RoK-China-Japan

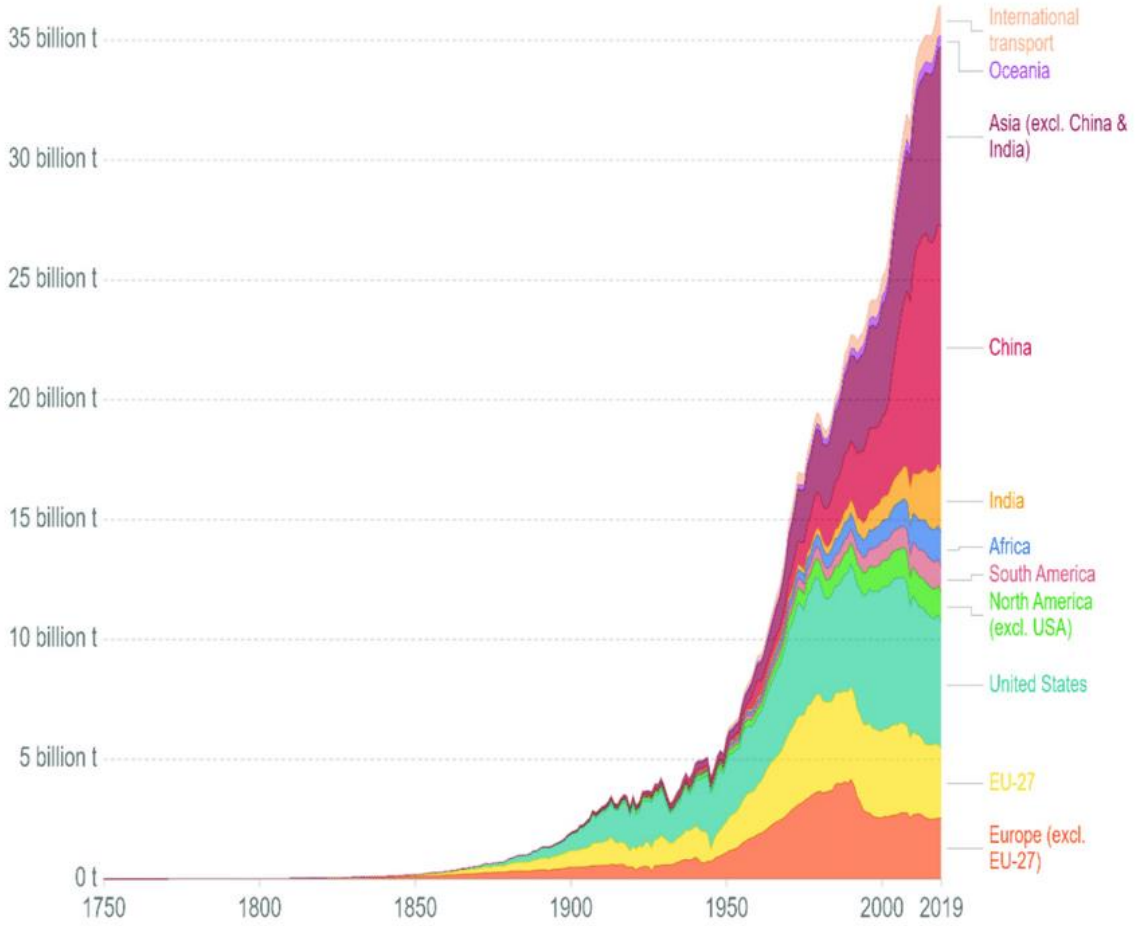
Reduce CO2 by
Ammonia and Nuclear Power

Jan. 17, 2021

East Asia Foundation Conference on CJK Cooperation

Jooho Whang

Self-Portraits



Research Gate

China > US > Europe > .....> Japan > Korea

China

Emissions tripled since 2000
Reduced carbon intensity by 45% compared to 2005
Peak emissions around 2030

Japan

Targeted, in 2010, reducing by 25% by 2020 and 80% by 2050.
Fukushima incident derailed targets

Korea

Announced, in 2009, reducing by 4% below 2005 levels by 2020.
In reality, emissions increased >30% by 2019

Prospects

by Wood Mackenzie, 2020

China capacity details (GW)

	2020	2060 base case	2060 Carbon neutral
Coal	1,098	-710	-810
Gas turbine	106	+210	+150
CCS	0	+9	+90
Alternative fuel (H_2, NH_3)	0	+150	+670
Nuclear	49	+280	+615
Hydro	349	+70	+250
Wind	234	+1,300	+2,030
Solar	195	+1,650	+4,500
Storage	38	+970	+3,080

US$ 6.4 trillion, H2/Ammonia +670GW, Nuclear +615 GW

Japan capacity details (GW)

	2020	2050 base case	2050 Carbon neutral
Coal	45	-20	-40
Gas turbine	85	-20	-70
CCS	0	0	+10
Alternative fuel (H_2, NH_3)	0	0	+130
Nuclear	7	+5	+20
Hydro	23	0	5
Wind	5	+40	+180
Solar	55	+145	+450
Storage	28	+40	+240

US$ 1.4 trillion, H2/Ammonia +130GW, Nuclear +20 GW

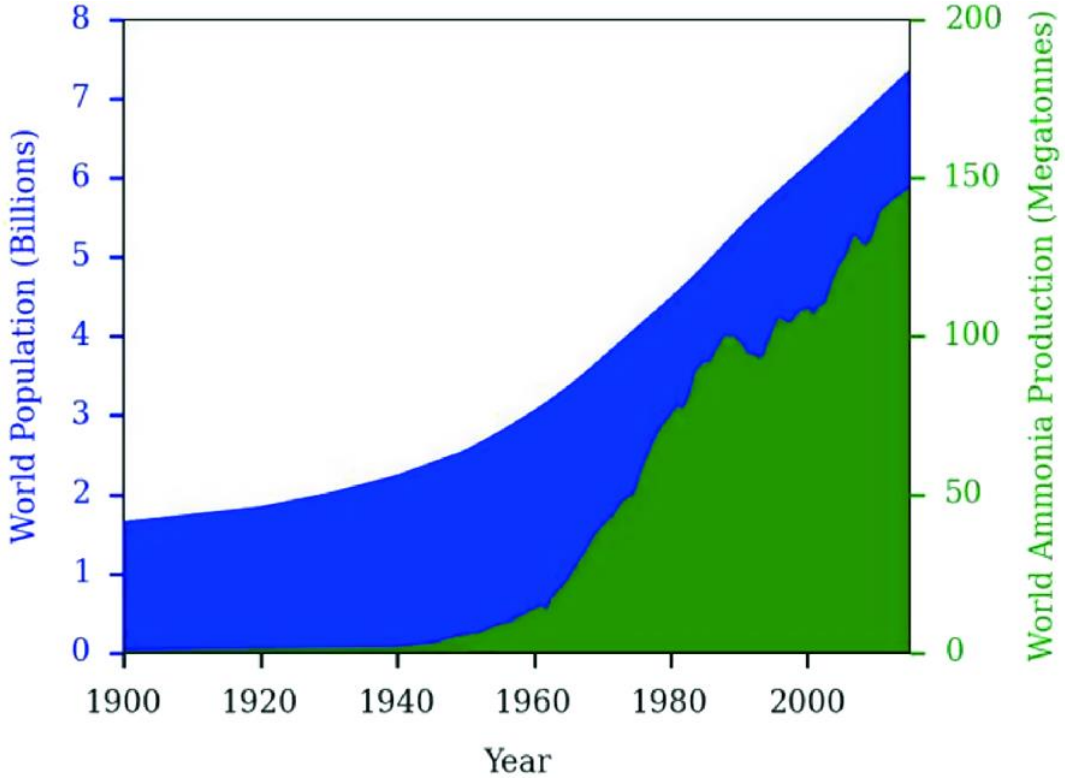
South Korea capacity details (GW)

	2020	2050 base case	2050 Carbon neutral
Coal	35	-15	-15
Gas turbine	41	+1	-5
CCS	0	0	+25
Alternative fuel (H_2, NH_3)	0	0	+135
Nuclear	26	-15	+15
Hydro	2	0	0
Wind	2	+30	+75
Solar	14	+35	+600
Storage	6	+35	+300

US$ 1.4 trillion, H2/Ammonia +135GW, Nuclear +15 GW

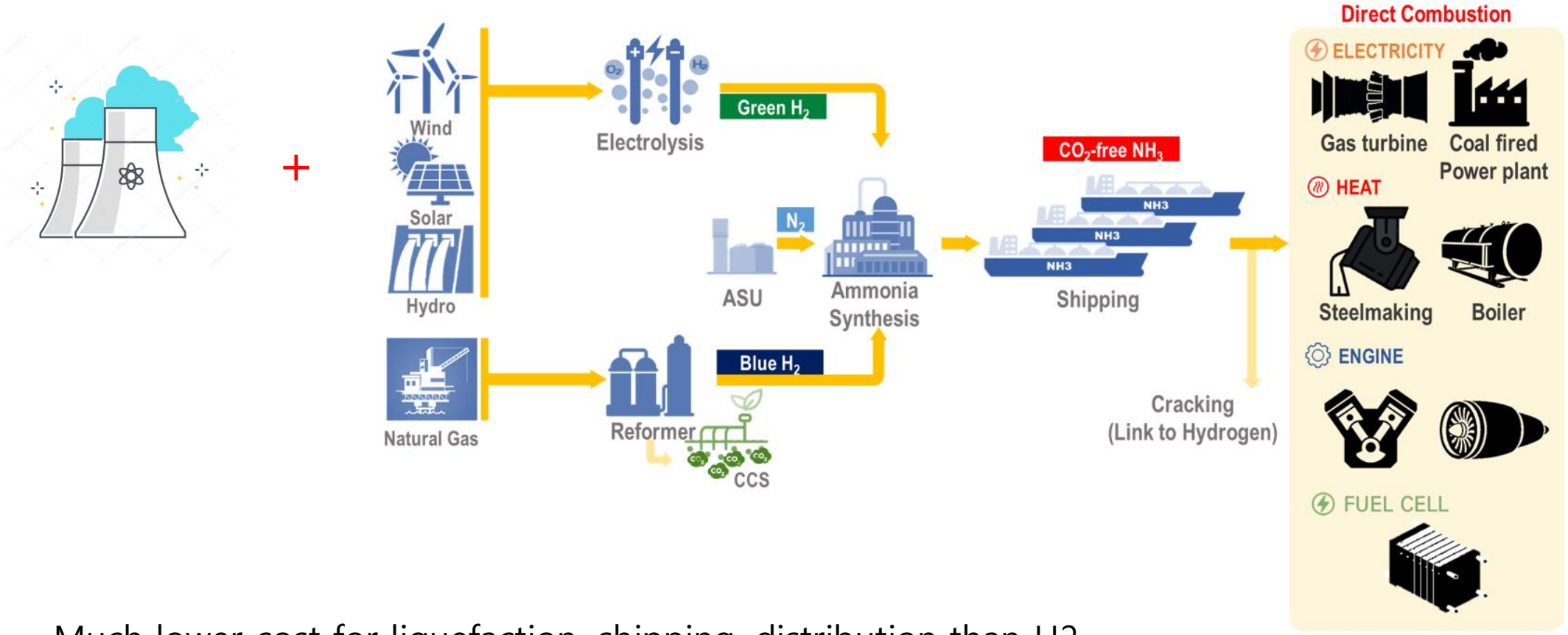
Ammonia

Fertilizer broke the Principle of Population



Springer Link

Ammonia Value Chain



Much lower cost for liquefaction, shipping, distribution than H2

Ammonia

Ammonia Bus Fleet in Belgium, 1943

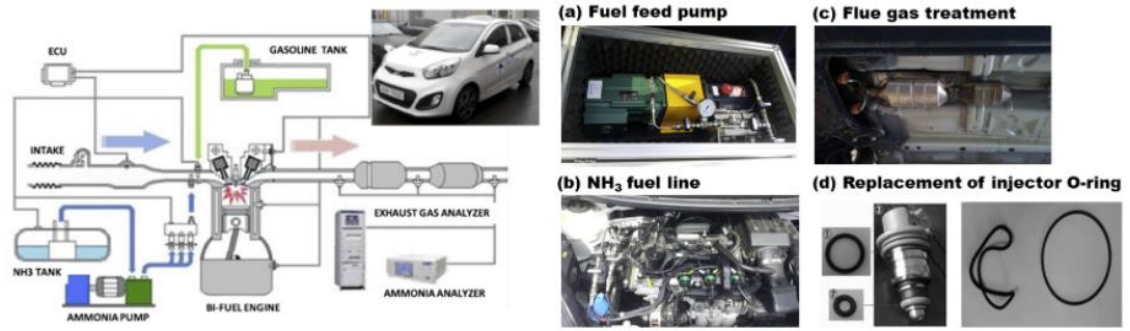


Fig. 14. Ammonia based engine for transportation in Korea. Modified from [22].

40MW NH3 Turbine, MHI

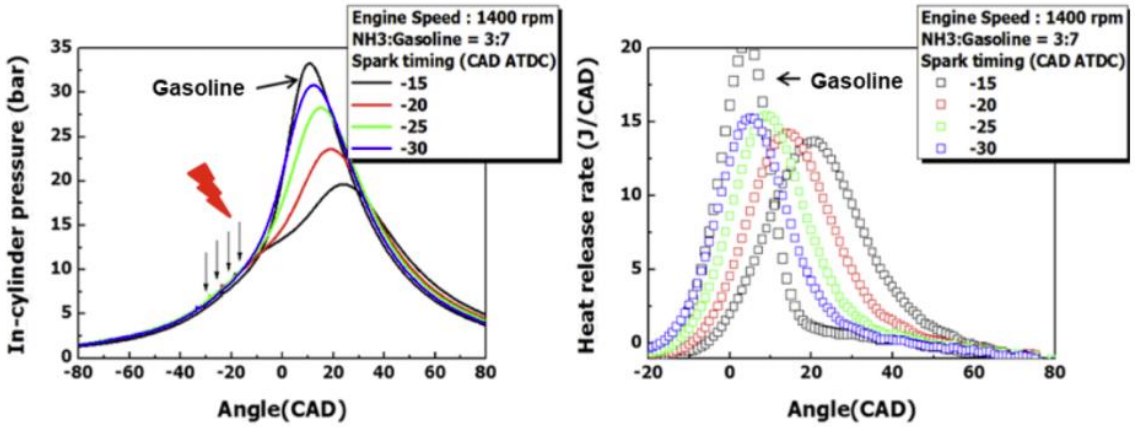


Fig. 15. Combustion characteristics diagram of ammonia-gasoline mixture. (a) combustion pressure, (b) heat release rate.

NH3 powered Car, Auto Hire International

Offshore Energy

Journal of The Korean Society Combustion. March 2021. 84-106
https://doi.org/10.15231/jksc.2021.26.1.084

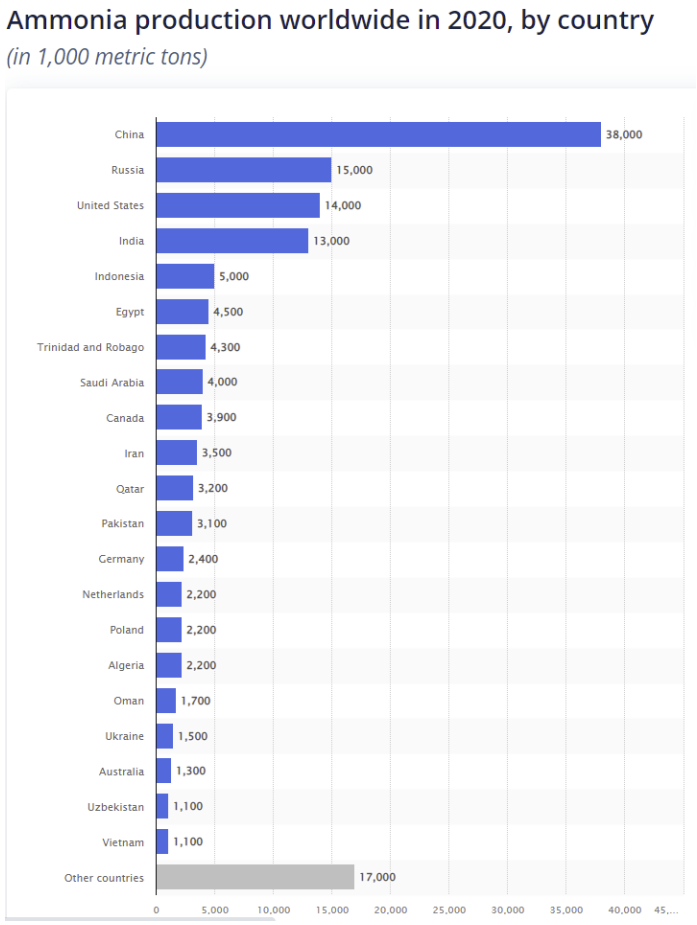
China

Photochemical smog: CO_2 is not the only issue in China.

Zaolin Wang, Xiamen University, 2015

China

Producer of 1/3 World Ammonia



Statistica

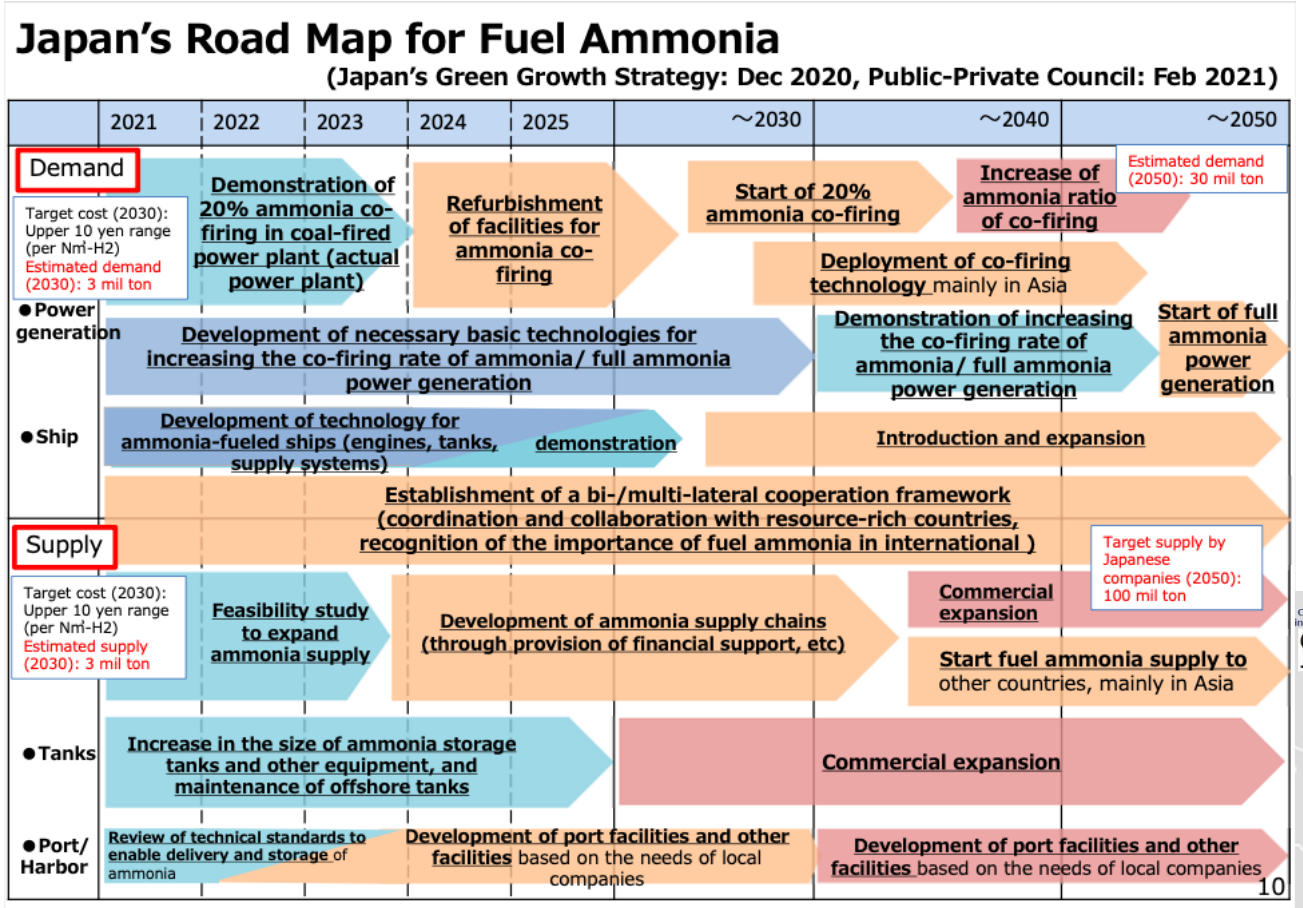
"Dirty" coal-fed ammonia-urea plants in China are being closed faster than they are being replaced.

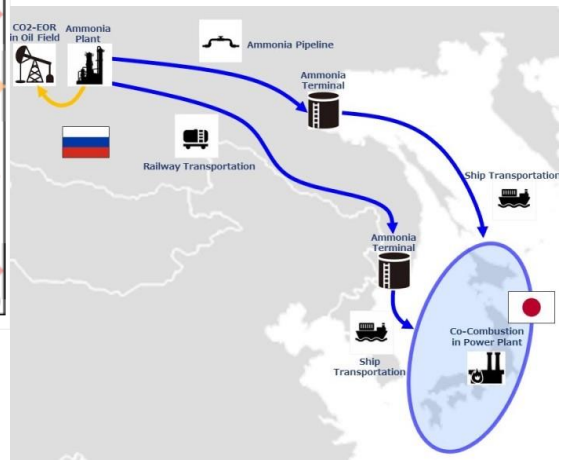
Tomorrow's technology: electrochemical ammonia synthesis

At the same time, Chinese academics are publishing more research papers on next-generation ammonia synthesis technologies than academics from any other country, possibly even including the United States.

Ammonia Energy Association

Japan

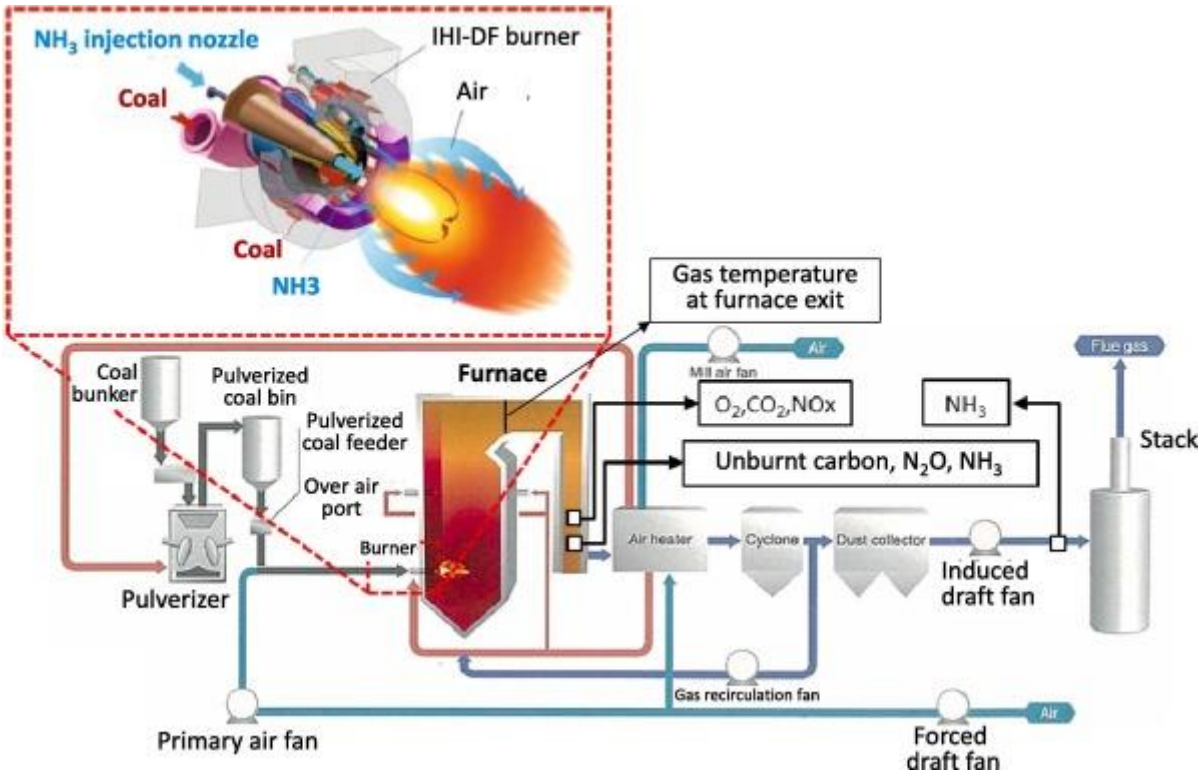




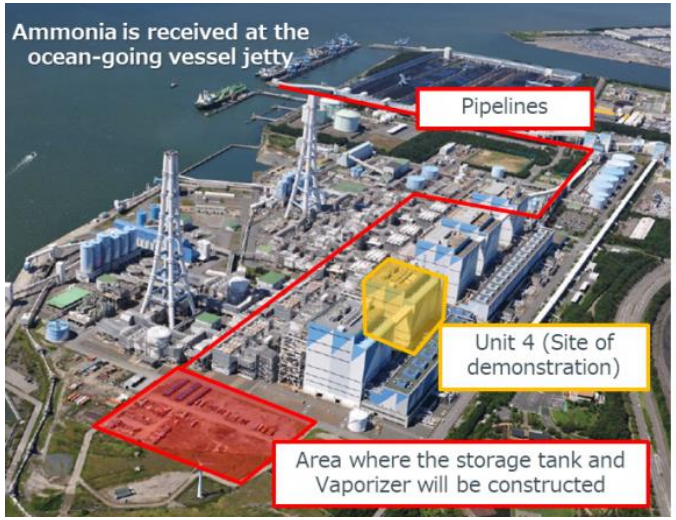
Demand: 3 mil ton by 2030, 30 mil ton by 2050
Supply by Japanese companies: 100 mil ton

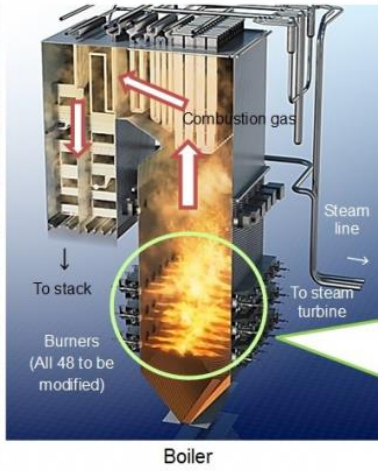
Japan

Ammonia Demonstration



Science Direct





Ammonia co-firing started in June, 2021,
Gas to Power Journal

Korea

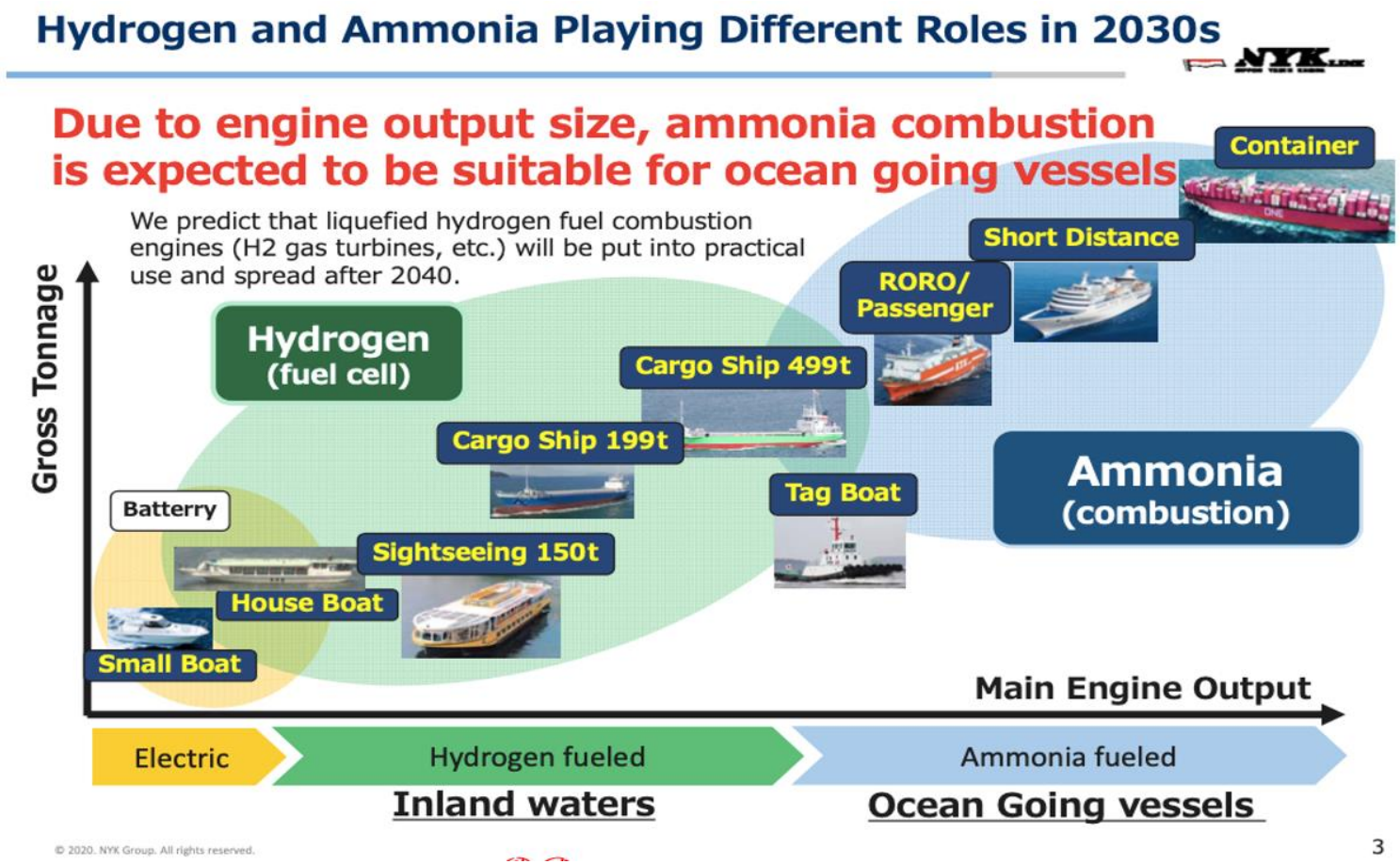
- Hydrogen Demand and Supply
  - Fuel Cell Car, 6.2 million, 1,200 station y 2040
  - Power Generation 14 GW, Building 2.1 GW
  - H2 Production 5.26 mil ton/yr at 3,000 won/kg
- NDC 2030: Ammonia Power Generation 22.1TWh
- Carbon Neutral Scenario by 2050: 13.8~21.5% Power Generation by H2+NH3
- Ammonia co-firing (20%) by 2030, H2 co-firing(30%) by 2035

Korea

GS Energy to import ADNOC's blue hydrogen to South Korea

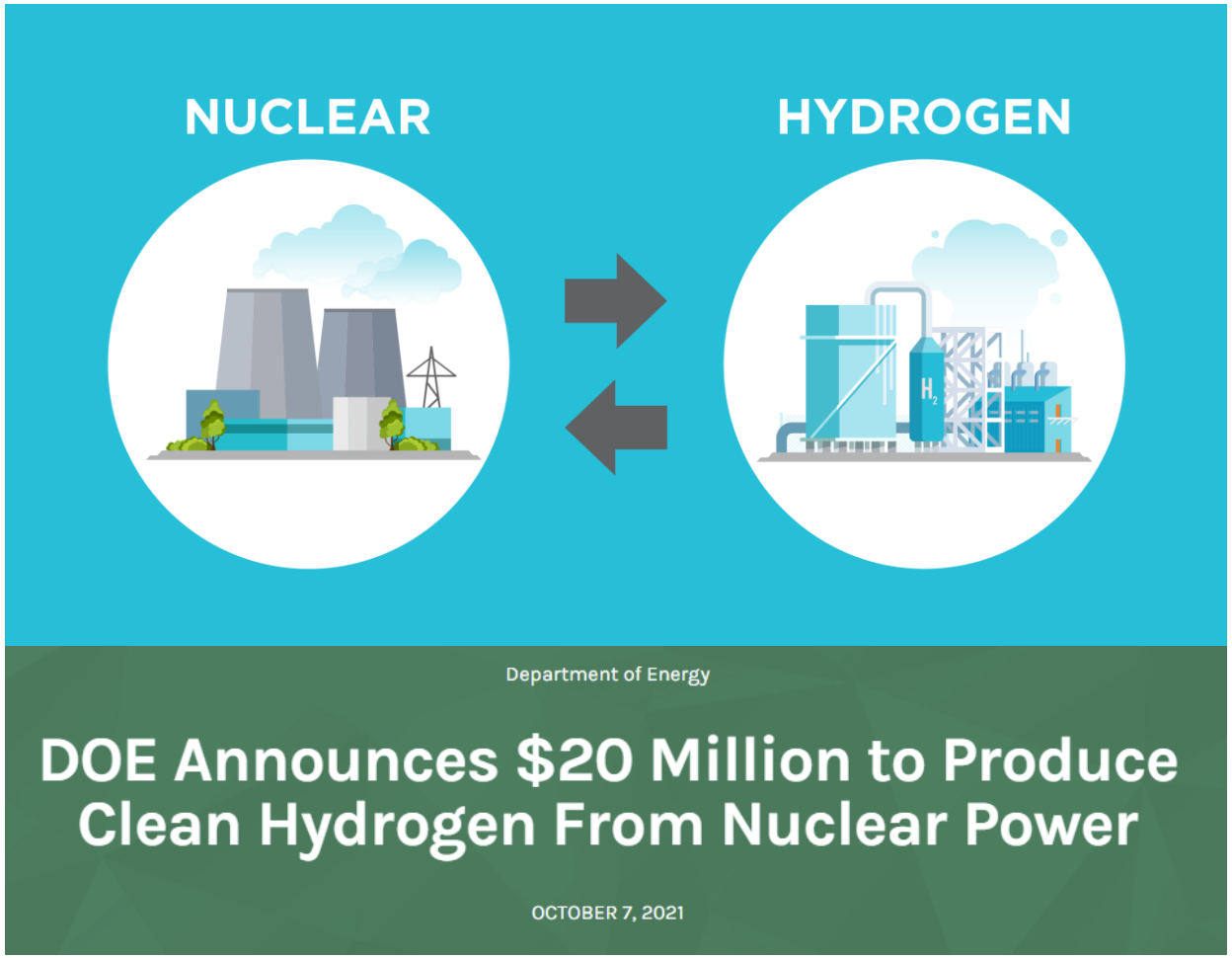
Mitsui and GS Energy to Join TA'ZIZ in World-Scale Low-Carbon Blue Ammonia Project

Korea



3 Korean Ship Builders to Commercialize NH3 and H2 Ships by 2025

Korea



Cooperation for Hydrogen Production by Electrolysis and Electrochemical Production of Ammonia

Let’s think about it

Ammonia production spends ~2% of world energy consumption now.
It emits as much CO2 as Korea does and will consume more energy in the future.

Ammonia finds many applications in reducing CO2.

China, Japan and Korea need to develop economic ways to produce Carbon-free Ammonia.

1 GW Nuclear Power, operating 24 hours 7days a week, may produce 250,000~350,000 tonH2/yr.