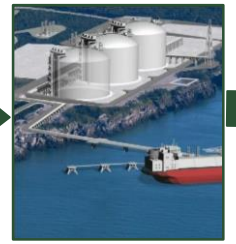
Example: All Supply Chain Roles Covered

Renewable Power

H_2 Production & Conversion



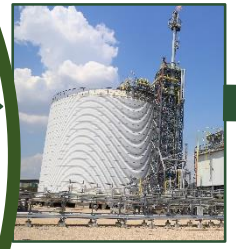
Local gas distribution



Storage & Export

Transport

GREEN



Storage Design & operation

Local distribution

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Future shipping: todays's readyness

With green ammonia in shipping the "Full Value Chain" can be 100% Green

40,000m³ MEDIUM-SIZE GAS CARRIER (Panda 40P)

MAIN PARTICULARS

Length, oa	max	180.00 m
Length, bp		176.80 m
Breadth, mld		30.00 m
Depth, mld		18.60 m
Design Draft (Td)		9.80 m
Scantl. Draft (Ts)		10.90 m

DEADWEIGHT

Deadweight (Td)	abt.	25,400 t
Deadweight (Ts)	abt.	29,500 t

CARGO LIST

Pure propane, Commercial propane (max 5% mole ethane in the liquid phase), Butane (normal and ISO butane), mixture of Propane and Butane in any portion, Propylene, Butylene, Anhydrous Ammonia(NH_3), VCM (partial load)

CLASSIFICATIONS ABS

✠A1, (E), Liquefied Gas Carrier with Independent Tanks, SH,SHCM SEA(
LESS, NOx-Tier III, RRDA, ENVIRO, DFD-LPG
✠AMS, ACCU
With record: Ship type 2G, Maximum Vapour Pressure of 0.25barG at sea and 0.45barG at harbor, Minimum Cargo Temperature of -50°C,
Ammonia Fuel Ready Level 2D (S, TA)

FLAG Marshal Island

COMPLEMENT 25 p

TANK CAPACITIES

Cargo Tank	abt.	40,000 m³
Deck Fuel Tank (case-I)		200 m³
Deck Fuel Tank (case-II:**Option**)		2x500 m³
VLSFO		1,400 m³
MGO		300 m³
Fresh Water		300 m³
Ballast Water		11,000 m³
Urea Solution Tank (40%)		50 m³

MAIN ENGINE

Main Engine	6G50ME-C9.6-LGIP(LPG)
MCR	10,320 kW x 100 rpm
SMCR	7,529 kW x 93 rpm

SERVICE SPEED

Service Speed	abt.	16.0 kn
Sea Margin		15 %

FUEL CONSUMPTION OF PROPULSION

D.FGC:	abt.	21.4 t/d
D.FO	abt.	24 t/d

CRUISING RANGE abt. 18,000 nm

REGULATION

a) NO_X Tier-III	by SCR
b) SO_X EC	by LPG as fuel
c) EEDI 2 EXI	by LPG as fuel

CARGO SYSTEM

Cargo Tank:	3 Prismatic (-50°C, 700 kg/m³, 0.25 barg)
Tank Insulation:	120mm PUF Spray
Cargo Pump:	Elec. Motor Driven-Deepwell
	400 m³/h x 120 mlc x 6 sets
Booster Pump:	400 m³/h x 120 mlc x 2 sets
Cargo Heater/Vaporizer:	Shell and Tube
	400 m³/h (-42°C ~0°C) x 1 set
Reliquefaction Plant	Direct Type x 3 units

WATER BALLAST SYSTEM

Ballast pump	500 m³/h x 2 sets
Water Ballast Treatment Plant	1,000 m³/h x 1 set

STEAM GENERATING PLANT

Composite Boiler	2,000 kg/h (FO Section)
	500* kg/h (EG Section)

* Based on ME LPG mode at NCR, Tier II & ISO condition

POWER SUPPLY

Diesel Generators	900kW x 3 sets
Emergency Generator	250 kW x 1 set
Shaft Generator (**Option**)	1500 kW x 1 set

NAVIGATION EQUIPMENT

Radars (ARPA) x2	DGPS Navigators x2
Gyro compass x2/Auto pilot	ECDIS (2 sets)
Speed log (dual axis)	BNWAS
Echo Sounder	

CSSC 江南造船

Offtake is the issue

Present markets do not exist for green ammonia

However: challenges to cope with are:

- Technology
- Public perception
- Financials
- Legislation Blue Green
- Markets today and in future

So

New opportunities arise, if the supply chain is “optimised” and challenges are beaten.

Proof of the pudding is “doing it”

Thank you

Do not forget:

EXPO 2020 in Februari 2022 in Dubai (UAE) : 9 & 10 Februari 2022

NH3eventeurope : Rotterdam (NL) : 2 & 3 June 2022

Follow our news: @nh3eventeurope.com