DR. NIKOLAOS LIAPIS

ActaNonVerba/managing partner

HIMT/ President

HSSA/ Member of the BoD

ΕΛ.Ι.Ν.Τ.
ΕΛΛΗΝΙΚΟ ΙΝΣΤΙΤΟΥΤΟ ΝΑΥΤΙΚΗΣ ΤΕΧΝΟΛΟΓΙΑΣ
HELLENIC INSTITUTE OF MARINE TECHNOLOGY

New energy products for shipping: Is supply feasible and secured?

Global shipping emissions

- The shipping industry is responsible for the movement of 90% of all global trade
- Supported by two million seafarers, the industry is the backbone of logistic supply chains, but it's facing urgent environmental and social pressures
- Currently accounting for more than 2% of global greenhouse gas (GHG) emissions and emitting around 15% of some of the world's major air pollutants annually
- 330 mil mt of fuel (around 3,800 TWh of energy, 13% of total electricity) are consumed as marine fuels annually U.S. Department of Transportation Maritime Administration

0.9 Gt emissions per annum, ~2% global emissions

Shipping decarbonization investment analysis

~$2.4T estimated investment needed globally over 2020-2050

Sectors involved by lever: Marine Freight Transport, Energy, Chemicals

Needs heavy subsidy — **Commercially viable**

$0.6T — Improve ship efficiency

- Investment to implement technologies related to drag reduction, exhaust treatment and power systems in global fleet
- Several technologies require R&D with commercial readiness in short-medium term (R&D capex not considered in investment estimate)

- Some technologies available today, while others need further development in medium-term

$0.1T — Improve operational efficiency

- Digital solutions to optimize routing, speed, engine, energy systems, hull performance
- Will require measurement and enforcement of decarbonization outcomes to ensure alignment with decarbonization pathways
- Technologies under development by large marine players

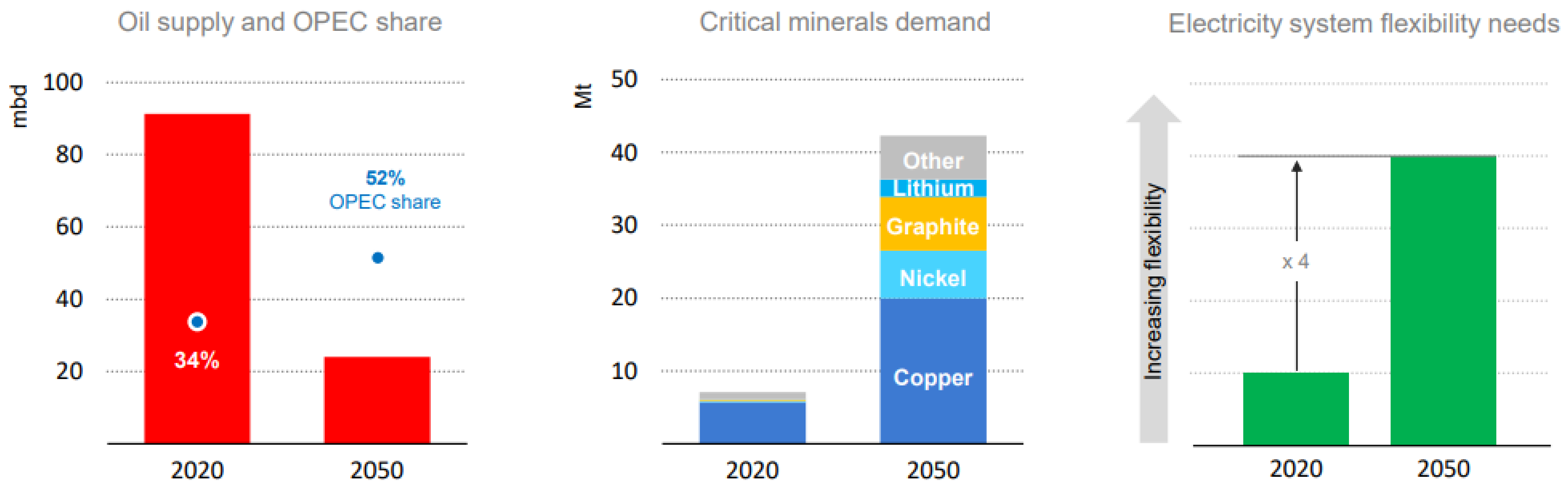
- Relatively new concepts, being tested in market

$1.7T — Use fuel alternatives

- Financing for vessels with new fuel sources (e.g., engines and on-board storage)
- Investment in land-based infrastructure (e.g., H_2, fuel production and storage facilities) needed for e-ammonia, H_2 or e-methanol as alternative zero carbon fuel
- Estimated capex split: H_2 production $0.7T (assumed for O&G sector), Ammonia synthesis/ storage/ distribution $0.7T (Chemicals), on-board engines & storage ~$0.2T (Marine Freight)

- E-ammonia, H_2 or e-methanol: not viable, needs heavy incentives and policies to support

Addressing emerging energy security risks now



Source: IEA

Clean energy supply chains risks

- The supply chain for many clean energy technologies and their raw materials is more geographically concentrated than it is for oil or natural gas
- Clean energy technologies often have higher material requirements than traditional energy technologies and generally they have more complex supply chains
- Their manufacturing is often very technically complex and highly specialized, which also lends itself to concentration
- In addition, as the technologies have developed, incumbent producers have benefited from economies of scale, which has increased concentration
- Supply chain diversity is vital to the security of supply for clean energy transitions

Many of the technologies needed to reach net zero are not yet commercially available

- Achieving net zero by 2050 requires a major acceleration in clean energy innovation, as many of the technologies needed are not yet on the market
- Almost half of the emissions reductions in 2050 in the Net Zero Emissions by 2050 Scenario stem from technologies that are only at demonstration and prototype stages today
- Commercializing those technologies hinges on faster innovation
- The level of technology readiness has significant implications across supply chains

IEA's Net Zero Roadmap

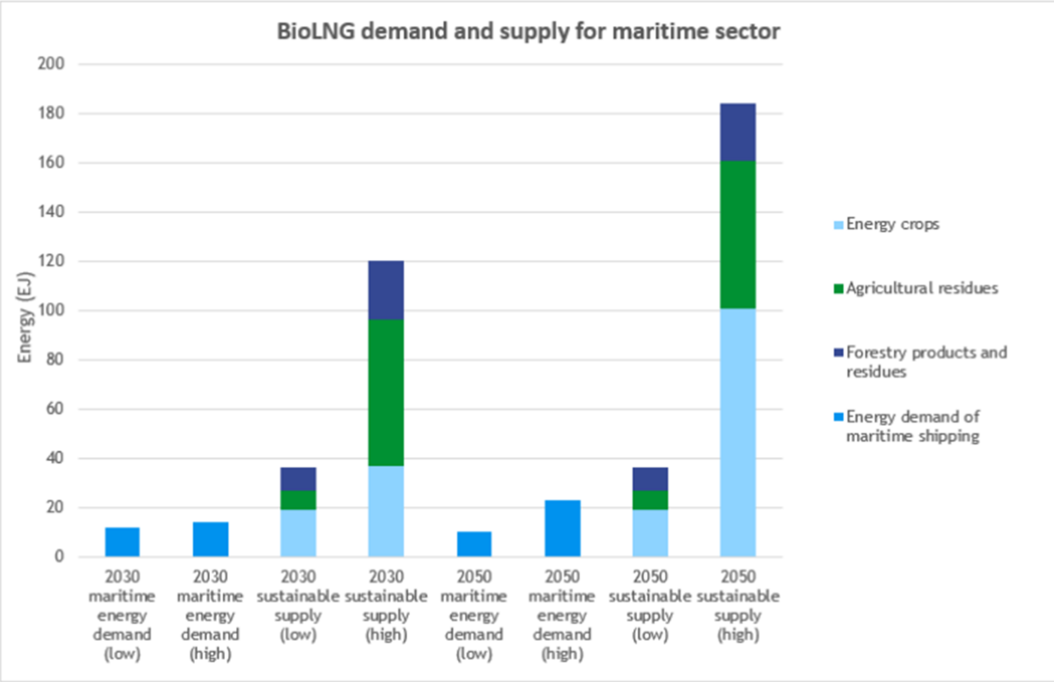
- The latest edition of the IEA's Net Zero Roadmap forecasts a key role for ammonia fuel in decarbonising the global shipping sector.
- With international shipping activity to more than double by 2050, ammonia's share of final energy consumption will rise from 0% last year to 44% in 2050, with a suite of other low-carbon fuels to play a role (biofuels and hydrogen 19% each, methanol 3%).
- 15% of shipping activity will still be fossil-powered, but the sector will have drastically reduced its carbon emissions by this time, with further reductions to occur.

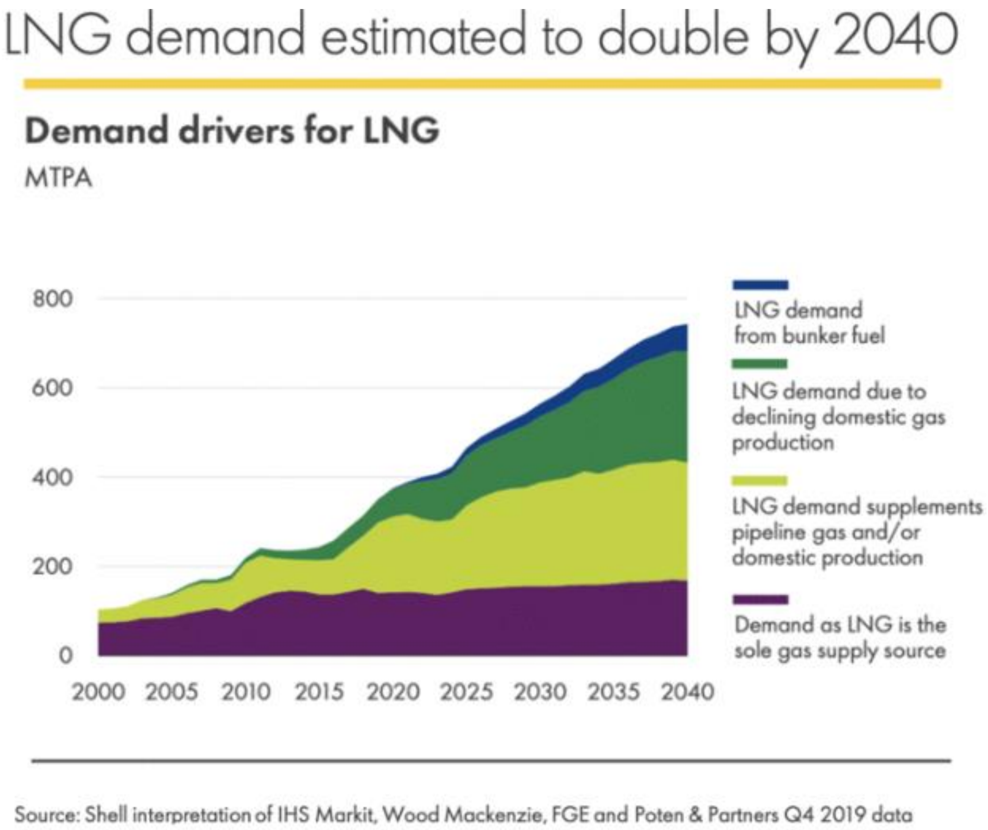
Bio LNG

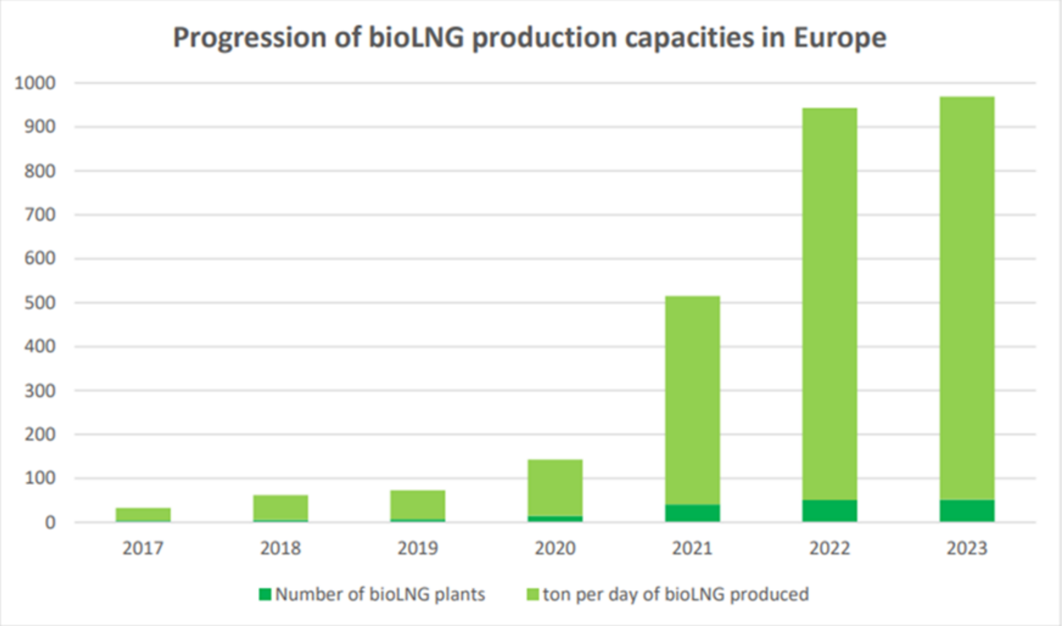
- The investment case for bioLNG is identical to fossil LNG in terms of CAPEX
- In terms of price, bioLNG blend is currently commercially viable in NW Europe, with a 10% blend of bioLNG with LNG compared with 0.10% marine gasoil (MGO), in Rotterdam
- Analysis in the recent study from CE Delft concludes that bioLNG is likely to be commercially competitive relative to other low- and zero-carbon fuels such as green hydrogen and ammonia
- It has the clear commercial advantage over these fuels that existing LNG infrastructure can be used to transport and bunker bioLNG
- ***But***… Methane is still a high-risk GHG molecule

Source: A joint White Paper about bioLNG

BioLNG availability







Methanol bunkering infrastructure

- From an infrastructure standpoint, methanol is advantageous for shipping
- Methanol is liquid at ambient temperature and pressure and thus enables the continued use of conventional fuel storage and bunkering with just a few modifications
- This makes a transition to methanol relatively easier and more affordable
- 88 out of the top 100 international ports already have the bunkering infrastructure in place to support methanol fuel

Green methanol production

- Global methanol production currently amounts to about 80 million metric tonnes per year
- “Grey” methanol, produced using natural gas as a feedstock, has emissions similar to other fossil fuels such as liquified natural gas (LNG) and marine diesel oil (MDO)
- “Green” methanol (or bio-methanol) may be produced via biological pathways (anaerobic digestion), thermo-chemical pathways (gasification) or electrofuel pathways (power to gas)
- Large scale production of green methanol from biogas could be economically competitive with grey methanol from natural gas when the system is optimized utilizing circular economy systems (wastes to anaerobic digestion, curtailed electricity used for hydrogen and valorization of O_2) and significant carbon taxes are imposed on fossil fuels

Green Ammonia Availability

- One way of making green ammonia is by using hydrogen from water electrolysis and nitrogen separated from the air
- These are then fed into the Haber process (also known as Haber-Bosch), all powered by sustainable electricity.
- In the Haber process, hydrogen and nitrogen are reacted together at high temperatures and pressures to produce ammonia
- IEA's Net Zero Roadmap forecasts that ammonia's share of final energy consumption will rise to 44% in 2050
- To meet this demand, more than 2,000 TWh of renewable energy is needed
- *Global electricity generation in 2022: 29,000 TWh*

Green hydrogen availability

- Hydrogen will be available in ports
- As its energy density per unit of volume, even when liquefied, is significantly lower than that of distillates, storing the same amount of energy onboard requires tanks to be seven times larger
- Demands enormous high investment in storage and bunkering infrastructure production
- Production of green hydrogen demands huge quantities of green electricity

CONCLUSIONS

- Alternative marine fuels will be available or in the near future
- There is not a single solution
- Bunkering infrastructure is feasible towards 2040
- Big investments are needed
- Key Factor: the production of huge quantities of green electricity

Thank You!

ΕΛ.Ι.Ν.Τ.
ΕΛΛΗΝΙΚΟ ΙΝΣΤΙΤΟΥΤΟ ΝΑΥΤΙΚΗΣ ΤΕΧΝΟΛΟΓΙΑΣ
HELLENIC INSTITUTE OF MARINE TECHNOLOGY

DR. NIKOLAOS LIAPIS

ActaNonVerba/managing partner

HIMT/ President

HSSA/ Member of the BoD

nl@actanonverba.gr

+30 6944 884674